Sprained Ligaments of the Knee

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Agenda

- Introduction
- Diagnostic Procedures
- MRI Images
- Our Patient
- Summary
Introduction

The knee is the most commonly injured joint

• Most common orthopedic problem in the ED with 1.3m ED cases per year

• Over 50,000 knee injuries require operations in the U.S. each year

• Knees are the most common joints examined by MRI

• Injuries continue to increase due to sports activities
Ligament Anatomy

# Anterior Cruciate Ligament vs. Posterior Cruciate Ligament

<table>
<thead>
<tr>
<th>Ligament</th>
<th>Size</th>
<th>Location</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL</td>
<td>Smaller</td>
<td>Anterior tibia to lateral condyle</td>
<td>Prevent hyperextension and posterior displacement of femur</td>
</tr>
<tr>
<td>PCL</td>
<td>Larger</td>
<td>Posterior tibia to medial condyle</td>
<td>Prevent hyperflexion and anterior displacement of femur</td>
</tr>
</tbody>
</table>
## Ligament Injuries

<table>
<thead>
<tr>
<th>Ligament</th>
<th>Force</th>
<th>Cause</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior Cruciate</td>
<td>Lateral w/ Knee Extended</td>
<td>Sports</td>
<td>60%</td>
</tr>
<tr>
<td>Posterior Cruciate</td>
<td>Frontal w/ Knee Flexed</td>
<td>MVA</td>
<td>3-10%</td>
</tr>
<tr>
<td>Lateral Collateral</td>
<td>Medial</td>
<td>Rare</td>
<td>Common</td>
</tr>
<tr>
<td>Medial Collateral</td>
<td>Lateral</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Meniscus Anatomy

• 52% of injuries occur with ACL tears

• Failure to repair damage may speed up articular degeneration
O’Donoghue Triad

1959 Description

• Anterior Cruciate Ligament
• Medial Collateral Ligament
• Medial Meniscus

Arthroscopy & MRI

• Anterior Cruciate Ligament
• Medial Collateral Ligament
• Lateral Meniscus


Treatment

- RICE: Rest, Ice, Compression, Elevation
- Surgery

<table>
<thead>
<tr>
<th>Severity</th>
<th>Treatment</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>RICE</td>
<td>5 – 14 days</td>
</tr>
<tr>
<td>Grade II</td>
<td>RICE</td>
<td>14 – 30 days</td>
</tr>
<tr>
<td>Grade III</td>
<td>RICE / Surgery</td>
<td>Months</td>
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</table>
Diagnostic Algorithm

History / Physical Exam

Suspect Arterial Damage

Arteriogram

Fracture No Fracture

Plain Films

CT

MRI / Arthroscopy

Ultrasound

Pain

RICE

Diagnosis / Treatment

No Diagnosis

Grade III

Grade I or II

Diagnosis

Treatment
History and Physical Exam

**Advantages**

- Cheap
- Non-invasive
- Can identify most knee joint lesions
- 90% sensitive in detecting ACL injuries

**Disadvantages**

- 58% accuracy compared with arthroscopy
- Very difficult to diagnose: chondral fractures, loose bodies, and fibrotic fat pads
- 38-95% accurate in diagnosing ACL injuries

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Plain Films

**Advantages**
- Cheap
- Non-invasive
- Rules out fractures and foreign bodies

**Disadvantages**
- Overly used: 85% of knee injuries seen in ED get radiographs, but only 6-12% yield fractures
- Cannot image meniscus or ligament

Plain Film – ACL Avulsion

Bony ligament avulsion apparent at tibial intercondylic eminence

CT Athrogram

**Advantages**
- Excellent for fractures
- Good for ligament and meniscal tears
- Used if MRI contraindication

**Disadvantages**
- Not as good as MRI
- May be painful

Arthroscopy

- **Therapeutically**, the most commonly performed orthopedic surgical procedure
- **Diagnostically**, the gold standard for intra-articular pathology of the knee, but has been replaced by MRI

**Advantages**
- 84-97% accuracy in diagnosing knee pathology
- Excellent for treatment
- Simultaneous therapy through ligament debridement or reconstruction

**Disadvantages**
- Invasive
- Cannot see posterior meniscal tear
- Difficult to see PCL

MRI

**Advantages**

- No radiation
- Non-invasive
- Highly sensitive and specific for diagnosing ligament and meniscal lesions
- Aid for pre-operative planning
- Can preclude unnecessary arthroscopy

**Disadvantages**

- Expensive, $600-$1,200

MRI Knee Coil

- Knee coils eliminate image distortions
- Patient is supine, hip fully extended, and knee slightly flexed
- Complete exam takes 20 minutes

Normal ACL and PCL

ACL

• Visualized as linear low signal ligament strand (blue arrows)
• Less homogeneous than PCL
• Parallels roof of intercondylar notch (yellow arrows)

PCL

• Uniformly low in signal intensity
• Curves superiorly and anteriorly from the tibia to femur

Complete ACL Tear

- Poorly defined, mixed signal intensity at location where ACL should be. This is due to blood and edema.
- High intensity (F) is joint effusion.
Acute PCL Tear

- High signal intensity wavy fibrids where PCL should be located. This represents hemorrhage and edema
Normal Menisci

Proton density-weighted sagittal images of two C-shaped menisci with the curves extending peripherally

Lateral meniscus peripherally

Lateral meniscus slightly more centrally through the two horns shows two triangles

Lateral meniscus centrally through the two horns shows two triangles

Medial meniscus centrally through horns demonstrates two triangles

Meniscal Tear

High signal intensity in posterior horn of medial meniscus extending to the surface indicates clinically significant tear.

Our Patient

HPI: • 46 year-old white male with a basketball injury of left knee

PE: • Suggests meniscus tear

Plain Films: • Negative for fractures and bony avulsions

An MRI is indicated
Diagnostic Algorithm

History / Physical Exam

Suspect Arterial Damage

Arteriogram

No Diagnosis

Plain Films

No Fracture

Fracture

CT

CT

MRI

Ultrasound

RICE

Grade III

Grade I or II

Diagnosis

Diagnosis / Treatment

No Fracture

No Fracture

Treatment

Pain

Pain

24
Our Patient: Normal Menisci

Menisci are normal in signal intensity and morphology in both lateral and medial compartment. Cartilage is preserved.
Our Patient: Bone Contusions

In the lateral compartment, bony contusions involving lateral femoral condyle and proximal tibia
Our Patient: ACL Tear

*Increased signal intensity, wavy fibrils* where ACL should be. All of these signs suggest complete ACL tear.
Our Patient: Normal PCL

PCL is intact and normal in signal intensity.
Our Patient:
Medial Collateral Ligament:
Grade II Sprain

There is increased signal intensity surrounding the medial collateral ligament. MCL is partially torn.
Summary of MRI Findings on our patient

Ruled Out: • Mensical tear

Ruled In: • Complete ACL tear
         • Bone contusions
         • Medial collateral ligament, grade II sprain
# Diagnostic Procedure Comparison

<table>
<thead>
<tr>
<th></th>
<th>HPI / PE</th>
<th>Plain Film</th>
<th>CT</th>
<th>US</th>
<th>ART</th>
<th>MRI</th>
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<tbody>
<tr>
<td><strong>Accuracy:</strong></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>Risks:</strong></td>
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<td>✓</td>
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<tr>
<td><strong>Costs:</strong></td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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</tbody>
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31
Summary

• Knee injuries, especially ligament tears, are very common
• History and physical examination are valuable, but sometimes insufficient to diagnose ligament tears
• MRI is the superior diagnostic tool for ligament injuries of the knees
References

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