FOOT AND ankle injuries are common presentations in emergency departments (EDs), and are often assessed by X-ray (Mayer 2009). Most foot and ankle injuries involve fractures of the metatarsals and can be easily diagnosed. Some of these fractures and dislocations are subtle and difficult to identify, so practitioners must adopt a structured approach to reading X-rays. This article describes some of these injuries and offers advice, including X-ray illustrations, on how to identify them.

FOOT AND ankle injuries are common presentations in emergency departments (EDs), and are often assessed by X-ray (Mayer 2009).

Most foot and ankle injuries involve fractures of the metatarsals and can be easily diagnosed. However, some can be difficult to diagnose and, if missed, can have grave clinical consequences, such as non-union and avascular necrosis, which can in turn lead to long-term pain and disability for the patients concerned. These rarer injuries include Lisfranc injury, fractured waist of talus and subtalar dislocation.

The first professionals contacted by people with such injuries are often emergency nurse practitioners (ENPs) or nurses in minor injury units. As these practitioners’ roles develop, they will be expected to be able to identify and manage these rarer foot and ankle injuries (Lowe 2010, Lau et al 2013). This article therefore describes these more subtle injuries and how to identify them on X-ray.

If, after conducting thorough histories and examinations, practitioners suspect foot fracture, they should request X-rays according to the Ottawa foot rules (Stiell et al 1992). The standard views are anterior-posterior (AP) and oblique. The oblique view is taken with the foot everted at about 45°. In some circumstances, lateral ankle, lateral foot, calcaneal, soft-tissue and weight-bearing view X-rays can be specified too. If ankle injuries are suspected, lateral and AP mortice ankle views can be requested, and clinicians should be guided by the Ottawa rules to help decide when this is appropriate (Stiell et al 1992). Dedicated calcaneal views give more detail of the calcaneus and complement lateral ankle views when calcaneal injuries are suspected.

Soft-tissue views are usually requested when clinicians suspect radiopaque foreign bodies may be present, for example if patients have stood on glass. Weight-bearing views can highlight injuries such as a Lisfranc injury but they may be impractical for patients in pain. Anterior-posterior and oblique view X-rays of the foot showing the major bones are shown in Figure 1.

Fifth metatarsal fractures The most common fracture of the foot is that of the base of the fifth metatarsal and most such cases are simple avulsion fractures. They occur due to avulsion of the metatarsal tuberosity, where the tendon of peroneus brevis inserts, usually due to forced inversion. Such simple avulsion fractures can be diagnosed by identifying a lucent line at the base of the fifth metatarsal, but care must be taken not to confuse the lucent line with an unfused apophysis (Figure 2, page 32). The most important features distinguishing a fifth metatarsal fracture from an unfused apophysis are listed in Table 1, page 32.

Abstract

As the roles of emergency nurse practitioners expand, more patients with minor injuries are being managed independently by nursing staff. Injuries to the foot and ankle are common among such patients, and X-rays are frequently performed to aid their diagnoses. Some of these fractures and dislocations are subtle and difficult to identify, so practitioners must adopt a structured approach to reading X-rays. This article describes some of these injuries and offers advice, including X-ray illustrations, on how to identify them.

Keywords

X-ray, Lisfranc injury, fracture, subtalar dislocation

If, after conducting thorough histories and examinations, practitioners suspect foot fracture, they should request X-rays according to the Ottawa foot rules (Stiell et al 1992). The standard views are anterior-posterior (AP) and oblique. The oblique view is taken with the foot everted at about 45°. In some circumstances, lateral ankle, lateral foot, calcaneal, soft-tissue and weight-bearing view X-rays can be specified too. If ankle injuries are suspected, lateral and AP mortice ankle views can be requested, and clinicians should be guided by the Ottawa rules to help decide when this is appropriate (Stiell et al 1992). Dedicated calcaneal views give more detail of the calcaneus and complement lateral ankle views when calcaneal injuries are suspected.

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Dislocated fifth metatarsals are rare and easily overlooked. They are usually caused by high impact injuries, such as road traffic or horse-riding accidents, and the patients concerned may have distracting injuries that make other injuries difficult to detect.

As they would with all patients who present following serious trauma, practitioners should adopt an ABCDE approach to identify potentially life-threatening injuries that require immediate management. After managing such injuries, practitioners should perform secondary surveys and take thorough histories to identify other injuries.

Dislocations of the fifth metatarsal can be identified on X-ray as a loss of tarsometatarsal joint space. The base of the metatarsal may overlap the cuboid or slip laterally.

The oblique and AP view X-rays in Figure 3, page 32, show a dislocated fifth metatarsal with associated subluxation of the fourth metatarsal.

**Lisfranc injury** This injury is named after Jacques Lisfranc, a French surgeon who fought in Napoleon’s army and who described a method of forefoot amputation through the tarsometatarsal joints (Early and Bucholz 1996). The Lisfranc joint refers to the articulation between the base of the metatarsals and the tarsus, and separates the forefoot from the midfoot.

The strongest ligament to provide stability for this joint is the Lisfranc ligament, which attaches the first, or medial, cuneiform to the base of the second metatarsal. The base of the second metatarsal is firmly keystoned into a tight articulation with the surrounding bones preventing dorsal displacement (Salvi 2014).

A substantial force is usually required to cause a Lisfranc injury. Most such injuries are secondary to road traffic accidents but can also occur during sports when an axial load is applied to a plantar-flexed foot, for example when a footballer falls on the raised heel of another footballer whose toes are planted in turf (Sands and Grose 2004). Lisfranc injuries can also be caused by crush injuries to the dorsum of the foot (Gupta et al 2008).

Diagnosis of Lisfranc injury is important because walking and weight bearing depends on bony alignment of the tarsometatarsal bones (Raby et al 2005). According to a recent literature review, about one third of Lisfranc injuries are missed on initial presentation (Van Rijn et al 2012).
The injury is identified on X-ray from abnormal alignment of the metatarsals at the tarsometatarsal joints. In a patient with a normal foot, an AP view X-ray reveals that the medial margin of the base of the second metatarsal aligns with the medial margin of the second, or middle, cuneiform; in an oblique view, the medial margin of the third metatarsal aligns with the medial margin of the third, or lateral, cuneiform (Raby et al 2005). When a Lisfranc injury occurs, there is disruption of these lines. Oblique and AP view X-rays of a Lisfranc injury are shown in Figure 4.

In subtle cases of Lisfranc fracture dislocation, the only radiographic sign may be a widening of the space between the base of the first and second metatarsals, which in a normal patient is no more than 2mm (Salvi 2014).

Anterior-posterior and oblique view X-rays of a subtle Lisfranc injury with widening of the intermetatarsal space between the bases of the first and second metatarsals are shown in Figure 5.

If there is a high index of clinical suspicion that a Lisfranc injury is present, practitioners can request weight-bearing AP X-rays, which exaggerate the injury and make it easier to see. However, such requests may be impractical if the patient concerned is in pain.

Fractured waist of talus Fractures through the waist of the talus can be difficult to identify but, if they are missed or managed inappropriately, the patients concerned may develop avascular necrosis.

The most common mechanism of injury is forced dorsiflexion resulting in the talar neck being forced against the inferior margin of the tibia. Such injuries are sustained by, for example, drivers with their feet on pedals when becoming involved in road traffic accidents or people who fall from heights and landing in a crouching position.

Practitioners examining X-rays should look for a lucent line through the waist of the talus and a breach of the cortex. Impacted fractures can be

<table>
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<th>Table 1</th>
<th>How to distinguish a fifth metatarsal fracture from an unfused apophysis</th>
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<tr>
<td>Fractured base of fifth metatarsal</td>
<td>Unfused apophysis</td>
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<tr>
<td>Age of patient</td>
<td>Any age</td>
</tr>
<tr>
<td>Orientation of injury</td>
<td>Perpendicular to metatarsal</td>
</tr>
<tr>
<td>Line</td>
<td>Sharp</td>
</tr>
<tr>
<td>Margin</td>
<td>Lucent and non-corticated</td>
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particularly difficult to diagnose because a lucent line may be absent but there may be subtle sclerosis due to the overlying bones.

A lateral view X-ray of ankle in cast showing a fracture through the waist of the talus is shown in Figure 6.

**Subtalar dislocation** When there is disruption of the talocalcaneal and talonavicular joints, subtalar dislocation occurs (Horning and DiPreta 2009). These are serious injuries, which usually require substantial force, such as that involved in road traffic accidents or falls from a height. Patients should be managed initially by a trauma team adopting an ABCDE approach to identify potentially life-threatening injuries.

Subtalar dislocation should be reduced as soon as possible to reduce the chance of neurovascular damage. However, because it is a serious injury, practitioners may want to seek orthopaedic opinion before proceeding.

Patients with subtalar dislocation are likely to be in severe pain and distress. Strong analgesia, such as intravenous morphine, may be required to enable full assessment.

A lateral view X-ray of an ankle with subtalar dislocation causing the talus to slip anteriorly off the calcaneum is shown in Figure 7, page 34.

**Stress fractures** Usually occurring in the second metatarsal, stress fractures typically occur in long distance runners, especially after changes to their training programmes. Stress fractures can be difficult to detect and have a variety of appearances on X-ray, ranging from normal to profuse callus.
formation (Raby et al 2005). They may not be visible on initial X-rays.

If there is a high clinical suspicion of a stress fracture, X-rays can be repeated after between two and four weeks, when the fracture may have become visible. Periosteal reaction may be seen as a fuzzy line parallel to the shaft of the metatarsal. Alternatively, a more florid callus may be present.

Periosteal reaction is not specific to trauma and may occur due to a variety of reasons, including infection and malignancy. However, if history and examination findings are in keeping with diagnosis of a stress fracture, this is the most likely cause.

Figure 8 shows AP view X-rays of two different feet showing, left, subtle periosteal reaction and, right, more obvious periosteal reaction.

Conclusion
Foot injuries are common and most are easy to identify. As this article makes clear, however, some are difficult to diagnose, especially in patients who have experienced high impact trauma and sustained distracting injuries.

After adopting an initial ABCDE approach to identify and manage life-threatening injuries, practitioners should undertake secondary surveys to identify foot and ankle injuries.

If patients are in pain and distressed, appropriate analgesia may be required before examinations. If practitioners become familiar with the appearances in X-rays of some of the more difficult-to-diagnose injuries, their confidence and diagnostic accuracy will improve.

References

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Conflict of interest
None declared