EASILY MISSED FRACTURES IN ACUTE KNEE INJURIES

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DISCLOSURES

None
OBJECTIVES

• To recognize the fractures that are often missed following knee trauma and their significance

• By the end of the presentation, the reader will have a number “review areas” that can be used upon assessing radiograph of an acutely injured knee
INTRODUCTION

There are a number of subtle knee fractures that can go undetected by the inexperienced observer. Several of those “small” fractures can signify major injuries.

Prompt diagnosis of these fractures is the first step in preventing the long-term consequences of delayed treatment, specifically the chronic morbidity associated with posttraumatic osteoarthritis.
SEGOND FRACTURE

• Cortical avulsion of the tibial attachment of the anterolateral ligament or iliotibial band

• **Mechanism:** The mechanism is often internal rotation of the knee and varus stress

• MR imaging should be performed in all cases of Segond fracture due to the association with significant knee injuries:

  • **ACL tear (75%-100%)**
  • **Bone contusions (82%),**
  • **Meniscal tears (53%)**
  • **Posterolateral corner injuries (35%)**
  • **MCL tears (35%)**
  • **Popliteus tendon injuries (23%)**
**Fig. 1:** AP radiograph (A) showing a Segond fracture (arrow). Sagittal (B) and coronal (C) Proton Density Fat Suppressed (PDFS) MRI showing wavy torn ACL (arrow heads), partial MCL tear (yellow arrow) and the Segond fracture (white arrow)
ARCUATE COMPLEX AVULSION FRACTURE

• The “arcuate sign” describes an avulsed bone at the level of the fibular head

• This fracture is at the attachment of the arcuate, popliteofibular, and fabellofibular ligaments into the styloid process of the fibula

• Avulsion fractures at the conjoined tendon (biceps femoris and lateral collateral ligament) usually occur at the lateral margin of the fibular head

• **Mechanism:** Posterolateral corner injuries most commonly occur via a direct blow to the anteromedial aspect of the proximal tibia in the fully extended knee
ARCUATE COMPLEX AVULSION FRACTURE

ASSOCIATED INJURIES:
• Posterolateral capsular tear (67%)
• Cruciate ligaments injury (89%)
• Bone bruise or fracture (100%)
• Medial and lateral meniscal tear (28% and 22%)
• Popliteus muscle injury (33%)

• Failure to recognize injuries to the posterolateral corner of the knee is a likely cause of failure after reconstruction of the ACL and PCL, as well as chronic knee instability
Fig. 2: AP (A) and lateral (B) radiographs showing an avulsion fracture (arrows) of the tip of the fibular styloid process (arcuate fracture). Not the Salter-Harris type II fracture of the proximal tibia (open arrow).
**Fig. 3:** Coronal and Sagittal PDFS MRI of the same knee in Fig. 2, demonstrating the arcuate fracture (arrows)
ACL AVULSION FRACTURE

• In children, it is secondary to forced flexion with internal rotation of the tibia
  ASSOCIATED INJURIES: Usually none

• In adults, it results from severe hyperextension and has a higher prevalence of associated injuries
  ASSOCIATED INJURIES: MCL and PCL tears
Fig. 4: AP and lateral knee radiographs (A and B), coronal PDFS (B), sagittal PD MRI (C) demonstrating an avulsion fracture at the tibial attachment of the ACL (arrows). Note the Segond fracture (open arrow)
PCL AVULSION FRACTURE

• **Mechanism:** Direct blow to the anterior tibia with the knee flexed (dashboard injury during) or severe hyperextension (commonly in athletic trauma)

• **ASSOCIATED INJURIES:**
  - Disruption of the medial and lateral collateral ligaments
  - Medial and lateral meniscal tears
Fig. 5: AP and lateral knee radiographs of the knee demonstrating a triangular bony fragment at the posterior aspect of the intercondylar eminence, consistent of a PCL avulsion fracture
Fig. 6: Sagittal CT (A), sagittal PD (B) and coronal PDFS (C) MRI demonstrating the PCL avulsion fracture at its tibial attachment with fracture lines extending further on either sides of the avulsion site.
FRACTURES ASSOCIATED WITH PATELLAR DISLOCATION

Mechanism of patellar dislocation: Usually valgus stress to the flexed, internally rotated knee on a planted foot

More than two-thirds of the patients will show chondral or osteochondral lesions of the medial patella, which are detected at MR imaging with a sensitivity of more than 90% but are overlooked on the radiographs in 40%–60% of the cases.
Fig. 7: Irregular bony fragment lateral to the patella. This appearance should raise the suspicion of a recent transient patellar dislocation.
Fig. 8: MRI of the same knee in Fig.7. Axial PD (A and B) and coronal PDFS (C) demonstrating a large displaced patellar osteochondral fracture fragment (arrow heads) with a defect at the lateral patellar facet (arrows). Sagittal PDFS images (D and E) demonstrating edema at the lateral femoral condyle and medial aspect of the patella consistent with transient lateral patellar dislocation.
OSTEOCHONDRAL FRACTURE

• The medial femoral condyle is the most affected (85% of cases)
• Chondral injuries may predispose to premature osteoarthritis
• MRI is useful in assessing stability of the lesion and to look for displaced fragments which has surgical implications
Fig. 9: AP and lateral knee radiographs showing subtle bony irregularity at the medial femoral condyle with underlying sclerosis consistent with an osteochondral lesion. Bony irregularity at the articular surface of the patella suspicious of an osteochondral lesion.
**Fig. 10:** Coronal and sagittal PDFS (A and B) demonstrating the osteochondral lesion (arrow) on the radiograph (Fig. 9). Sagittal PDFS (C) confirming a patellar osteochondral lesion (arrow)
PATELLAR SLEEVE FRACTURE

• This usually occurs in the pediatric age group

• Acute avulsion of the inferior patellar pole with an underlying bone fragment

• MRI can identify the true extent of injury, including the presence of a nondisplaced osteochondral fracture, the extent of soft-tissue injury, and the need for operative management

Fig. 11: Avulsion fracture fragment at the inferior pole of the patella on a lateral knee radiograph
SUMMARY OF RADIOGRAPHIC REVIEW AREAS [AP] IN THE ACUTELY INJURED KNEE

- Patellar fracture secondary to transient dislocation
- OCL
- ACL/ PCL avulsion
- Segond
- Arcuate
SUMMARY OF RADIOGRAPHIC REVIEW AREAS [LATERAL] IN THE ACUTELY INJURED KNEE

- PCL avulsion
- Arcuate
- ACL avulsion
- Patellar sleeve
CONCLUSION

• There are subtle injuries that can be easily missed on the radiograph following acute knee trauma.
• These fractures often have high association with significant soft tissue injuries or may indicate underlying joint instability.
• Prompt radiographic recognition of these injuries is paramount. Knowledge of the expected location and appearance of such injuries on the knee radiograph can assist the reader in establishing early detection.
REFERENCES


