Injuries of the carpus and scaphoid

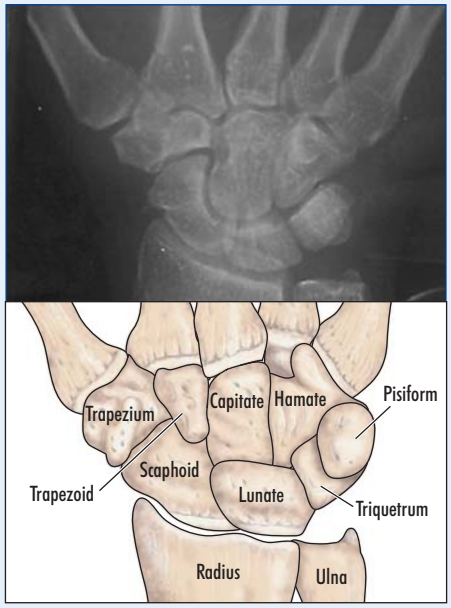
Anatomy and function

The scaphoid is one of eight carpal bones which lie in two rows (*Figure 1*). They are articulated together to form a semicircle, the convexity of which is proximal and articulates with the forearm bones. The scaphoid occupies the most radial position (thumb side) in the proximal row. It is a boat-shaped bone, which articulates directly with the radius proximally and is a critical link in the mechanism of the carpus. The scaphoid is commonly divided into four distinct parts: the proximal pole, the waist, the distal body and the tuberosity. It is a key bone to both wrist motion and stability.

A complex series of interosseous ligaments exists between the scaphoid and other carpal bones: the scapholunate ligament appears to be the primary stabilizer between the scaphoid and lunate and the radioscaphocapitate and scaphotrapezial ligaments are secondary stabilizers (Berger, 2001). The blood supply of the scaphoid arises from the radial artery entering the scaphoid at or distal to its waist along the dorsal ridge. This accounts for up to 80% of the entire blood supply and as much as 100% of the supply to the proximal pole. Therefore fractures through the waist and proximal third render the more proximal fragment of the scaphoid at risk of avascular necrosis (AVN) or death.

The other bones of the carpus must not be ignored although the scaphoid is the commonest bone to fracture. The carpus serves as a conduit for passage of the wrist and digital motors, providing more mechanical advantage to move the hand on the wrist. When high-energy forces pass through the carpus distal to the radius, soft tissue and bony injuries occur and may cause significant instability patterns. Fractures of carpal bones other than the scaphoid usually require referral to orthopaedic teams following stabilization by plaster of Paris so that instability can be excluded. Important dislocations of carpal bones, mainly the lunate, will be mentioned later in the article. The main focus of this article will be the scaphoid.

Figure 1. The carpus.



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Mechanisms of injury

Because of its offset proximal and distal articular surfaces, the scaphoid has a natural tendency to palmar flex with longitudinal loading. Hence, extension of the scaphoid places progressively increasing tension on the palmar cortex of the curved waist of the scaphoid. Excessive extension or ulnar deviation of the wrist, coupled with excessive loading, mechanically predisposes the scaphoid to fracture, especially if the strong ligaments attaching to the scaphoid retain their integrity (Short et al, 2002).

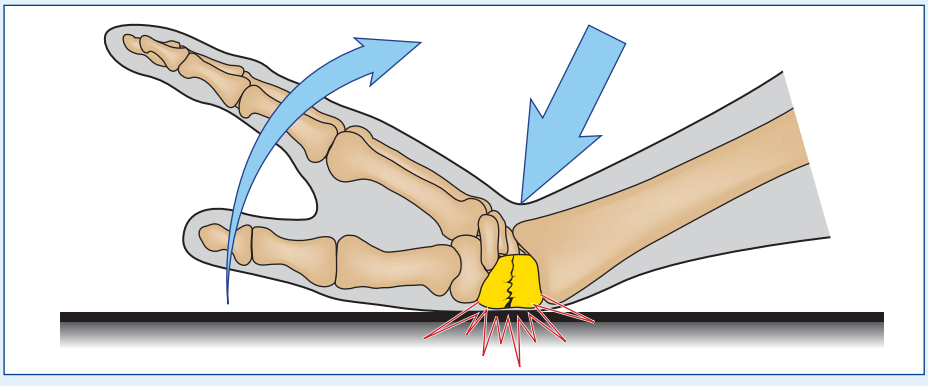
Most wrist injuries are incurred by falling on an outstretched hand (*Figure 2*). The wrist is usually hyperextended. Radial or ulnar deviation can determine the specific outcome of the injury. Direct trauma may be responsible for hamate hook fractures as can improper swings of sporting equipment. Axial load to the metacarpals can also cause carpal fracture dislocations and, rarely, isolated capitate fractures.

Clinical picture and investigations

Most painful wrists are seen in the accident and emergency department where often, inexperienced doctors are assessing the patient. It is important to take a clear and accurate history although this can be difficult. The age and sex of the patient must be taken into account along with the mechanism of injury. Often the painful wrist is examined without comparison to the other side. Many individuals experience pain in the anatomical snuffbox when the superficial radial nerve is compressed.

There is much in the literature on how a scaphoid fracture can be accurately diagnosed. These range from the combination of clinical signs, e.g. evaluating tenderness in the anatomical snuffbox and over the scaphoid tubercle, pain on longitudinal compression of the thumb and range of thumb movement (Parvizi et al, 1998). When these clinical signs were used in combination within the first 24 hours following injury they produced

Figure 2. Injury to the scaphoid from a fall onto outstretched hand.



100% sensitivity and specificity of 74%. Failure to diagnose scaphoid fractures that can be well treated acutely may result in delayed or non-union (with subsequent osteo-arthritis) and deformity at a later date. Initial suspicion may be of a distal radial fracture, but if no radial fracture is seen on the preliminary wrist X-rays, then a scaphoid fracture must be suspected.

In the case of other carpal bone fractures, the same principles apply; the carpus may display the obvious deformity of a dislocation. The carpal bones must be examined and palpated individually and a neurovascular assessment performed and documented.

Owing to the complex anatomy of the scaphoid at least four views on plain X-ray are required to show the bone adequately (scaphoid views). Despite four views these can still be difficult to interpret and consequently some fractures are missed. If no fracture is seen but one is highly suspected, the patient is commonly placed in a scaphoid cast and asked to return 7–10 days later for a follow-up X-ray. The fracture is often diagnosed at this juncture when the X-rays are more likely to show a fracture line but inevitably a proportion are still not evident – missed or true negatives.

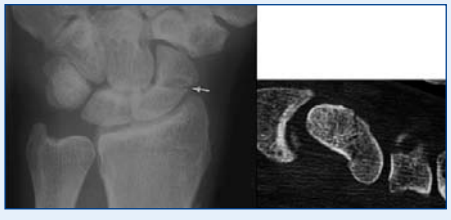
If the diagnosis cannot be established by clinical and simple radiographic means (*Table 1*), bone scans have been recommended in the literature and preferred over computed tomography (CT) or magnetic resonance imaging (MRI), for reasons of cost. MRI allows an early definitive diagnosis to be made and should be regarded as the gold standard investigation. MRI also has the advantage of being the best investigation to determine AVN in the longer term, while CT has an established role in detecting non-unions.

Common fractures and dislocations

Approximately 50% of fractures of the scaphoid occur across the waist (*Figure 3*); about 38% of fractures occur in the proximal half and 12% in the distal half.

Two methods of classifying scaphoid fractures are recognized. Russe in 1960 described the fractures in three types, based on the relationship of the fracture line to the long axis of the scaphoid: transverse, vertical oblique and horizontal oblique. Herbert and Fisher in 1984 classified scaphoid fractures more broadly (*Figure 4*) as unstable or stable; stable fractures including crack fractures and tuberosity fractures; unstable fractures including distal third, proximal pole and displaced waist fractures, as well as fractures associated with carpal dislocation and communited fractures.

Figure 3. Typical scaphoid waist fracture on (a) X-ray and (b) computed tomography.



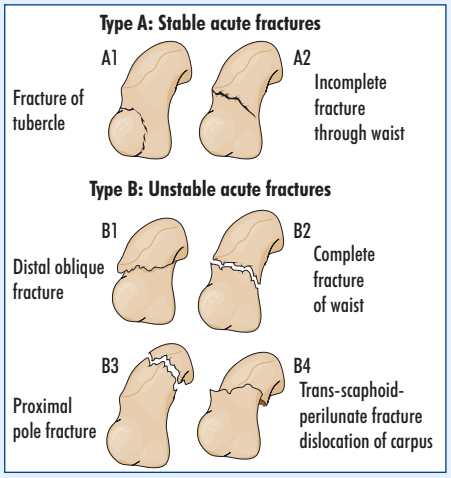


Figure 4. Herbert classification of scaphoid fractures. From Herbert and Fisher (1984).

It should be noted that marked displacement of a fractured scaphoid can be associated with carpal dislocation.

Dislocations of the carpus fall into two main groups. In the first, the metacarpals,

Figure 5. Perilunate dislocation.

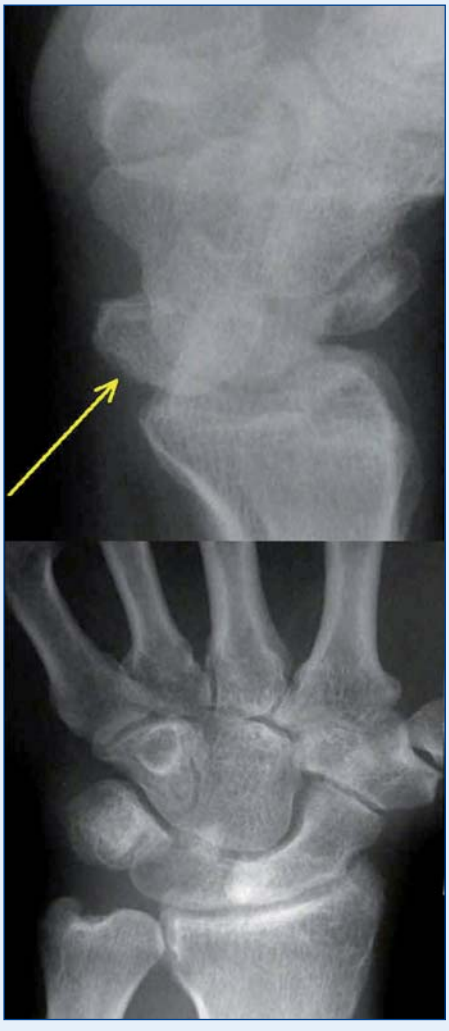


Table 1. Differential diagnosis of suspected scaphoid injury

Diagnosis	Physical and radiographic findings
Arthritis of the carpometacarpal or radiocarpal joint	Local tenderness, abnormal radiographs
De Quervain's tenosynovitis	Lateral wrist pain, tenderness over radial styloid, positive Finkelstein's test
Distal radius fracture	Local tenderness and deformity, abnormal plain radiographs
Extensor carpi radialis strain	Local tenderness, swelling, and pain elicited with wrist flexion
First metacarpal fracture	Local tenderness and deformity, abnormal plain radiographs
Flexor carpi radialis strain	Local tenderness, swelling, and pain elicited with wrist extension
Injuries to radioulnar joint	Local tenderness
Scapholunate dissociation	Tenderness over scapholunate ligament, increased gap between scaphoid and lunate on plain films
Scaphoid fracture	Anatomic snuffbox tenderness, pain with scaphoid compression test, tenderness of scaphoid tubercle

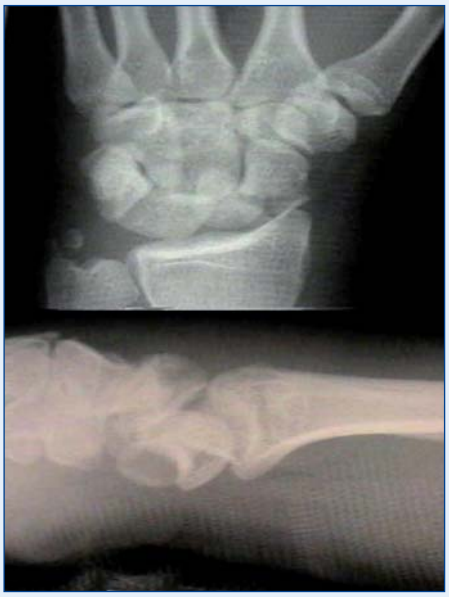
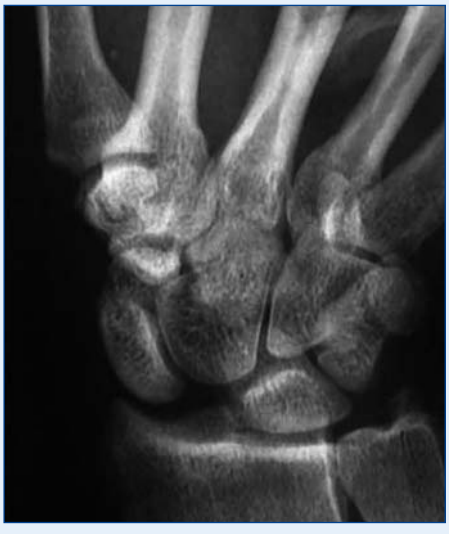


Figure 6. Trans-scapho perilunate dislocation.

the distal row of the carpus and part of the proximal row dislocate dorsally; the prefix 'peri' is used to describe undisplaced structures in the proximal row (commonly the lunate), e.g. perilunar dislocation of the carpus (*Figure 5*), periscapholunar dislocation and trans-scapho perilunar dislocation of the carpus (*Figure 6*). The latter involves a fracture of the scaphoid in addition to a perilunar dislocation. In the second group, the distal row re-aligns with the radius and part of the proximal row is extruded; these tend to be pure dislocations of a carpal bone, e.g. scaphoid, lunate (the commonest), lunate and scaphoid or lunate and part of the scaphoid.

Figure 7. Scapholunate dissociation ('Terry Thomas' sign).



Finally scapholunate dissociation (*Figure 7*) needs to be mentioned. This occurs when attachments of the lunate and the scaphoid have been completely lost by either fracture of the scaphoid or complete rupture of the scapholunate interosseous ligaments. Subtle changes on the X-ray are seen including widening of the intercarpal space with or without a fracture. Pain may be global acutely and sub-acute examination may yield more information in terms of point tenderness and ballottment or shift of the bones involved (Watson-Kirk test).

Accident and emergency management

If there is any doubt about the injury in this area, orthopaedic opinion should be sought. Interpretation of X-rays can be difficult, especially in dislocations. If dislocation is seen, then mandatory referral is recommended.

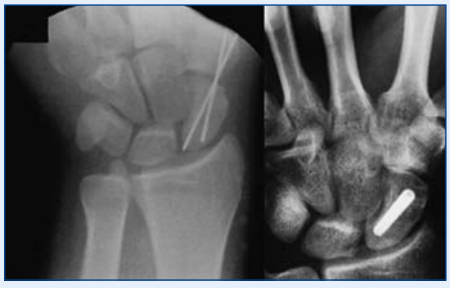
For undisplaced scaphoid fractures, no reduction is required. Importance is placed on the application of an appropriate plaster cast – a below-elbow cast with a thumb spica essentially; however, the wrist should be fully pronated, radially deviated, moderately dorsiflexed and the thumb in mid abduction. Moreover interphalangeal movement of the thumb should not be restricted. The patient should be reviewed in an orthopaedic clinic in a week.

Dislocations generally require reduction under general anaesthesia. They frequently also require fixation either percutaneously or internally so should be referred urgently, particularly if there is neurological compromise. Temporary stabilization in a volar plaster of Paris slab is adequate. A sling for elevation for reduction of swelling is helpful.

Further management

Undisplaced scaphoid fractures are casted for 6 weeks. X-ray after cast removal demonstrating union is sought. Clinical assessment is then performed. If adverse symptomology persists, however, it is not uncommon practice to allow further time in a cast for union to occur; this may be up to 4 further weeks. However, prolonged time in a cast has significant disadvantages, particularly for athletes and young employed adults, and thus

Figure 8. Percutaneous fixation of a scaphoid waist fracture.



KEY POINTS

- The scaphoid is a boat-shaped bone, which articulates directly with the radius proximally and is a critical link in the mechanism of the carpus.
- The blood supply of the scaphoid arises from the radial artery entering the scaphoid at or distal to its waist along the dorsal ridge, so fractures through the waist and proximal third render the more proximal fragment of the scaphoid at risk of avascular necrosis.
- Most wrist injuries are incurred by falling on an outstretched hand. The wrist is usually hyperextended. Radial or ulnar deviation can determine specific outcome of the injury.
- Accurate diagnosis of a scaphoid fracture can be made by evaluating tenderness in the anatomical snuffbox and over the scaphoid tubercle, pain on longitudinal compression of the thumb and range of thumb movement.
- If no fracture is seen but highly suspected, the patient is placed in a scaphoid cast and asked to return 7–10 days later for a follow-up X-ray, which is more likely to show a fracture line.
- Magnetic resonance imaging allows an early definitive diagnosis to be made and should be regarded as the gold standard investigation.
- Marked displacement of a fractured scaphoid can be associated with carpal dislocation.
- For undisplaced scaphoid fractures, no reduction is required. Importance is placed on the application of an appropriate plaster cast – the wrist should be fully pronated, radially deviated, moderately dorsiflexed and the thumb in mid abduction.

signs of delayed union or non-union (*Figure 8*) at 8–10 weeks may signal the need for operative intervention. Union rates for displaced fractures are less and lower thresholds for operative intervention predominate.

Operative options are open reduction and internal fixation with or without bone grafting, commonly with a Herbert screw (*Figure 9*), or closed manipulation and percutaneous fixation (*Figure 8*). Both techniques have good success and choice is surgeon dependent (Inoue and Shionoya, 1997; Haddad and Goddard, 1998).

Figure 9. Herbert screw fixation of a scaphoid waist fracture.

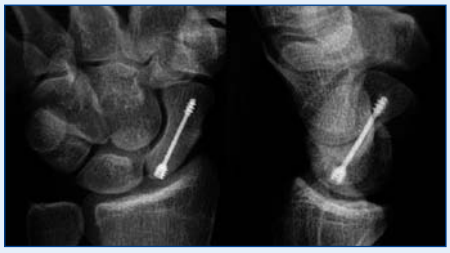
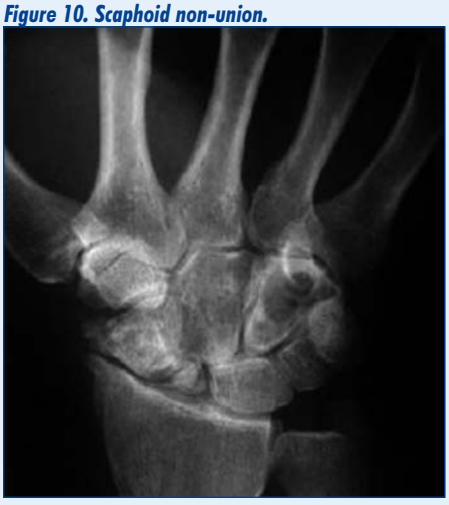


Figure 10. Scaphoid non-union.



Longer term follow up (*Figure 10*) of this group of patients is paramount as late AVN and non-union are well-recognized late complication (particularly in waist and proximal pole fractures), which may be diagnosed by MRI and will require further operative intervention. **BJHM**

Conflict of interest: none.

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