Ankle fractures

Anatomy and function

The ankle joint comprises three bones, the tibia, fibula and talus, together with the ligamentous structures which bind them together. Three groups of ligaments can be distinguished: the deltoid ligament medially, between tibia and talus; the lateral collateral ligaments laterally, comprising anterior talofibular, calcaneofibular and posterior talofibular ligaments; and the syndesmosis complex, comprising the interosseous membrane between tibia and fibula, anterior tibiofibular, posterior tibiofibular, inferior transverse and interosseous ligaments (*Figure 1*). Together, these structures allow movement of the talus within the mortise joint formed by tibia and fibular of 30° of dorsiflexion and 45° of plantar flexion.

Stability of the ankle joint, or its ability to maintain normal anatomical relationships between the bony structures through a range of motion, is conferred by both bony and ligamentous integrity. Accurately assessing fracture stability will therefore rely on identification of both bony and ligamentous injuries.

Two arteries cross the ankle joint to supply the foot, the anterior and posterior tibial arteries. Ensuring the presence of foot pulses is of paramount importance in assessing potential fracture dislocations of the ankle.

Mechanisms of injury

Ankle fractures are commonly the result of a combination of axial and rotational forces. The foot acts as a lever, such that forces transmitted through it to the ankle are multiplied, resulting in potential injury. The commonly used Lauge–Hansen classification (1950) classifies these injuries according to the presumed mechanism of injury, each mechanism leading to a predictable combination of radiographical findings (*Figure 2*).

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Figure 1. Schematic representation of ligaments of the ankle joint. The deltoid ligament (blue), the lateral collateral ligaments (green) (anterior talofibular, calcaneofibular (shown) and posterior talofibular ligaments (not shown)), the syndesmosis complex (red) (the interosseous membrane, anterior tibiofibular and interosseous ligaments (shown); the posterior tibiofibular and inferior transverse ligaments (not shown)).

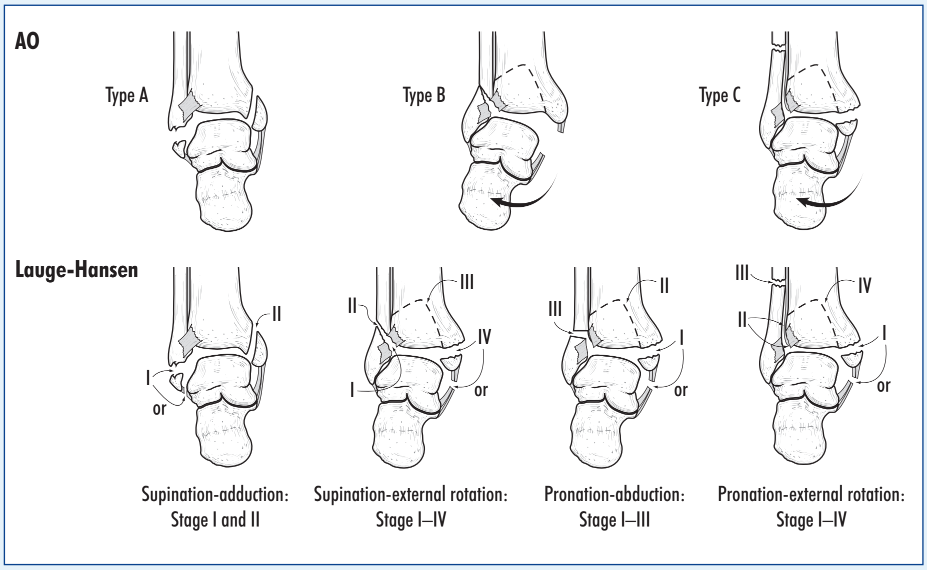
Clinical presentation

Patients with ankle fractures present in varying degrees of distress, ranging from an antalgic gait through to the inability to weight bear associated with severe discomfort. Ankle examination should proceed along the traditional model of 'look, feel, move'. Inspection will reveal swelling (*Figure 3*). This may be localized to the affected malleolus or more diffuse. The integrity of the skin must be assessed, paying attention to any blistering or tenting. Any gross deformity noted at this stage, suggestive of ankle dislocation, should be dealt with by immediate reduction before radiographical assessment.

Palpation for point tenderness over medial, lateral and posterior malleoli should be carried out. The fifth metatarsal should also be palpated to rule out associated injury. The entire length of the fibula must also be examined, as associated fibula fractures can be found as high as the proximal tibio-fibular articulation. Finally

Figure 3. Appearance of an ankle fracture, with swelling and bruising over the lateral malleolus.

Figure 2. Ankle fracture classification – the relationship between the AO–Danis–Weber and Lauge–Hansen systems.



a neurovascular examination should be carried out, paying particular attention to the presence of dorsalis pedis and posterior tibial pulsations.

In assessing ankle injuries for the presence of a fracture, the Ottawa ankle rules should be applied (Stiell et al, 1992). These have been shown to be 100% sensitive and 40.1% specific in detecting malleolar fractures, and can be used to significantly reduce the number of radiographical studies requested. When applied to the ankle, these state that radiographs should only be requested for patients with pain in the malleolar zone and fulfilling either of the following criteria:

1. Bony tenderness at the posterior edge of distal 6 cm or tip of medial or lateral malleolus
2. Inability to weight bear both immediately after injury and in the accident and emergency (A&E) department by walking four steps.

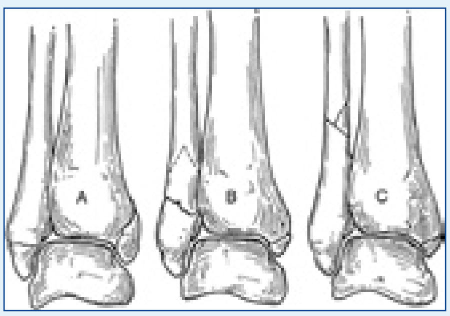
For patients fulfilling the above criteria, mortise and lateral view radiographs should be requested.

Classification of injuries

Two classification systems are in common usage: the AO–Danis–Weber (Mueller et al, 1990) and the Lauge–Hansen (Lauge–Hansen, 1950). The former is the simpler of the two, classifying injuries according to the level of the fibular fracture alone: the more proximal the fracture, the greater the chance of associated instability (*Figure 4*).

While this system does provide some information as to the nature of the injury, and thus aids communication between clinicians, it ignores the medial side.

Figure 4. The AO–Danis–Weber classification of ankle fractures. Type A: a fibular fracture below the syndesmosis. Type B: a fibular fracture at the level of the syndesmosis. Type C: a fibular fracture above the syndesmosis.



The Lauge–Hansen (1950) classification is more comprehensive, but as a result is less easily applied. Injuries are classified according to the pattern of injury, which relates to a specific mechanism. These categories are the result of the author's cadaveric experiments. Each configuration is defined by two factors: the position of the foot (pronation or supination) and the force applied to the ankle (adduction, external rotation or abduction). In addition each configuration has a number of stages describing sequential injuries as force is applied:

- Supination-adduction – transverse lateral malleolar fracture below the tibial plafond and vertical shearing fracture of the medial malleolus
- Supination-external rotation – anterior syndesmotic injury, oblique fibular fracture at the level of the plafond, medial malleolar fracture or deltoid avulsion, posterior syndesmotic injury and posterior malleolar fracture
- Pronation-abduction – medial malleolar or deltoid avulsion, anterior syndesmotic injury, interosseous membrane tear, high fibular fracture
- Pronation-external rotation – medial malleolar or deltoid injury, syndesmotic injury, bending fracture of fibula above syndesmosis.

In assessing any ankle fracture, the following points should be noted:

- Open or closed injury
- Location of fracture(s): lateral malleolus (Weber A, B or C), medial malleolus or posterior malleolus
- Displacement of fragments
- Talar shift (*Figure 5*).

These points, together with the overall clinical picture, will help to make a decision as to fracture stability and therefore the appropriate management regimen.

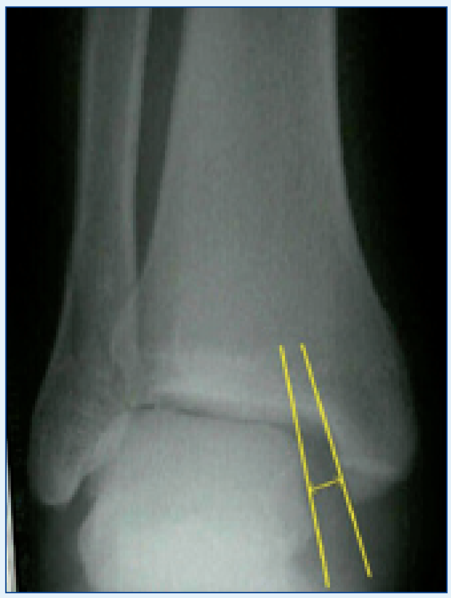
Management

As illustrated in *Figure 6*, initial management will depend on whether the ankle is in joint or not. A fracture-dislocation of the ankle requires emergency reduction and stabilization in a backslab plaster before any radiographical assessment. Emergency reduction is necessary in order to minimize injury to the talus, remove excess pressure from the skin and ensure normal arterial supply to the foot. This can be carried out under sedation, ensuring adequate analgesics are also provided. However, if there is any doubt as to the integrity of the vascular supply to the foot then it may be necessary to relocate the ankle without sedation, although entonox should be provided.

The patient should be warned that he/she may feel a sharp increase in discomfort before relief. The deformity should be examined and an attempt made to reverse it. The heel is held in one hand while the other supports the calf. Once normal ankle contours have been achieved, the ankle is supported in the reduced position while a plaster of Paris backslab is applied. At this stage radiographs can be requested. This should be followed by prompt orthopaedic referral for further management.

Ankle fractures which are not dislocated at presentation require assessment of stability to decide on appropriate management. Isolated undisplaced Weber A and B lateral malleolar fractures which do not show signs of instability, such as talar shift or evidence of deltoid ligament injury, can be managed by the application of a backslab and the provision of oral analgesics and crutches. Patients should be kept non-weight bearing for the initial post-injury period until fracture clinic review and advised to keep the ankle elevated as much as possible for the first week.

Figure 5. Lateral talar shift. The medial clear space has increased following a lateral malleolar fracture, indicating deltoid ligament injury and instability.



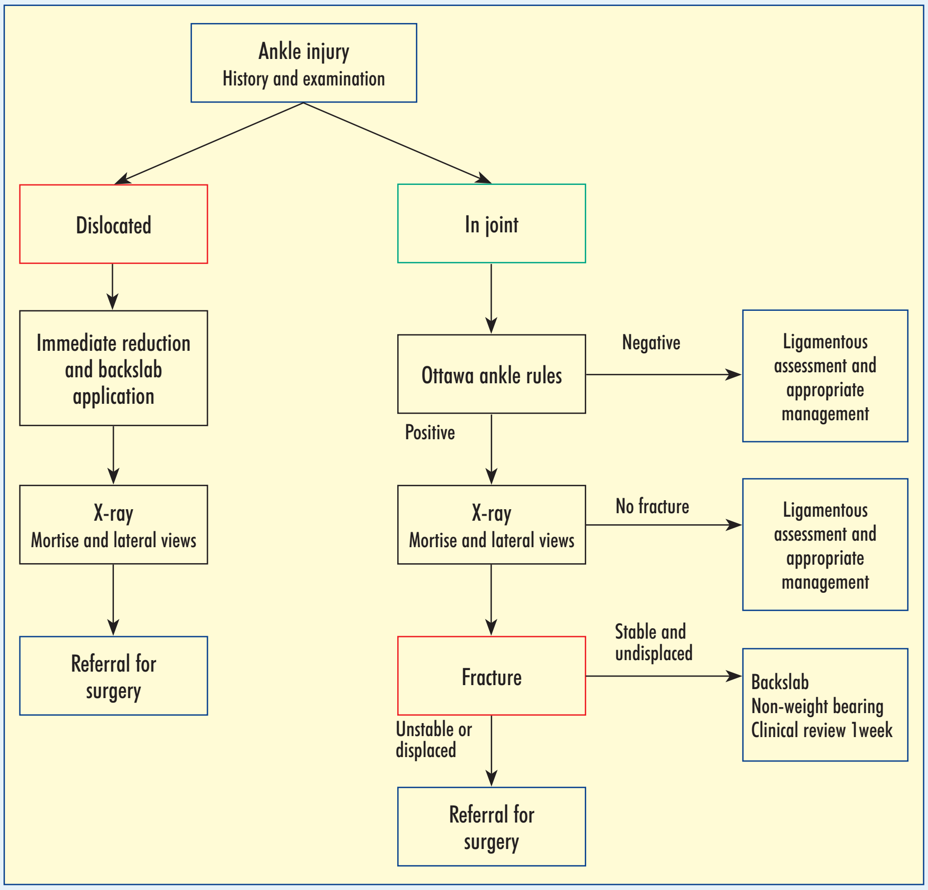


Figure 6. Summary of suggested management of ankle injuries.

Displaced or unstable fractures require open reduction and internal fixation. Patients with injuries falling into this category should still receive adequate analgesia and the application of a backslab for comfort. Additionally, medial malleolar fractures are often treated operatively as there is a risk of non-union associated with non-operative management. Prompt orthopaedic review should be requested, as surgery can be delayed if too much swelling has accumulated making skin incisions difficult to close.

Operative management involves the anatomical reduction of the fracture together with rigid fixation, usually with a combination of plates and screws (*Figures 7* and *8*).

Conclusions

Fracture-dislocations of the ankle require emergency reduction and immobilization. Patients who present with ankle injuries which are not dislocated should be assessed by application of the Ottawa ankle rules. Those who go on to have a fracture diagnosed require assessment as to the stability of the injury. Classification aids this process, through the accurate application of either AO–Danis–Weber or Lauge–Hansen systems. Unstable and/or displaced fractures require operative management. BJHM

Figure 3 *is reproduced courtesy of www.emedx.com and* Figure 4 *is reproduced courtesy of http://www.orthoteers.co.uk*

Conflict of interest: none.

KEY POINTS

- Injuries to the ankle are among the most common encountered in the accident and emergency department.
- Fracture dislocations require prompt reduction.
- Accurate classification aids decision making when considering operative management.

Figure 7. A bi-malleolar displaced ankle fracture.

Lauge–Hansen N (1950) Fractures of the ankle: II. Combined experimental-surgical and experimental roentgenologic investigations. *Arch Surg* **60:** 957–85

Mueller ME, Nazarian S, Koch P, Schatzker J (1990) *The Comprehensive Classification of Fractures of Long Bones.* Springer-Verlag, Berlin

Stiell IG, Greenberg GH, McNight RD, Nair RC, McDowell I, Worthington JR (1992) A study to develop clinical decision rules for the use of radiography in acute ankle injuries. *Arch Emerg Med* **21:** 384–90

Figure 8. The same fracture as Figure 7 following open reduction and internal fixation.