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Focus On
Ankle Fractures

Ankle fractures account for 9% of fractures[1] representing a significant portion of the trauma workload: proximal femoral fractures are the only lower limb fracture to present more frequently. Ankle fractures have a bimodal age distribution with peaks in younger males and older females.[2] There has been three-fold increase in the incidence amongst elderly females over the past three decades.[3] In addition, amongst multiply injured patients foot injuries are prognostically important: those who survive their injuries are far more impaired functionally if they have a foot injury in addition to multisystem trauma.[4] This review provides a summary of ankle fractures, including the classification, clinical presentation, appropriate radiological evaluation, treatment and outcomes.

Classification

The first classification system for ankle fractures, developed by Percival Pott,[5] describes fractures in terms of the number of malleoli involved, thus dividing injuries into unimalleolar, bimalleolar and trimalleolar. Although easy to use, with good intraobserver reliability, it does not distinguish between stable and unstable injuries.

Two other common classification systems for rotational ankle fractures attempt to aid in this distinction. The Danis-Weber classification system,[6,7] shown in Table I and Figures 1 to 3, categorises ankle fractures on the basis of the location of the distal fibular fracture in relation to the syndesmosis. The Lauge-Hansen system[8] (Table II), a mechanistic classification, describes firstly the postion of the foot at the time of injury and secondly the deforming force on the ankle and provides further information about the stability and hence the treatment likely to be required.

Diagnosis

Clinical Features. *History.*

- Ankle fractures are usually due to a twisting mechanism[9] sustained as a result of a low-energy injury.
- The position of the ankle at the time of injury and subsequent direction of force generally dictates the fracture pattern, as described by the Lauge Hansen classification system.[8]
- On occasion, a diabetic patient presents with a history of little or no trauma, which should raise the suspicion of Charcot neuroarthropathy.
- A higher energy mechanism should raise the possibility of compartment syndrome of the leg[10] or a more severe injury to the plafond: the pilon fracture.
- Other pertinent factors in the history include medical comorbidities such as diabetes, peripheral vascular disease and smoking, which can complicate wound and fracture healing.[11,12]
- A social history should be taken to identify the patient's pre-injury level of mobility, home situation and regular activities as well as their future functional aspirations.

Table I. The Danis-Weber classification system for rotational ankle fractures

Type	Description
A	Fracture below the syndesmosis. Avulsion injuries associated frequently with oblique or vertical medial malleolar fractures (correlates with supination adduction injury; Fig. 1).
B	Fracture begins at joint level and extends proximally in an oblique fashion. When accompanied by medial malleolus fracture or with deltoid ligament rupture (correlates with supination external rotational injury; Fig. 2) the ankle is considered unstable.
C	Fractures above the joint line, generally with syndesmotic injury. Can be associated with transverse avulsion medial malleolus fracture or deltoid ligament rupture (includes some pronation-abduction and pronation-external rotation fractures; Fig. 3).

Table II. Lauge-Hansen classification system for rotational ankle fractures

Type	Description
Supination-external rotation (SER)	Most common ankle fracture. Fibular component is Weber B The SER fracture type II, has no medial injury and because these are mechanically stable injuries do not require surgery and can begin immediate weightbearing to tolerance. The SER IV fracture has a medial component: either a medial malleolar fracture or a deltoid rupture. It may look very similar if the medial malleolus is intact, but is distinguished by talar subluxation on presentation, or with mechanical stress.
Pronation-external rotation (PER)	Correlates to Weber C The fracture is proximal to the plafond, and may be as high as fibular neck (Maisonneuve) with associated syndesmotic injury.
Supination-adduction	Correlates to Weber A Transverse fracture of the lateral malleolus inferior to the ankle joint with classically vertical fracture of the medial malleolus. Associated plafond impaction may require reduction prior to fracture fixation.
Pronation-abduction	Comminuted fracture of fibula above ankle mortise with medial malleolar fracture or deltoid ligament tear (Fig. 4). The fibular fracture may require a bridging technique or a nail.

Examination

- Initial examination should identify open injuries and any evidence of dislocation, both of which require urgent intervention. Dislocation with skin compromise necessiates immediate reduction on recognition to prevent skin necrosis.
- Palpation then procedes in a logical sequence incorporating both medial and lateral sides, and including the whole length of the leg to the knee in order to avoid missing the high fibular (Maisonneuve) fracture[13]. Note that the absence of medial-sided tenderness does not however, exclude a deltoid ligamentous injury[14] and thus instability.
- The neurovascular status of the limb should be checked before and after reduction.

Radiological Features. A standard radiological series of the ankle, including anteroposterior, lateral, and mortise radiographs, is generally sufficient to classify these injuries and plan treatment.

Where a patient has more proximal leg tenderness or medial clear space widening with no obvious fibular fracture, full-length radiographs of the tibia and fibula should be obtained to rule out the presence of a Maisonneuve injury.[13]
More complex axial imaging is rarely indicated; exceptions include triplane and pilon fractures.

Treatment

The management of all ankle fractures involves reduction (where displaced), and initial immobilisation in a splint or cast. Once the fracture has been immobilised the decision regarding definitive treatment depends on two key features: tibio-talar congruence and stability.

Good outcomes can be anticipated when the talus is held anatomically within the mortise until fracture healing. When this cannot be achieved with closed reduction, open reduction should be undertaken, so long as there is no medical contraindication. Previous studies have demonstrated a significant increase in intra-articular contact stresses with minimal residual displacement of the talus.[15,16] One study demonstrated that displacement of the fibula in a pronation/ external rotation fracture model increases contact stresses most with shortening of the fibula, followed by lateral translation, followed by external rotation.[17]

When closed anatomical reduction can be achieved then the stability of the injury should be considered. Instability may be suggested by the fracture pattern or may require further imaging with stress radiographs or MRI. Stable fractures can be treated conservatively in either a moonboot or a cast for a period of six weeks with good outcomes.[18] Unstable injuries may be treated either operatively or conservatively. However, non-operative treatment requires close surveillance to assess for any late displacement requiring further, often surgical, input. As a result many chose to manage unstable injuries operatively.

Operative management of the lateral malleolus most commonly involves open reduction and internal fixation following standard AO techniques[19]. Variations on this technique have been studied but there have been no significant conclusions.

Fig. 1

Anteroposterior (A) and lateral (B) x-rays demonstrating Weber A fracture of the ankle. Note transverse fracture of fibula below the level of plafond and vertical fracture of the medial malleolus.

Fig. 2

Anteroposterior (A) and lateral (B) x-rays demonstrating Weber B fracture of the ankle. Note the bimalleolar pattern with transverse fracture of the medial malleolus and oblique fracture of fibula beginning at the mortise.

Fig. 3

Anteroposterior (A) and lateral (B) x-rays demonstrating Weber C ankle fracture. Note fibular fracture above the level of the plafond with intact medial malleolus in this case.

Locking plates have shown impressive stability on biomechanical testing in cadavers[20] but clinical results have been less satisfactory with a higher infection rate when compared with one-third tubular plates.[21] Antiglide plating techinques do not appear to result in significantly different outcomes to traditional plating techniques.[22] Lag screw only fixation appears to give good results in a young patient population.[23] Recently intramedullary fixation of the lateral malleolus has been investigated with good results[24] This technique appears to have particular benefits for those with poor soft tissue including the elderly and those with significant comorbidities.[25] Medial malleolar fixation may be achieved with partially threaded cancellous screws or a tension band wire technique (Fig 4).

Syndesmotic stability should be assessed following fibular fixation. Most surgeons advocate intraoperative stability assessment after plating fibular fractures above the level of the plafond where syndesmotic and interosseous membrane injury may have occurred (Fig 5). Where there is evidence of disruption of the syndesmosis a syndesmotic screw to stabilise the syndesmosis should be placed until soft-tissue healing occurs. No consensus exists regarding the method of stabilization: controversy exists regarding smaller (3.5 mm) versus larger (4.5 mm) screws[26,27] or three-cortex (Fig 6) versus four-cortex fixation following these injuries,[28,29] or for flexible suture devices (Fig 7). No advantage has been shown for any particular configuration, or for the later removal of the syndesmosis screw,[30] although many surgeons offer this.

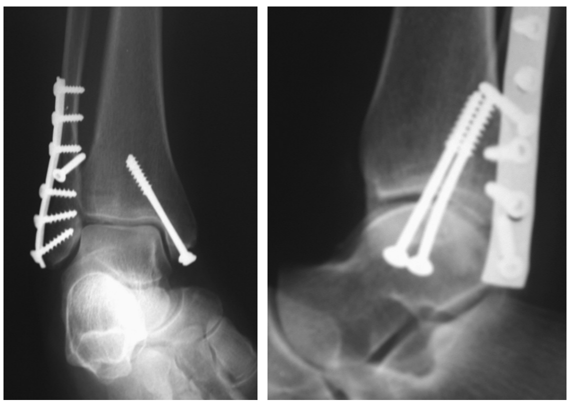

Fig. 4

Postoperative anteroposterior (A) and lateral (B) x-rays demonstrating fixation of bimalleolar Weber B supination/ external rotation ankle fracture.

Fig. 5

Intraoperative external rotation stress view with Weber B/ SER IV equivalent fracture. Note marked medial instabilty indicating ruptured deltoid ligament thus an unstable fracture pattern.

Fig. 6

AP xray of patient who underwent open reduction and internal fixation of Weber C/PER IV ankle fracture with standard medial and lateral plate fixation and stainless steel 3.5mm cortical screw through 3 cortices.

Fig. 7

Mortise and lateral x-ray following fixation of high fibular fracture (Maissoneuve fracture) with stainless steel 3.5mm cortical screw and flexible suture button device (Tightrope; Athrex, Maples, Florida).

Outcomes

In general, the results following an anatomic reduction of a displaced ankle fracture are good. Posttraumatic arthritis has been described in 14% of patients despite an anatomic reduction,[31] most likely as a result of chondral injury sustained at the time of initial injury. One arthroscopic study found 79% of patients to have some degree of chondral injuries, especially in patients with Weber C/PER fractures.[32] Although some degree of stiffness is to be anticipated, most patients resume full activities following healing of these fractures.[33]

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