Clinical assessment of adult ankle fractures

Introduction

Ankle (malleolar) fractures are commonly seen in the emergency department. Although there are relatively few epidemiological studies, the incidence is thought to be increasing, particularly among the elderly (Court-Brown et al, 1998; Kannus et al, 2002). The complex regional anatomy of the ankle joint means that there is a wide variety of injury patterns and management options. An objective and structured assessment is required to define the injury, identify the best course of treatment and prevent unfavourable sequelae.

Epidemiology

The incidence of ankle fractures has been estimated between 107 and 187 per 100 000 population per year (Daly et al, 1987). Unimalleolar fractures represent approximately two thirds of these fractures (Court-Brown et al, 1998). They are most common in young men aged 17–24 years and older women aged 65–75 years. The commonest mechanism of injury is external rotation of a supinated foot.

Anatomy

Appreciation of the anatomy of the ankle joint is key to understanding the structures involved in different injury patterns.

The ankle is a synovial joint involving the articulation of distal tibia, fibula and talus. The talus itself is wedge shaped, being wider anteriorly. As the ankle dorsiflexes the fibula moves posterolaterally, 'rolling' around the talus.

'Malleoli' are the bony prominences at each side of the ankle joint that act as the ankle's bony constraints, through which a fracture can propagate. In addition to the lateral malleolus of the distal fibula and medial malleolus of the distal tibia, the posterior aspect of the distal tibia (posterior malleolus) also breaks in some fracture patterns. Malleolar fractures may occur in isolation (uni-malleolar) or may have bi-malleolar (two malleolar fractures, usually the lateral and medial) or tri-malleolar fracture patterns (lateral, medial and posterior malleolar fractures). Posterior malleolar fractures result from posterior tibiofibular ligament avulsion, or posterior bony impaction from the talus. The tri-malleolar fracture pattern implies a high energy transfer injury. (*Figures 1–5* show examples of ankle fractures.)

Stability further arises from a series of ligament complexes including the tibiofibular syndesmosis, medial and lateral complexes. The syndesmosis consists of three ligaments that hold the fibula to the incisura fibularis on the lateral tibia. Medial stability is provided by the deltoid ligament, a strong triangular thickening with deep and superficial components. The lateral complex is made up of the comparatively weaker anterior talofibular ligament, posterior talofibular ligament and calcaneofibular ligament. The anterior talofibular ligament is particularly weak and commonly disrupted in ankle injuries (Ferran and Maffulli, 2006).

This arrangement leads to a highly stable joint both at rest (static congruity) and during motion (dynamic congruity).

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Figure 1. Anteroposterior X-ray of a Weber A fracture.

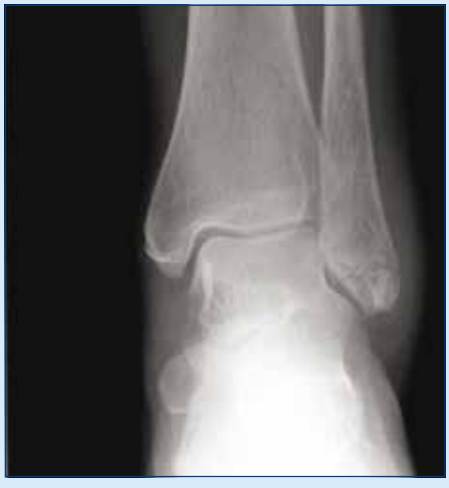


Figure 2. Anteroposterior X-ray of a Weber B fracture.

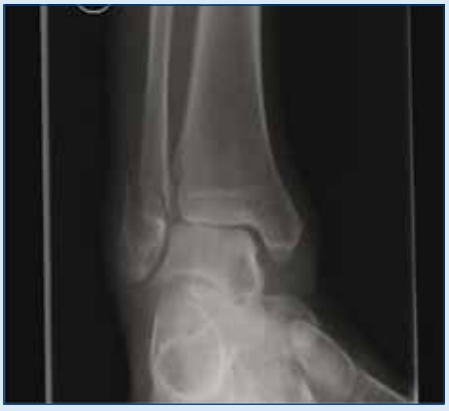


Figure 3. Anteroposterior and lateral X-ray of an ankle fracture dislocation which includes a Weber B fracture of the lateral malleolus and a medial malleolar fracture.

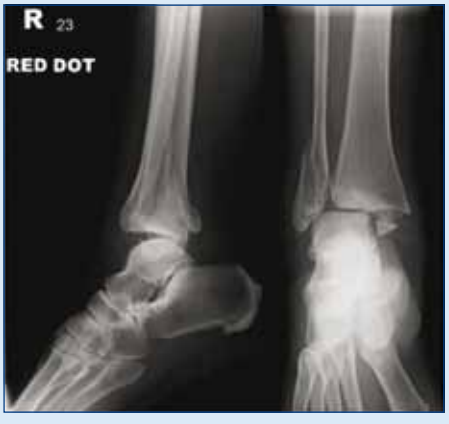
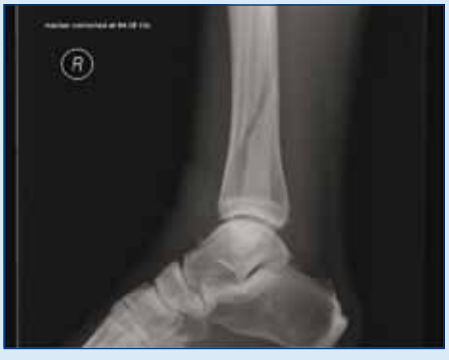


Figure 4. Lateral X-ray of a Weber C fracture of the lateral malleolus with a syndesmosis injury and talar shift.



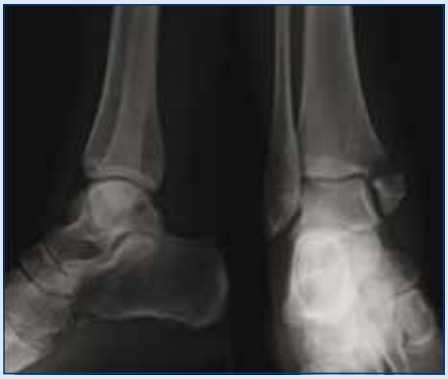


Figure 5. Anteroposterior and lateral X-ray of an isolated medial malleolar fracture.

Clinical evaluation

History

Rotational injuries are the commonest mechanism of injury. This may occur in conjunction with axial loading as a result of a fall from a significant height. A higher energy transfer injury is more likely to result in significant intra-articular ankle injury, soft tissue damage and other associated injuries (Takao et al, 2004).

It is important to establish whether there is a history of previous ankle trauma as this may influence the prognosis. Equally, significant comorbid illnesses and a history of smoking could influence wound healing and the ability to rehabilitate post treatment (Krannitz et al, 2007).

Further information that is needed from the patient includes the mechanism of injury, time of injury, position of the foot at the time of the injury, energy involved in the injury (e.g. higher energy injuries may be associated with increased soft tissue damage, bony comminution and an increased risk of complications), and whether any other injuries have been sustained. Comorbidities such as smoking, peripheral vascular disease and neuropathy are important to note, as they can change the course of management. Smoking and alcohol intake, as well as occupation and accommodation (stairs or lift) are also key aspects of the social history that need to be obtained.

Multiply injured patients or patients who have sustained high-energy injuries should be managed according to Advanced Trauma Life Support principles. This consists of a rapidly conducted systematic primary survey to identify life-threatening injuries, followed by a more extensive secondary survey to catalogue all injuries and plan definitive management.

Examination

Examination of the injured ankle should focus on assessing deformity, swelling and tenderness. A structured approach is to 'look, feel, move, document the neurovascular status and examine the joint above and the joint below'.

Key observations on inspection include the status of the soft tissue envelope and the degree of deformity. Early reduction of a dislocated joint will help alleviate further soft tissue compromise and reduce pain.

Tenderness on palpation may confer little diagnostic information in the swollen, painful ankle. However, in certain fracture types, isolated tenderness is important to document. Proximal tenderness over the fibula may suggest a Maisonneuve fracture (Kalyani et al, 2010). In isolated fibula fractures, medial tenderness may suggest a deltoid complex injury, thereby influencing stability of the ankle fracture.

Palpating and documenting both posterior tibial and dorsalis pedis pulses is prudent at the time of initial assessment. Capillary refill time is a less specific measure of tissue perfusion, but should be between 2 and 3 seconds. On occasion, reduction of the dislocated joint will help restore perfusion in a pulseless foot. Meticulous sensory and motor examination of the foot is essential to document any neurological deficit as a result of the original injury. This helps to avoid any confusion in the postoperative patient presenting with a neurological deficit, for example from compartment syndrome, a regional nerve block or early complex regional pain syndrome. Sensation in the foot is supplied by the saphenous nerve medially, the superficial peroneal nerve over the anterolateral ankle, the sural nerve laterally and the posterior tibial nerve which divides into the medial and lateral plantar nerves supplying the sole of the foot (*Figure 6*).

Inspect and compare the injured ankle with the contralateral side. Are there any wounds which might imply an open injury? Assess for deformity: the foot is commonly externally rotated and the distal tibia appears more prominent in medial malleolar injuries whereas posterior displacement of the foot may be associated with posterior malleolus injuries. Gross deformity may indicate a fracture-dislocation of the ankle. Swelling is common in all ankle injuries.

Imaging

X-ray images should be obtained according to the Ottawa ankle rules (*Figure 7*). Images should include antero-posterior and lateral views of the ankle as well as specific mortise views (foot internally rotated by 10–15°) to accurately examine the position of the talus within the ankle joint.

A systemic review of 32 studies on the accuracy of the Ottawa ankle rules showed that they have a very high sensitivity of

Figure 6. Cutaneous innervations of the foot.

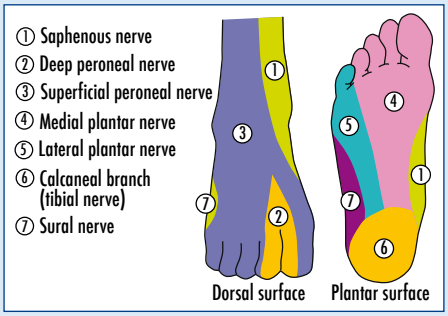
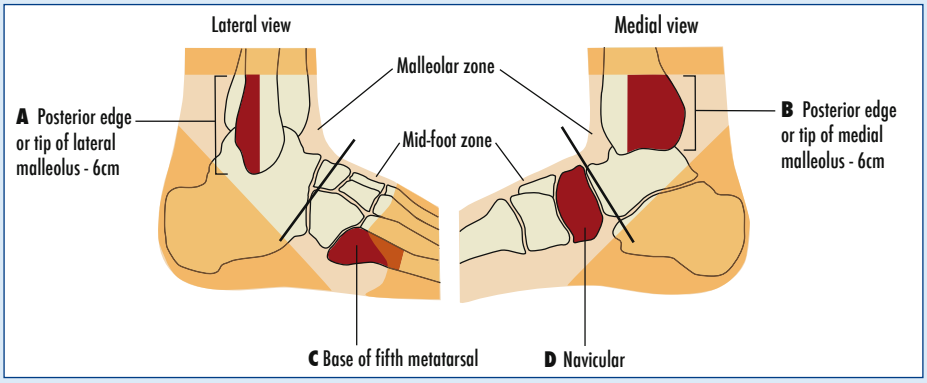


Figure 7. Ottawa ankle rules. A series of ankle X-ray films is required only if there is pain in either malleolar zone and bone tenderness at A or B, or the inability to bear weight (either immediately post injury or in the emergency department). A foot X-ray is required only if there is mid-foot pain, along with bony tenderness at C or D, or inability to bear weight (either immediately or in the emergency department).



almost 100% and a modest specificity ranging between 42% and 77%. The pooled negative likelihood ratio is 0.08 (Bachmann et al, 2003). Another report involving seven studies found the negative predictive value to be greater than 99%. These results support the effectiveness of the Ottawa ankle rules for ruling out a fracture of the ankle or foot. However, with the low specificity and a positive predictive value of less than 20%, these rules are not reliable at confirming a fractured ankle or foot (Markert et al, 1998). The Ottawa ankle rules are effective as clinical practice guidelines for acute ankle injuries in the adult patient. Patients with negative results when the rules are used are highly unlikely to have a fractured ankle, but the diagnosis of a fracture for positive patients is less certain and therefore radiography is recommended.

Antero-posterior

Some overlap of the tibial and fibular components is normal inferiorly. Significant overlap or clear space >5 mm proximal to the overlap may indicate an injury to the syndesmotic ligament complex.

Lateral

Assess the posterior aspect of the distal tibia (posterior malleolus) for fracture, as well as the congruity of the talar dome within the tibial plafond.

Mortise

An increased medial clear space compared to the rest of the joint implies lateral talar shift and ligamentous injury. The tibial and talar articular surfaces should be parallel and increased tilt may indicate ligamentous injury (Geissler et al, 1996).

Stress view

The purpose of this investigation is to establish the stability of the ankle fracture. An isolated distal fibula fracture with no talar shift on stress images is likely to be stable and therefore amenable to non-operative treatment with functional bracing and early range of motion (Dietrich et al, 2002). An image is taken through the ankle joint while the fractured ankle is stressed. This may be achieved by asking the patient to hang his/her foot over the contralateral leg (gravity stress view) or by manually stressing the ankle (manual stress view). Displacement of the fracture or a talar shift is suggestive of instability.

Computed tomography and magnetic resonance imaging may be useful in specific circumstances (*Table 1*).

Classification

Classification systems aim to define management on the basis of fracture patterns. Two classification systems are commonly used in the management of ankle fractures.

Danis–Weber

This classification was first described by Danis and amended by Weber in 1972. (Danis, 1949; Weber, 1972) It is both an anatomical and a prognostic classification system that helps guide treatment based on the fracture type. Fractures are classified based on their level in relation to the ankle syndesmosis (*Figure 8*):

Type A: Fibular fracture below the level of the syndesmosis (infra-syndesmotic) (*Figure 8a*)

Type B: Fibular fracture at the level of the syndesmosis (trans-syndesmotic) (*Figure 8b*)

Type C: Fibular fracture above the level of the syndesmosis (supra-syndesmotic) (*Figure 8c*).

Lauge-Hansen

This classification was initially described in 1950 following a series of cadaveric studies in order to guide closed treatment of ankle fractures (Lauge-Hansen, 1950) (*Table 2*). It was noticed that structures within the ankle could be disrupted in a sequential and predictable manner. It consists of two descriptors indicating the position of the foot within the ankle (supination or pronation) and the direction of the deforming force applied to it (translational or rotational), followed by a numerical scale to indicate the

Table 1. Indications for further imaging

Indications for computed tomography	Intra-articular fractures where congruence is imperative
	Growth plate injuries
	Osteochondral injuries of the talus
Indications for magnetic resonance imaging	Identify ligamentous injuries such as the syndesmosis, deltoid ligament or the lateral ligaments
	Suspicion of a stress fracture
	Associated tendon injuries, e.g. tibialis posterior or the peronei

Figure 8. Danis–Weber classification.

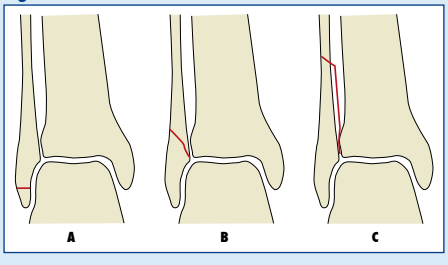


Table 2. Lauge-Hansen classification of ankle fractures

Descriptor 1: Position of foot	Descriptor 2: Deforming force		Structure injured	Short code
Supination	External rotation	1	Anterior tibio-fibular ligament	S-ER-1
		2	Spiral fibula fracture	S-ER-2
		3	Posterior malleolus or posterior tibio-fibular ligament	S-ER-3
		4	Medial malleolus or deltoid	S-ER-4
	Adduction	1	Lateral ligament or malleolus	S-AD-1
		2	Vertical fracture medial malleolus	S-AD-2
Pronation	Abduction	1	Deltoid or horizontal fracture medial malleolus	P-AB-1
		2	Anterior and posterior tibio-fibular ligaments	P-AB-2
		3	Horizontal or comminuted fibular fracture	P-AB-3
	External rotation	1	Oblique medial malleolus fracture	P-ER-1
		2	Anterior tibio-fibular ligament or avulsion (Tillaux) fracture	P-ER-2
		3	Spiral or oblique fibular fracture (may be proximal)	P-ER-3
		4	Posterior tibio-fibular ligament or syndesmosis rupture	P-ER-4

Adapted from McRae (2006)

severity of injury (related to the structures damaged). Although comprehensive, the Lauge-Hansen system is complicated and does not always correlate to in-vivo patterns of injury (Gardner et al, 2006).

The AO Foundation subsequently developed a classification that incorporates the differences between the two classifications in an attempt to ease management decisions. However, this can be quite complicated in its own right (*Figure 9*).

Conclusions

Clinical assessment of the fractured ankle begins with an appreciation of the mechanism of injury. Examination of the medial and lateral ankle complex followed by the proximal fibula will help establish the extent of bony and soft tissue injury Mortise views are useful to delineate talar shift secondary to bony or syndesmotic disruption. The Weber classification is the most commonly applied prognostic classification system. BJHM

Conflict of interest: none.

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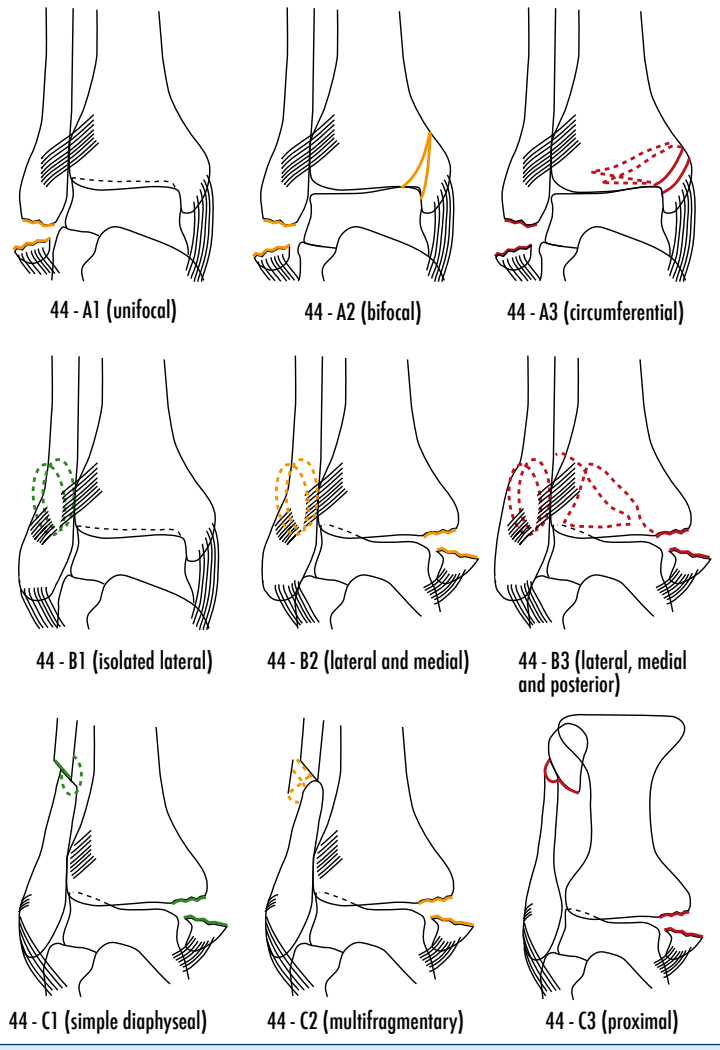
Figure 9. AO classification subgroups for malleolar fracture (adapted from www.aofoundation.org).



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KEY POINTS

- Ankle fractures are a commonly seen injury with a bimodal pattern of distribution.
- Knowledge of the anatomy and biomechanics of the ankle joint help to understand fracture patterns and subsequent treatment options.
- Several classification systems exist. The Danis–Weber classification may be used to describe a fracture type.