Radiology of acute knee injuries

Introduction

The knee has a variety of functional demands placed upon it and thus is one of the most vulnerable joints of the body. In acute knee injury clinical examination can be limited and therefore radiographs play an important role in the assessment.

This article gives an overview of this joint and the radiological interpretation of acute knee injury through understanding of the anatomy, radiological assessment and common injuries seen in the clinical setting.

Anatomy

The knee is a synovial joint formed by the osseous structures of the femoral condyles articulating with the tibia condyles (*Figure 1*). The patella lies anteriorly within the quadriceps tendon and articulates with the femoral condyles.

The common peroneal nerve runs close to the neck of the fibula and is therefore a consideration in fracture of the fibula neck. Posteriorly there is a popliteal artery which is closely related to the tibial plateau.

The anterior cruciate ligament is attached to the medial tibial spine and is therefore more prone to injury than the posterior cruciate ligament which is attached away from the lateral spine.

Bipartite patella (*Figure 2*) is a normal variant where the superolateral secondary ossicle centre may not unite, mimicking a fracture. It is recognized by the well-defined margin and superolateral location.

Radiological assessment and classical signs

When assessing any joint radiologically it is important to adopt a system to ensure all aspects of the radiograph are assessed. The ABCS approach is used by many clinicians:

- Adequacy
- Alignment
- Bones
- Congruity
- Soft tissue.

Adequacy

When assessing a joint radiologically a minimum of two views are required. Standard views are anteroposterior and lateral, and additional views which may be needed are skyline patellar, oblique, and anteroposterior with valgus or varus stress.

Alignment

In the anteroposterior projection the femoral condyles should sit on the tibia condyles and the patella should be in the midline. In the lateral projection with the knee extended the patella should lie anterior to the proximal portion of the femoral condyles.

Bones

Look at the density of the bones. Trace the cortical margin around the entire joint looking for steps or breaks. Carefully assess the entirety of the image captured on the radiograph and not just the joint, as a distal fracture of the femur or the proximal tibia or fibula can occur in acute knee injury.

Congruity

Look at the joint space between the femoral and tibia condyles and assess for defects such as osteochondral defects. Ensure that all the bony outlines are carefully examined for subtle breaks in the cortex as these are easily missed. Suspect lateral tibial plateau fracture if the lateral margin of the lateral tibial plateau lies more than 5 mm lateral to the lateral femoral condyle.

Figure 1. Normal knee. a. Anteroposterior radiograph showing alignment of the femoral condyles with tibial condyles. b. Lateral knee radiograph showing the patella lying anterior to the femoral condyles.

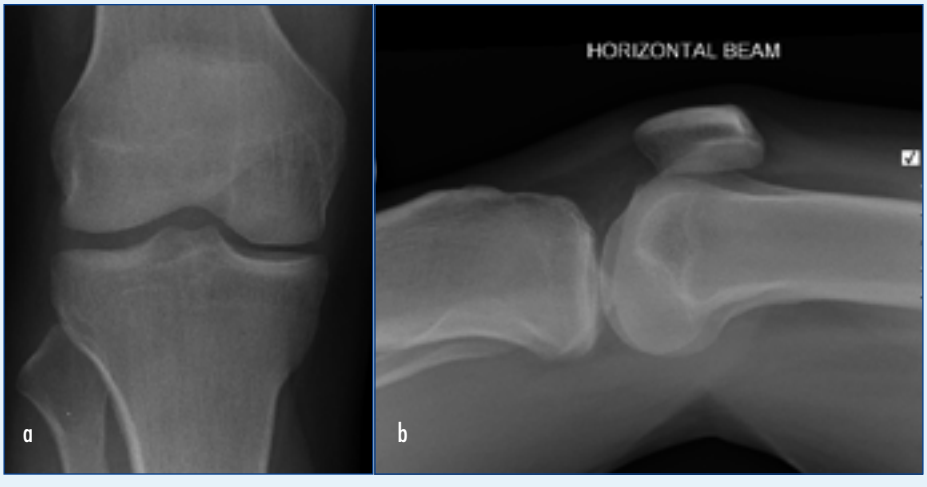
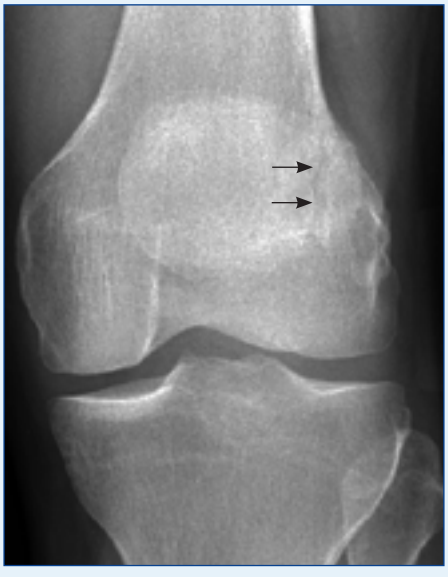


***Figure 2. Bipartite patella: the unfused superolateral ossicle has a clearly defined margin (arrows). It is wider than the rest of the patella. Compare with the normal anteroposterior radiograph in* Figure 1a.**



Dr V Taylor *is Foundation Year 2 Doctor, East Lancashire Hospitals NHS Trust and*
Dr SHM Khan *is Consultant Radiologist and Honorary Senior Lecturer in the Radiology Department, East Lancashire Hospitals NHS Trust, Blackburn, Lancashire BB2 3HH*

Correspondence to: Dr SHM Khan

Soft tissue

Joint effusions in the pre-patella pouch are seen as a tongue of soft tissue density extending superiorly from the patella-femoral joint to behind the quadriceps. Although this may be seen in fractures it is more commonly a result of intra-articular soft tissue injury. Lipohaemarthrosis (*Figure 3*) occurs when blood and fat has leaked from the fracture resulting in a blood–fat fluid level in the suprapatellar pouch. Air in the soft tissues in joint spaces can indicate subcutaneous emphysema in open fracture.

Pitfalls

- Normal variants such as bipartite patella can mimic fracture
- If a horizontal beam radiograph is not requested a lipohaemarthrosis may be missed as this is not seen on a standard anteroposterior projection
- The patella may appear subluxed or the lateral margin of lateral tibial plateau may appear displaced in inadequately centred radiographs.

Injuries

Femoral shaft fracture

This injury is usually a result of a considerable force impacting the leg such as in a road traffic collision. It is generally obvious as segments are displaced (*Figure 4*).

Femoral condylar fractures

These injuries occur mainly after a road traffic collision, but may result from a fall in the elderly. If the injury is intra-articular the bone can fail to unite as the synovial fluid interferes with the organization of a haematoma. Look carefully at all bony structures as there may be an associated spiral fracture of the distal femur.

Tibial plateau fracture

This type of injury is as a result of a severe valgus stress on the joint, for example when hit by a car bumper. It most commonly involves the lateral tibial plateau and less often the medial plateau. Lateral tibial plateau fracture can be subtle and the only sign may be increased density of the lateral tibial plateau (*Figure 5*). Also look for displacement of the lateral margin relative to the lateral margin of the lateral femoral condyle. If it is >5 mm, then look closely for a fracture. An oblique radiograph can help detect some of the subtle fractures.

Fibula neck fracture

This injury (*Figure 6*) can have quite severe complications as the common peroneal nerve lies close to this site and damage to this nerve can lead to foot drop. Fractures may be subtle and classical signs may be absent. Look carefully for bony incongruity and soft tissue indicators of injury. The clinical presentation may be with an ankle injury such as a Maissoneuve fracture, which is associated with high fibular shaft or neck fractures.

Patella fracture

These fractures are fairly common and are mainly of two types (*Figure 7*). The transverse fracture is more common and is caused by forceful quadriceps contraction. The comminuted stellate fracture is the result of direct blunt trauma to the patella. An appreciation of bipartite patella is needed as this can be easily misinterpreted as a fractured patella.

Ligamentous injuries

These are generally not visible on radiographs and require a magnetic resonance imaging scan. The most common sign noted on the radiograph is joint effusion. Occasionally, particularly in children, anterior cruciate ligament tear may be seen as

Figure 4. Fracture of femoral shaft. a. Anteroposterior radiograph of the knee showing comminuted fracture of distal shaft. b. Lateral radiograph again demonstrates the comminuted fracture with overlapping of fragments. There is also rotation of the fracture fragment.

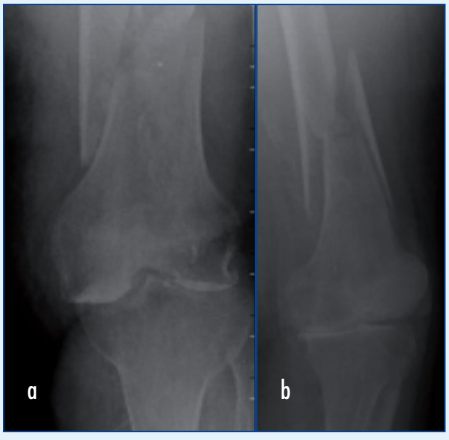


Figure 6. Fibula neck fracture: spiral fracture of the fibular neck is seen.

Figure 5. Lateral tibial plateau fracture. a. There is depression of the lateral tibial plateau with increased density relative to the medial plateau. The lateral margin is also more than 5 mm away from the lateral margin of the lateral femoral condyle. b. Also note the lipohaemarthrosis on the lateral radiograph.

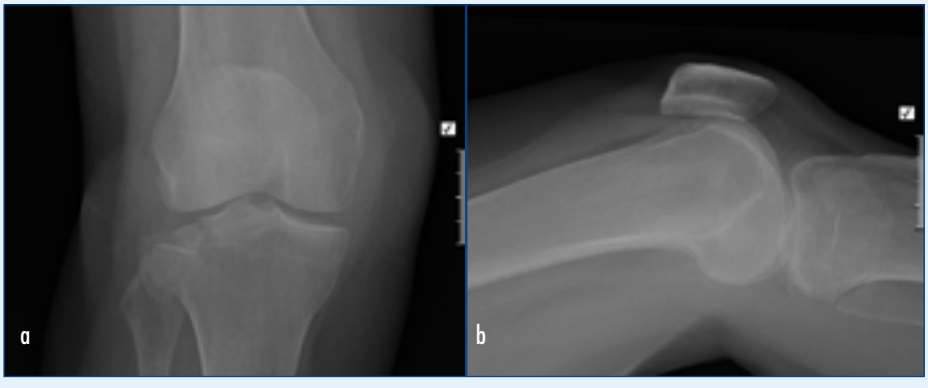


Figure 3. Lipohaemarthrosis.

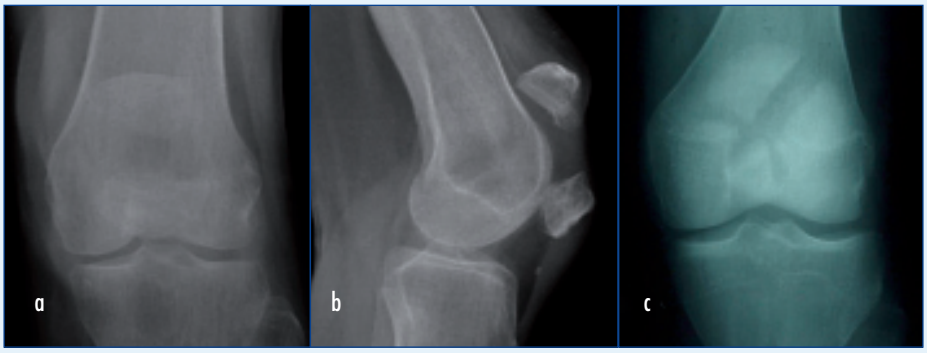


Figure 7. Patella fracture: (a) transverse fracture of the patella with (b) separation of the fragment. c. The stellate fracture with comminution is the result of the direct blow to the patella.

avulsion of the intercondylar tubercle. A Segond fracture is a thin sliver of bone seen on the lateral aspect of the lateral tibial plateau (*Figure 8*), caused by avulsion of the lateral capsular ligament. This fracture is associated with significant intra-articular injuries including anterior cruciate ligament tear.

Posterior cruciate ligament tears are uncommon but in adolescents may manifest radiographically as avulsion at the site of origin on the posterior aspect of the tibia.

Rarely the medial margin of the patella may be avulsed in a medial patellar retinaculum injury (*Figure 9*) which can occur in patellar dislocation. BJHM

KEY POINTS

- Most knee fractures are easily detected.
- In most ligamentous and meniscal injuries the knee radiograph is normal and may be associated with joint effusion. When interpreting radiographs of joints look at the joint in at least two views.
- The presence of a lipohaemarthrosis should increase suspicions of a fracture even if an obvious fracture site is not be seen.
- Avulsion fractures (Segond fracture) can be subtle on radiograph and are associated with significant intra-articular soft tissue injury.
- Tibial plateau fracture can occasionally be subtle. Check for an area of increased density or displacement of the lateral tibial margin.

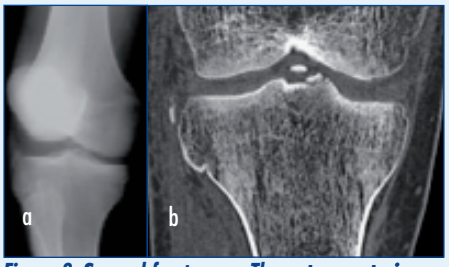


Figure 8. Segond fracture. a. The anteroposterior knee radiograph demonstrates the avulsed fragment on the lateral aspect of the lateral femoral condyle which represents avulsion of the lateral capsular ligament. There is also avulsion of the intercondylar eminence, which is the site of attachment of anterior cruciate ligament. b. The computed tomography coronal reconstruction clearly demonstrates both the avulsion injuries.

Conflict of interest: none.

Further reading

Nicholson DA, Driscoll PA (1995) *ABC of Emergency Radiology.* BMJ Publishing Group, London

Raby N, Berman L, De Lacey G (2000) *Accident and Emergency Radiology- a survival guide.* WB Saunders Ltd, London

Figure 9. Medial patellar retinacular injury with avulsion of medial margin of patella.