Fractures of the foot and ankle

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Abstract

Fractures of the foot and ankle are common in all age groups. Soft tissue swelling, smoking and co-morbidities such as diabetes mellitus and peripheral vascular disease should be considered when forming the management plan.

Careful attention to neurovascular status and the soft tissue envelope of the foot and ankle is essential to the management of these injuries especially where crush injuries have occurred. Open fractures should be treated urgently with a combined approach with the plastic surgeons.

A good understanding of surgical anatomy is key to managing these fractures. Good intra-articular involvement and ligamentous stability are crucial in predicting long-term prognosis.

The core principles of management are: to maintain the soft tissue envelope (minimize disruption); to obtain appropriate alignment; restoration of joint surfaces; and rehabilitation to obtain optimum function.

Keywords Calcaneal; Lisfranc; metatarsal; midfoot; neck; pilon; talar; talus; tibial; syndesmosis

Ankle fractures

Ankle fractures are the most common lower extremity injury and are increasing in frequency especially in young athletes and elderly osteoporotic women.

Pathoanatomy

The ankle joint is formed by the distal articular surfaces of the tibia, fibula, and the talus. The supporting ligaments of the ankle joint are crucial in determining its stability. The ligament complexes of the ankle joint can be considered in three broad areas: the distal tibiofibular joint or syndesmosis (anterior and posterior inferior tibiofibular ligaments and the interosseous ligament), the medial ankle ligaments (deltoid) and the lateral ankle ligament complex.

Motion at the ankle joint is complex with not only plantar- and dorsiflexion but also glide, rotation and slide of the talus. It is one of the most congruent joints in the body with low risk of osteoarthritis. However, small disruptions to this perfect symbiosis can lead to alterations of the normal kinetics and development of degenerative changes. It has been shown that 1 mm of talar shift can lead to a 42% reduction in joint contact area.[1]

Mechanism of injury and classification

It is essential to think of any ankle fracture not simply as a broken bone, but a complex twisting injury that also disrupts ligamentous balance.

There are two classifications: the Danis–Weber system and the Lauge–Hansen classification.

The Danis–Weber system

This was initially developed by Danis[2] in 1949 and later modified and popularized by Weber in 1967.[3] This classification relates to the location of the fibula fracture in relation to the syndesmosis (Figure 1). Although it is simple to remember and gives a clue to stability it is not that useful in identifying fractures with a poor prognosis (i.e. separating tigers from pussy cats).

The Lauge–Hansen classification (1950)

Lauge–Hansen carried out experiments on the ankles of cadavers.[4] Various forces were applied to specimens and he recorded the injuries sequentially. Two factors dictated the injury: the position of the foot (pronation or supination) and the direction of the deforming force (e.g. external rotation).

The commonest type is the supination–external rotation (SER), seen in a typical footballing inversion injury. In an SER injury as the deforming force continues to act a series of structures get injured. If the deforming force stops at any point (for example by holding onto something), then no further damage occurs. In sequence the first structure to be injured is the anterior inferior tibiofibular ligament (SER1), followed by a short spiral fracture of the fibula (SER2), followed by a tear of the posterior inferior tibiofibular ligament (or posterior malleolar fracture – SER 3), and finally a medial injury (either a medial malleolar fracture or deltoid tear (SER4)).

Distinguishing between an SER2 and an SER4 is essential, however, as the latter is a grossly unstable injury whereas the former might be stable. Indeed understanding the concept of stability is complex, but a good rule of thumb is that if more than one bone and/or ligamentous structure are injured it most likely represents an unstable situation.

All classifications have limitations. The Lauge–Hansen classification is better than the Danis–Weber at understanding severity but has poor inter- and intra-observer reliability.[5,6] For this reason we propose that you do not try and learn all of the various types of this classification, but just understand the principles.

Imaging

Radiographic views should include a lateral and mortise view (15 degrees internal rotation of the tibia – so as to level the fibula which sits posteriorly). If there is tenderness over the proximal fibula the knee should also be X-rayed to rule out a Maisonneuve fracture. Aside from obvious fractures, the most important sign is an equal joint space all around the talus. If this is not the case then it suggests a bony or ligamentous disruption that has led to a widened mortise. You should also check for tibiofibula overlap at the level of the syndesmosis (you would expect to see a

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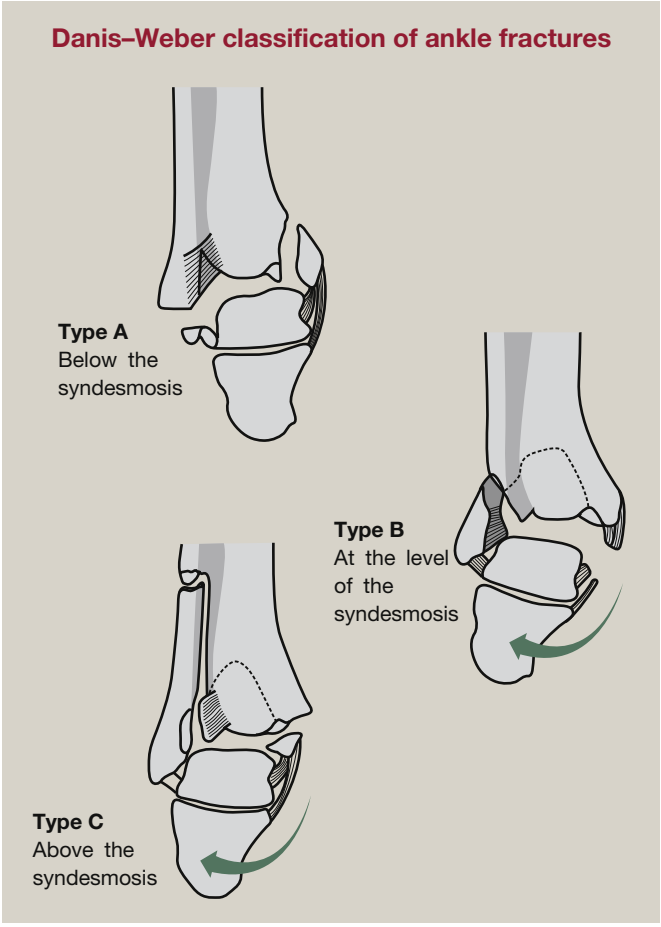

Figure 1

minimum of 1 mm measured 1 cm above the joint line). CT and MRI scans can be helpful in determining the presence of talar osteochondral lesions, posterior cortical comminution, and ligamentous injuries.

Treatment principles

The principles of treatment are to:

- identify unstable injuries
- restore anatomical alignment and joint congruity
- restore stability where necessary
- avoid missing concomitant injuries (such as a fracture of the lateral process of the talus)
- rehabilitate the patient appropriately.

In the emergency department, the neurovascular status of the limb must be assessed. Grossly displaced or dislocated joints should be reduced urgently documenting the neurovascular status before and after reduction. A well-padded plaster backslab is applied and a check X-ray obtained.

Non-operative treatment

This is indicated in stable fractures or in patients where surgery is contraindicated such as vascular insufficiency. A below-knee cast or ankle boot is worn, non-weight-bearing for 6 weeks, gradually introducing weight-bearing as comfortable. Some stable injuries can bear weight quicker.

Diabetic patients require special attention especially in the presence of neuropathy as they have much higher rates of complications including wound problems, delayed union and Charcot arthropathy. In diabetics it is essential that you examine for neuropathy using Semmes–Weinstein monofilaments and if present then you should consider treating the patient with 12 weeks of casting whether surgical or non-surgical treatment is used.

Operative treatment

Surgery is indicated in unstable injuries where the surgeon feels that an improved outcome can be achieved by operative reduction and fixation. Open anatomic reduction and restoration of joint surfaces are achieved using internal fixation commonly with interfragmentary lag screws, buttress or neutralization plates, or tension band wires.

Syndesmosis stabilization is performed (with a screw or ankle Tightrope™ suture) when it appears unstable using the hook stress test intraoperatively. The foot must be in neutral dorsiflexion at the time of stabilization as the talus is wider anteriorly than posteriorly. Controversy exists as to whether the screw should be partially or fully threaded and cross three or four cortices. The truth is that it probably does not matter. If a screw is used, then it is recommended to be removed prior to full weight-bearing after 6–10 weeks. This is a controversial subject however as some stable injuries can bear weight quicker.

Complications

The most frequently asked question after ankle fracture relates to the risk of developing post-traumatic osteoarthritis (OA). A systematic review performed by Gougoulias in 2010 suggested that stable injuries have a very good prognosis and more than 80% of patients will be symptom-free after 18 years. In contrast 60% of unstable injuries that were not operated upon went on to have radiographic signs of OA after 6 years. In those operated upon 20% went on to have radiographic signs of OA after 6 years.[7]

Although this was a retrospective review and the science therefore not robust, it does however suggest that in unstable ankles, surgery can reduce the chance of long-term OA by two-thirds. The study points out that elderly females, smokers and low educational level are all negative prognostic indicators.

Lisfranc injuries

Whilst there are a wealth of midfoot injuries that can occur, the most important one to understand is the Lisfranc injury.

Jacques Lisfranc de Martin was a gynaecologist and field surgeon in Napoleon's army. In 1815 he described the Lisfranc amputation at the tarsometatarsal joint to treat frostbite of the forefoot in soldiers on the Russian front. However he never described the Lisfranc ligament which is crucial in understanding Lisfranc injuries.

The Lisfranc joint is the articulation between the three cuneiforms and cuboid (tarsus) and the bases of the five metatarsals. Osseous stability is provided by the Roman arch of the metatarsals and the recessed keystone of the second metatarsal base. One of the most important stabilizers of this complex is the Lisfranc ligament, which is a large oblique ligament from the plantar aspect of the medial cuneiform to the base of the second

