Easily Missed Fractures in the Lower Extremity

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KEYWORDS
- Trauma • Hip • Femur • Knee • Ankle • Fractures • Injury • Ligaments

KEY POINTS
- A systematic approach is useful when evaluating radiographs of patients with acute trauma to their lower extremity.
- Recalling high-risk areas in the hip, knee, and ankle allows the radiologist to quickly evaluate key locations in each projection for findings that are frequently subtle and may be evident in only 1 view.
- The technique is simple and sufficiently comprehensive to maximize fracture detection.
- However, the key to success is meticulous attention to detail and remembering to not overlook regions that frequently hide fractures.

HIP

The hip joint is a stable spheroidal joint composed of the femoral head and the cup-shaped acetabulum. The capsule that encloses the joint attaches to the rim of the acetabulum and the femoral neck. Within the joint, the fibrocartilaginous labrum deepens the socket by adding to the surface area by 10% to 15% and is integral to both function and stability.1 Three capsular condensations, the iliofemoral, pubofemoral, and ischiofemoral ligaments, also contribute to joint stability.

The hip joint is frequently injured in trauma. Dislocations are relatively common in high-energy trauma and tend to occur in younger people.2 These dislocations are associated with a high incidence of cartilaginous and osteochondral lesions. Femoral neck fractures are important injuries in the elderly population but may be difficult to detect owing to arthritis, obesity, osteoporosis, or external rotation of the leg.

Radiographic Evaluation

A recurring scenario in the emergency department is hip pain after falling or motor vehicle collision. Evaluation of the hip joint starts with adequate radiographs that include an anteroposterior (AP) pelvic radiograph with accompanying AP and frog leg views of the hip.

Assessment includes close scrutiny for symmetry of the femoral heads and joint spaces, integrity of the acetabular arc and radiographic pelvic “teardrop,” and continuity of 4 critical osseous landmarks. The osseous landmarks are the iliopectineal line, ilioischial line, anterior acetabular rim line, and posterior acetabular rim line. These reference lines allow inspection of the quadrilateral plate, the anterior and posterior columns, and the acetabular walls. Shenton line, which is drawn along the superior margin of the obturator ring and laterally along the medial cortex of the femoral neck, is helpful in identifying dislocations.

Even with careful inspection, the incidence of radiographically occult hip fractures ranges from 4% to 9% in patients presenting with pain after trauma.3,4 In these situations, MRI is the most appropriate follow-up imaging study owing to its exquisite sensitivity to edema in the bone marrow (Fig. 1). The reported sensitivity and specificity of MRI for occult fractures is 100%.5,6

Acetabular fractures

Fractures of the acetabulum are often complex, and the Judet-Letournel classification is useful when reporting findings.7,8 By carefully evaluating

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the osseous landmarks and pelvic symmetry, most acetabular fractures may be easily identified and appropriately classified.

The most common type of fracture of the acetabulum is a posterior acetabular wall fracture, which comprises nearly one-fourth of fractures in this joint, and it is usually produced by a posterior hip dislocation. Unlike the shoulder, nearly 85% of dislocations of the hip are directed posteriorly, occurring with hip flexion so that the head of the femur is driven toward the back of the acetabulum.2

Visualizing the fracture may be quite subtle owing to overlapping osseous structures. Disruption of the posterior rim line is characteristic of a posterior wall fracture (Fig. 2).9 The fracture may involve the posterior acetabular rim and/or a portion of the retroacetabular surface. Oblique (Judet) views are optimal for diagnosis, but when there are large or numerous fragments, computed tomography (CT) is preferred for comprehensive evaluation for instability.10

**Pubic fractures**

Pubic bone fractures typically are associated with other fractures in the pelvis. Fractures in the rami may be subtle, particularly in patients with osteoporosis who have sustained trauma (Fig. 3). Meticulous attention to cortical disruption and changes in bone density is required.

Long-distance runners are susceptible to stress fractures of the pubic arch usually in the inferior ramus near the symphysis pubis.11 Because these fractures are nondisplaced, they are easy to overlook.

**Pediatric considerations**

Avulsion injuries that involve the ossification centers in skeletally immature patients constitute an important group of injuries that affect the muscular, tendinous, and ligamentous attachments about the hip joint (Fig. 4).12 These injuries frequently occur as a manifestation of strong muscular contractions during athletic events. In the hip, important areas to consider include the ischium (hamstring), pubis (adductors), and anterior inferior iliac spine (rectus femoris) (Fig. 5).

**Femoral head fractures**

Femoral head fractures most commonly are associated with hip dislocations. The incidence of femoral head fractures is about 7% in patients with posterior dislocation and ranges from 10% to 68% in patients with anterior dislocation.13,14 Note that fractures may be the result of either a shearing injury or a direct impaction. Both types of fractures may be extremely subtle. CT is advocated not only to confirm the diagnosis and identify other fractures but also to assess the presence of intra-articular fragments (Fig. 6).

**Proximal femoral fracture**

Fractures of the femoral neck are generally a condition of elderly people.15 Subcapital fractures are most common, but these may be difficult to detect when the femur is externally rotated or there is significant osteophyte formation from arthritis. Obesity and osteopenia may further compromise an already challenging hip radiograph, so meticulous inspection is required.
Fig. 2. Posterior wall fracture in a patient with hip dislocation. (A) Radiograph of right hip shows a linear fragment of bone posterior to the femoral head (arrow) and absence of the posterior rim line. (B) Left hip comparison shows the posterior rim line (arrowheads). (C) Computed tomographic three-dimensional reconstruction image shows the defect in the posterior wall and the displaced and rotated fragment of bone (arrow).

Fig. 3. Lateral compression anterior column/pubic fracture after bike accident. (A) Frontal radiograph shows subtle disruption of the right iliopectineal line (arrow), which was not detected initially. There is also a subtle fracture of the right inferior pubic ramus (open arrow). (B) Bone scintigraphy 10 days later confirms the anterior column fracture and the right inferior pubic ramus fracture (arrows). Note that the left anterior column was also abnormal.
Fig. 4. Risk areas for pediatric avulsion fractures. Asymmetry of the apophyseal plates should be viewed as suspicious in the setting of trauma and overuse. Abd, abdominal; AIIS, anterior inferior iliac spine; ASIS, anterior superior iliac spine; Gr Troch, greater trochanter; Lsr Troch, lesser trochanter; TF, tensor fascia.

Fig. 5. Pediatric avulsion fractures. Frontal (A) and oblique (B) radiographs show distracted fragments of bone that have pulled off the anterior superior iliac spine (arrows). Frontal (C) and frogleg lateral right (D) hip radiographs in a different patient show irregularity of the right ischial cortex consistent with a right hamstring tendon avulsion injury (open arrows in C and D).
Trochanteric fractures may be difficult to visualize when they are minimally displaced. Because bone overlap may provide a significant distraction, having an additional view often alleviates errors by offering a different perspective to the tubercles (Fig. 7).

**Femoral neck stress fractures**

Stress fractures of the femoral neck are common in athletes who participate in endurance activities, and these usually develop on the compressive side of the neck. A linear, sclerotic band oriented perpendicular to the medial cortex at the base of the neck is diagnostic of this type of fatigue fracture (Fig. 8). When present, no other imaging is necessary.

Stress fractures occurring on the tensile side of the neck, however, may progress to a complete fracture (Fig. 9). These fractures may be caused by overuse or may occur because of an underlying osseous abnormality. These fractures involve the outer cortex of the midportion of the neck, and a subtle linear lucency may be the only abnormality. Tensile stress fractures usually require surgical fixation.

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**Fig. 6.** Femoral head fracture from a hip dislocation. (A) Radiograph shows contour defect in the superolateral aspect of the femoral head (open arrow). Note the entrapped fragment of bone in the superior joint space (black arrows). (B) Coronal CT multiplanar reformatted (MPR) image confirms the osteochondral fragment of bone (white arrow) as well as a second fragment (open arrow) in the joint superior to the zona orbicularis.

**Fig. 7.** Greater trochanteric fracture after a fall. (A) Frontal radiograph does not reveal an obvious fracture as initially reported. But closer inspection shows disruption of the cortex in the superior margin of the greater trochanter (arrows). (B) Frog leg lateral view shows that the fracture distracted, particularly posteriorly (arrow). This view was neglected on initial inspection because the area of interest, the femoral neck, was not optimally depicted.
Bisphosphonate insufficiency fracture
Another important insufficiency fracture that affects the femur is related to long-term bisphosphonate use. Some investigators have referred to this condition as an atypical shaft fracture. The abnormality characteristically involves the lateral cortex of the middle 50% of the shaft sparing the subtrochanteric region proximally and the supracondylar region distally (Fig. 10). This fracture is seen in patients who have been on bisphosphonate therapy for over 3 years. Prodromal symptoms occur in 60% to 75% of patients as either groin or thigh pain that often is erroneously attributed to arthritis of the hip or back.

The characteristic radiographic appearance of this insufficiency fracture is a volcano-like elevation of the periosteum associated with a transverse lucency through the lateral cortex. It is noteworthy that more than 50% of patients present with a complete fracture of the shaft. Because the condition is bilateral in 50% to 60% of cases, evaluation of the contralateral leg is required once the diagnosis is confirmed in one extremity.

KNEE
Most ligament injuries of the knee are caused by low-energy trauma, such as from those that occur in sports, whereas many fractures are caused by high-energy trauma. Avulsion and impaction fractures may imply the presence of an underlying ligament abnormality. As many of these fractures are subtle, accurate detection of these fractures depends on knowledge of the anatomic high-risk areas.
areas as well as careful inspection of the radiographs. A mechanistic approach is often useful.21

**Mechanisms of Injury**

In general, unidirectional mechanisms result in unidirectional instability and complex mechanisms result in multidirectional instability. Hyperextension, posterior (dashboard) tibial translation, anterior tibial translation, valgus stress, and varus stress are considered simple or one-vector force mechanisms.

Complex injury mechanisms have multiple vector forces. External rotation and valgus stress with knee flexion, flexion with internal rotation and varus stress, hyperextension with valgus stress, and hyperextension with varus stress and internal rotation are complex types.

The pivot shift injury pattern is the most common mechanism of injury in the knee accounting for 46% of anterior cruciate ligament (ACL) tears.19 This injury occurs with rapid deceleration and a simultaneous change in direction so that the lateral femoral condyle strikes against the posterolateral margin of the lateral tibial plateau when the ACL fails.22,23

Flexion-internal rotation-varus accounts for about 1% of injury mechanisms that affect the knee.19 The Segond fracture occurs with this mechanism of injury. Hyperextension injuries are responsible for about 8% of ACL tears.19

*Tibial eminence anterior cruciate ligament avulsion fractures*  
Avulsion of the ACL usually occurs at the tibial eminence (Fig. 11). Although this injury is more common in adolescents, it is not considered uncommon in adults. There are 4 types of ACL avulsion fractures in the Meyers and McKeever classification system.24

In type I, there is incomplete osseous avulsion that shows no or minimal displacement of the tibial eminence fragment. In type II, the fragment is anteriorly elevated but the fracture is still not complete. In type III, there is complete separation of the fragment, and in type IV, the fragment is displaced and rotated.

*Impacted condylopatellar sulcus (deep lateral notch)*  
The condylopatellar sulcus is a natural depression in the condylar region of the femur that separates the patellar articular surface from the tibial surface. A pivot shift mechanism may produce impaction of the lateral notch causing the sulcus to deepen (Fig. 12). In the lateral radiograph, when the depth exceeds 1.5 mm, it is associated with a torn ACL in 70% of the patients and when the depth exceeds 2.0 mm, 100% of patients reportedly have a torn ACL.25,26

*Posterolateral tibial chip fracture*  
A posterolateral compression fracture involving a small portion of the cortex may be the only evidence of a pivot shift injury mechanism (Fig. 13).27 This fracture is a rare finding on conventional knee radiographs but when suspected, the small fracture fragment may be visible on an internally rotated oblique radiograph.
The Segond fracture is a vertically oriented avulsion fracture occurring at the lateral tibial plateau several millimeters below the articular surface of the plateau (Fig. 14). This fracture is best depicted on AP radiographs, and it involves that region of the tibia where the middle third of the lateral capsular ligament, anterior oblique band of the fibular collateral ligament, and the posterior fibers of the iliotibial tract converge.28

Avulsion of the cortical bone occurs when a varus force is introduced on the knee when the foot is firmly planted as the femur internally rotates, a common maneuver in running athletes. This injury produces bone contusions in the medial femoral condyle and the posteromedial tibial plateau, and it is associated with tears of the ACL in 75% to 100% of patients and lateral meniscal tears in 33% of patients and can lead to anterolateral rotational instability.29

**Medial Segond fracture**

An avulsion fracture that arises from the cortex of the medial tibial plateau has been referred to as a medial or reverse Segond fracture. The rotational mechanism that causes the avulsion of the deep

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**Fig. 11.** ACL avulsion fracture from a motorcycle accident. (A) Frontal radiograph shows a fracture through the base of the medial tibial spine (arrows). It is important not to mistake the bone fragment as an intra-articular body. (B) The lateral radiograph shows a typical elongated bone fragment above the tibia (oval). (C) Sagittal T2-weighted magnetic resonance image shows that the ACL attaches to the avulsed fragment (arrows). Note the surrounding marrow edema and the lipohemarthrosis (open arrow).
capsular component of the medial collateral ligament is the opposite of that which creates the classic Segond fracture.\textsuperscript{30} This fracture is associated with tears of the posterior cruciate ligament (PCL) and the root of the medial meniscus.\textsuperscript{31,32} The medial Segond fracture is best depicted in the AP view of the knee appearing as a small linear fracture fragment involving the corner of the tibia (Fig. 15).

\textbf{Avulsion fracture of the fibular styloid process (arcuate sign)}

A transversely oriented fracture of the fibular styloid occurs when there is direct impact to the anteromedial tibia when the knee is extended referred to as an arcuate sign (Fig. 16)\textsuperscript{,33} which is an important indicator of posterolateral knee instability. A concomitant tear of either the ACL or the PCL has been reported with this fracture.

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**Fig. 12.** Deep lateral notch sign after a twisting injury. (A) Lateral radiograph shows a deepened lateral condylar-lateral tibial notch (arrow). (B) Sagittal T2-weighted magnetic resonance image shows bone contusions in the lateral femoral condyle and the posterolateral tibia (open arrows). Anterior tibial translation from an ACL tear exposes the posterior horn of the lateral meniscus (curved arrow).

**Fig. 13.** Posterolateral tibial chip fracture. (A) Lateral radiograph shows a small compression chip fracture in the posterolateral tibia (square). This occurs in pivot shift injury mechanisms when the tibia strikes the lateral femoral condyle. (B) Sagittal T1-weighted magnetic resonance image in another patient shows a posterolateral fracture fragment (arrow) and an anterior drawer sign from a torn ACL.
If the arcuate sign is unrecognized or left untreated, reconstruction of an ACL ligament tear is likely to fail. The structures that attach to the fibular styloid include the popliteofibular, fabellofibular, and arcuate ligaments.

**Posterior tibial eminence posterior cruciate ligament avulsion fractures**

Up to 6% of PCL tears are associated with an osseous avulsion fracture. Like the ACL, avulsions fractures of the PCL arise at the distal tibial attachment. The most common mechanism of injury is a dashboard injury, although occasionally other mechanisms may be responsible. Nearly all injuries that produce a tibial avulsion fracture are caused by motor vehicle accidents.

The characteristic radiographic appearance is a variable-sized triangular fragment of bone that is displaced superiorly into the joint seen on lateral knee radiographs (Fig. 17).

**Avulsion fracture of the fibular head**

The lateral aspect of the knee contains the iliotibial tract, biceps femoris muscle and tendon, lateral capsular ligament, and lateral collateral ligament (LCL). The LCL is the primary stabilizer against excessive varus force. When there is sufficient varus force, an isolated ligament rupture or avulsion fracture of the fibular head at the insertion of the conjoined occurs.

Radiographically, the fracture orients vertically in the lateral aspect of the fibular head (Fig. 18).

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Fig. 14. Segond fracture in a football player. (A) Frontal radiograph shows an avulsion of the lateral tibial cortex below the joint line (arrow). (B) Coronal T1-weighted magnetic resonance image shows that the fragment is attached to the iliotibial band (open arrow) and the anterior oblique band of the lateral collateral ligament (not shown).

Fig. 15. Reverse Segond fracture in a soccer player. (A) Frontal radiograph shows a small flake of bone in the medial tibia at the joint line (arrow). (B) Coronal T1-weighted magnetic resonance image shows that the fragment arises at the attachment of the deep capsular component of the medial collateral ligament (square).
The fracture fragment is usually larger than that associated with a fibular styloid fracture. The fragment often migrates superiorly, producing a ribbonlike deformity of the LCL on MRI.

ANKLE

Low-energy trauma accounts for three-fourths of injuries to the ankle, and often such trauma is from athletic activity. Ankle pain is one of the most common problems encountered by emergency physicians, and radiography remains the mainstay diagnostic tool for diagnosing fractures. About 85% of ankle sprains are the result of an inversion mechanism, although eversion, internal and external rotation, excessive dorsiflexion, as well as adduction and abduction stresses on the foot are also forces that can produce fractures. Diagnosis often depends on the knowledge of high-risk areas, so it is useful to have a search strategy that is based on anatomic landmarks (Fig. 19).

Fractures of the Posterior Tibial Malleolus

The ankle joint is considered a ring, thus the medial and lateral malleoli ought to be scrutinized together. Fractures involving the attachments of the deltoid ligament and the LCL complex...
generally are not difficult to detect, particularly when there is overlying soft tissue swelling. However, fractures involving the posterior tibial malleolus caused by tension from the posterior tibiofibular ligament may be difficult to visualize. These fractures can vary in size (Fig. 20); they are important because they are associated with a distal tibial spiral fracture or can be present as part of a trimalleolar fracture complex.

Fractures of the Anterior Tibial Tubercle

The Tillaux fracture, an avulsion fracture of the anterior tibial tubercle, occurs when tension from the anterior tibiofibular ligament overwhelms the bone. This fracture occurs from external rotation and abduction of the foot. The appearance is characteristic on an oblique radiograph appearing as a vertically oriented fracture line that extends...
Fig. 20. Posterior tibial malleolus fractures. (A) Lateral radiograph shows a small flake of bone arising from the posterior tibial malleolus (arrow). This flake occurred from a twisting injury. (B) Lateral radiograph in a different patient after a plantar flexion injury shows a fracture (arrows) with a larger fragment of bone.

Fig. 21. Anterior tibial tubercle fracture from falling off a curb. (A) Frontal radiograph show a subtle oblique fracture line (arrows) and soft tissue swelling. (B) Lateral view appears normal. (C) Coronal three-dimensional CT image more clearly depicts the fracture line and size of the bone fragment (arrow). (D) Sagittal CT multiplanar reformatted (MRP) image shows the fracture orientation in this projection (arrows).
from the tibial articular surface proximally commu-
nicating to a horizontal component that extends
laterally violating the lateral cortex of the tibia
(Fig. 21).

**Fractures of the Lateral Process of the Talus**

A fracture of the lateral process of the talus is either
deed by ankle eversion with dorsiflexion so that
the superolateral surface of the calcaneus strikes
against the inferior margin of the lateral talus pro-
cess or occasionally by ankle inversion47; it is
known as a snowboarder’s fracture.48 The fracture
is apparent only on frontal views of the ankle, and a
tip-off is that the epicenter of the soft tissue swelling
is distal to the lateral malleolus (Fig. 22).

**Fractures of the Posterior Process of the Talus**

The posterior talus process has 2 tubercles, the
medial and lateral tubercles. Avulsion fracture of
the medial tubercle of the posterior process of
the talus occurs after forceful dorsiflexion-pronation of the ankle.49 Chip fractures occur
when the ankle is severely plantar flexed so that
the posterior tubercle become wedged between
the posterior tibial lip and the calcaneus com-
pressing the lateral tubercle.50 These fractures
may be extremely subtle and require differentiation
from the os trigonum.

Fractures of the posterior tubercles are best de-
tected in the lateral view, but because these frac-
tures are often difficult to visualize using standard

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**Fig. 22.** Lateral talus process fractures. (A) Frontal radiograph shows an avulsion fracture of the lateral talus pro-
cess (arrow) from an inversion injury. Note that the soft tissue swelling is distal to the lateral malleolus (open ar-
row). (B) Radiograph from another patient shows a larger triangular fragment of bone (square) from an eversion
injury typical of a snowboarder’s fracture. (C) Sagittal T1-weighted magnetic resonance image from the second
patient showing the transverse fracture orientation (arrows).
radiographic views, shallow and steep external rotation oblique views have been suggested as adjunctive projections when there is a high index of suspicion and CT is not available (Fig. 23).51

**Anterior Calcaneus Process Fracture**

The anterior calcaneal process serves as the attachment site of the Y-shaped bifurcate bone.

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**Fig. 23.** Posterior talus process fractures. Lateral radiograph (A) and sagittal (B) T1-weighted magnetic resonance image shows a simple fracture of the posterolateral process (arrows). Only in retrospect was the fracture noted on the radiograph. Lateral radiograph (C) and axial CT (D) image shows a comminuted fracture of the posteromedial process (arrows).

**Fig. 24.** Anterior calcaneal process fractures. (A) Lateral radiograph shows a nutcracker fracture of the anterior calcaneal process (arrows). The overlap with the navicular can obscure the fracture. (B) Lateral radiograph in another patient shows the fracture from an inversion injury (arrow). This mechanism results in smaller bone fragments.
ligament, which consists of 2 components, the calcaneonavicular and calcaneocuboid limbs. The bifurcate ligament is an important stabilizer in plantar and dorsal flexion of the ankle.52

Fractures of the anterior calcaneal process may be caused either by tension or by compression.53 These fractures are often missed on initial radiographic inspection. These fractures occur by tension on the bifurcate ligament during forceful inversion and plantar flexion of the foot, or by compression of the anterior process between the cuboid and the talus during eversion and dorsiflexion. Impaction fractures, or nutcracker lesions, tend to be larger than avulsion fractures.

The lateral projection of the ankle offers the best opportunity for identifying the fracture, and close scrutiny for a break in the cortex is the key to making the correct diagnosis (Fig. 24).42 If the lateral view is equivocal, an oblique projection of the foot may be diagnostic.

**Extensor Digitorum Brevis Avulsion Fracture**

Another important calcaneal avulsion fracture occurs at the origin of the extensor digitorum brevis muscle during forced inversion of the ankle.54 This fracture is best depicted on the AP projection as a variable-sized fragment or fragments of bone that arise from the dorsolateral aspect of the calcaneus (Fig. 25). An important observation is that soft tissue swelling occurs distal to the lateral malleolus.

**Lisfranc Joint Complex**

The tarsometatarsal (TMT) joints, collectively referred to as Lisfranc joint, are partially stabilized by the intermetatarsal ligaments from the second to the fifth rays. The first and second TMT joints are different in that there is no intermetatarsal ligament between the bases of the first and second metatarsals.55 Discrete dorsal, interosseous, and plantar ligaments attach the medial cuneiform to the base of the second metatarsal. The Lisfranc ligament is the strongest of these ligaments stabilizing the base of the second metatarsal to the medial cuneiform.

Fractures involving the Lisfranc ligament occur as a result of plantar flexion with either pronation or supination.56 Although Lisfranc fracture dislocations account for 0.2% of all fractures, the diagnosis is initially missed in approximately 20% of the cases.57 Initial radiographs may appear normal, but weight-bearing views may show subluxation or dislocation.

The classic finding is an osseous fragment between the second metatarsal base and medial cuneiform associated with widening of the intermetatarsal space from lateral subluxation of the second metatarsal base (partial homolateral type), although this constellation of findings is not common (Fig. 26). Subluxation can also occur at the navicular-medial cuneiform articulation, resulting in a divergent type of Lisfranc injury (Fig. 27A).

The lateral Lisfranc complex is composed of the bases of the fourth and fifth metatarsal bones, which articulate with the distal surface of the cuboid. The dorsal and plantar cuboideometatarsal, along with the intermetatarsal ligaments, peroneus brevis tendon, and lateral cord of the plantar fascia, contribute to the overall stability of the lateral midfoot region. Direct trauma and forced plantar flexion of the forefoot can disrupt these ligaments.

A small cortical avulsion from the cuboid can be seen on the oblique view of the foot (Fig. 27B).58 Soft tissue swelling proximal to the base of the fifth metatarsal base may be associated with subluxation of the TMT joint.
Fig. 26. Lisfranc fracture after falling off a horse. (A) Frontal radiograph shows a small bone fragment adjacent to the medial cuneiform bone (arrow) and lateral subluxation of the base of the second metatarsal. (B) Close-up of weight-bearing lateral view shows subtle dorsal subluxation of the second metatarsal with respect to the middle cuneiform (rectangle). (C) Axial STIR magnetic resonance image shows disruption of the Lisfranc ligament (arrow) as well as marrow edema in the first through third metatarsals and medial and middle cuneiforms.

Fig. 27. Lisfranc fracture variations. (A) Divergent type of Lisfranc injury with medial subluxation of the medial cuneiform (curved arrow) resulting in widening of the space between the first and second metatarsal. Note the fracture adjacent to the medial cuneiform (arrow). (B) Lateral Lisfranc injury with a cuboid avulsion from the cuboideometatarsal ligament (arrow). Note that the soft tissue swelling occurs proximal to the base of the fifth metatarsal (open arrow).
SUMMARY

A systematic approach is useful when evaluating radiographs of patients with acute trauma to their lower extremity. Recalling high-risk areas in the hip, knee, and ankle allows the radiologist to quickly evaluate key locations in each projection for findings that are frequently subtle and may be evident on only 1 view. The technique is simple and sufficiently comprehensive to maximize fracture detection. However, the key to success is meticulous attention to detail and remembering not to overlook regions that frequently hide fractures.

REFERENCES