The Segond Fracture:
A Plain Film Clue to an MR Diagnosis

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Overview

- Patient Presentation: 46 yo female who presents with knee pain.
- Approach to Imaging Orthopedic Trauma: Menu of Tests & Efficacious Use
- The Knee: Normal Anatomy
- The Segond Fracture: Diagnosis and Implications
- Ligamentous Injury of the Knee: The Role of MRI
Our Patient: ED Presentation

- Patient was walking down her stairs at home when she felt her knee “give in”
- Although she did not fall, she states her knee felt instantly “loose”
- Since that time her knee has not been the same, she has had difficulty walking due to significant pain and discomfort in the joint
- PMHx: +HIV ’92, +RPR ’91, HTN, Hepatitis C, Asthma, Anemia, Lipodystrophy, Thrush, Central Obesity, Hyperglycemia, Hip Pain, Low Back Pain, Smoking Hx, Substance Abuse Hx (IVDU, EtOH, Cocaine)
Our Patient: Orthopedic Physical Exam

- Moderate joint swelling
- No endpoint with anterior drawer
- Solid endpoint with posterior drawer
- Positive pivot shift
- Medial & lateral joint line tenderness
- Knee extension to 0 degrees
- Knee flexion to 90 degrees
- Stable to varus & valgus stress
- Considerable pain with ambulation
Knee Instability: Anterior & Posterior Drawer Tests

- Anterior:
  - Sensitivity: 41% Specificity: 95% (Amer Journal of Sports Med)

- Posterior:
  - Sensitivity: 90% Specificity: 99% (Courtesy Iowa Orthopaedic Journal)
Knee Instability: Pivot Shift

- Sensitivity: 82%  Specificity: 98% (American Journal of Sports Med)

Courtesy Wheeless’ Textbook of Orthopaedics
Orthopedic Trauma Imaging

**Variant 2:**
Patient any age (excluding infants); fall or twisting injury, with one or more of the following: focal tenderness, effusion, inability to bear weight. First study.

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
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<tbody>
<tr>
<td>X-ray knee</td>
<td>9</td>
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<tr>
<td>MRI knee without contrast</td>
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<td>US knee</td>
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**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate.

*Relative Radiation Level*
The Knee: Normal Anatomy

 Courtesy Eric Sorenson
Companion Patient #1: Normal Knee Radiography Frontal

Femur
Patella
Lateral femoral condyle
Medial femoral condyle
Lateral tibial plateau
Tibial spines
Medial tibial plateau
Fibula
Tibia

Courtesy RadiologyMasterclass
Companion Patient #1: Normal Knee Radiography Lateral
Companion Patient #1: Normal Knee Radiography
Patellofemoral Joint
Our Patient: Frontal Knee Film

Pause to evaluate, continue to view findings

Courtesy Jim Wu, MD
Our Patient: Lateral Knee Film

Pause to evaluate, continue to view findings

Courtesy Jim Wu, MD
Our Patient: Magnified Frontal Knee Film

Pause to evaluate, continue to view findings
Our Patient: Segond Fx + Fibular Avulsion Fx on Frontal Knee Film

- Avulsion fracture of proximal lateral tibia
- “Segond Fracture”
- Small avulsion fx of fibular head
Our Patient: Effusion on Lateral Knee Film

- Pre-Femoral Fat Pad
- Effusion
- Suprapatellar Fat Pad
Our Patient: Segond Fx on Frontal Knee Film

- Small, thin, vertically oriented fracture fragment
- Located at the midpoint of the lateral aspect of the tibial plateau inferior to the joint line
Our Patient: Knee XR Impression

- Avulsion fracture of the lateral tibial plateau consistent with a Segond fracture. These fractures are associated with ACL injury and an MR could be performed for evaluation of ACL injury if clinically suspected.
- Avulsion fracture of the left fibular head.
- A small suprapatella effusion is noted.
- The joint spaces are preserved and demonstrate normal alignment.
The Segond Fracture

- A small vertical avulsion fracture of the lateral aspect of the proximal tibia distal to the plateau – noted on AP view
- Result of excessive internal rotation with valgus stress on a flexed knee
- First demonstrated on cadavers by Paul Segond 1879
- First reported in radiographs in 1936 by Henry Milch
- Cortical avulsion of the tibia at site of insertion of middle third of the LCL
- Also known as “lateral capsular sign”
- Valuable for implications of associated ligamentous injury

Courtesy Springer Images
A Clue to Intra-Articular Pathology

- Sensitivity: of all ACL ruptures, 9-12.5% with concomitant Segond Fx
- Specificity: of all Segond Fx, 75-100% with ACL ruptures
Orthopedic Trauma Imaging

**Clinical Condition:**

**Acute Trauma to the Knee**

Variant 3:

Patient any age (excluding infants); fall or twisting injury with either no fracture or a Segond fracture seen on a radiograph, with one or more of the following: focal tenderness, effusion, inability to bear weight. Next study.

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*Relative Radiation Level*
Companion Patient #2: Normal Knee Anatomy on MR

Companion Patient #2: Normal Knee Anatomy on MR

T1 Sagittal

Courtesy Univ Wash Radiology
Companion Patient #2: Normal PCL on MR
Companion Patient #2: Normal PCL on MR
Companion Patient #2: Normal ACL on MR

T1 Sagittal

Courtesy Jim Wu, MD
Companion Patient #2: Normal ACL on MR

• ACL: running posterior-laterally to anterior-medially

• Composed of multiple fibers oriented in a linear or spiral direction

T1 Sagittal
ACL: Anatomy & Physiology

- Fan shaped structure, tightly bound femoral attachment that expands at the tibial attachment
- Courses anteromedial from lateral femoral condyle posteriorly to medial tibia anteriorly
- Intra-articular extrasynovial structure (along with PCL)
- Central support of the knee + most significant stabilizing mechanism against excessive anterior translation of the tibia
ACL: Mechanism of Injury

- Lateral/Valgus stress to the knee with the foot fixed in position (mechanism of “terrible triad” & football related injury)
- External rotation of the femur on a fixed tibia with valgus force or knee in extension (mechanism in basketball & ski related injury)
- Most tears occur within the ligament itself, with <20% involving osseous attachments
- 70-90% will be complete tears
- Associated with joint effusion, medial meniscus tear, and possible anterior tibial subluxation
Our Patient: Sagittal Knee MR

T1 Sagittal

T2 Sagittal

Pause to evaluate, continue to view findings
Our Patient: Sagittal Knee MR

- Complete ACL rupture
- Joint Effusion

T1 Sagittal

T2 Sagittal
Our Patient: Sagittal Knee MR

T2 Sagittal
Courtesy Jim Wu, MD

Pause to evaluate, continue to view findings
Our Patient: Sagittal Knee MR

T2 Sagittal

• Joint Effusion
Our Patient:
Knee MRI Impression

- Avulsion fracture of the proximal lateral tibia consistent with Segond fracture.
- There is associated complete rupture of the anterior cruciate ligament and medial meniscal tear.
- Bone marrow edema in the articulating surface of the femur and tibia represent bone contusions.
- Moderate joint effusion.
- Sprain of posterior cruciate ligament without evidence of tear.
Our Patient: Treatment

- **DIAGNOSIS:** Left anterior cruciate ligament tear and left medial meniscal tear.
- **PRINCIPAL PROCEDURES:**
  - Arthroscopic anterior cruciate ligament reconstruction with hamstring autograft.
  - Arthroscopic medial meniscectomy.
- A hamstring autograft was taken & placed on stretch
- Complex tear of the posterior horn of medial meniscus was trimmed back to a stable margin
- Old ACL was removed, a 9mm tibial & femoral tunnel were created
- The graft was then placed through a looped EndoButton - it was doubled over so that it could be 4 strands - it was then passed from the tibial tunnel coming to end in the femoral tunnel at the appropriate position
EndoButton Reconstruction

Figure 9

Turning Space (9-10 mm)

Femoral insertion length (ex. 25 mm)

Figure 16

Courtesy Smith & Nephew, Inc.
EndoButton Reconstruction

Figure 17

Figure 18

Courtesy Smith & Nephew, Inc.
Summary

- For traumatic knee injury, radiographs are highly recommended for patients of any age with one or more of: focal tenderness, effusion, or inability to bear weight.

- Standard knee films include frontal, lateral, and patellofemoral (sunrise) views.

- The Segond Fracture is a small vertical avulsion fracture at the lateral aspect of the proximal tibia distal to the plateau best visualized on frontal film.

- Although the fracture is a result of avulsion at the site of insertion of the middle third of the LCL, Segond Fractures are highly associated with ACL tears.
Summary

- Although only ~10% of ACL tears present with Segond Fractures, 75-100% of Segond Fractures occur concurrently with ACL ruptures.

- Segond Fractures are a strong indication for knee MRI without contrast in order to evaluate ligamentous injury.

- The ACL, responsible for central support and preventing anterior tibial translation, is commonly injured by valgus stress on a fixed tibia. 70-90% of ACL tears will be complete.

- ACL repair usually involves using a hamstring/gastrox graft and a tunneling procedure into the femur and tibia to recreate the attachment and stabilizing force of the ACL.
References


References

References

Image References

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