

Scaphoid Fracture Fixation Leading Keys: Educational Corner

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Background

The carpal structure consists of eight individual bones aligned in officially two rows, in axial plains, proximal and distal. The proximal row is made of three main bones and one sesamoid bone and from radial to ulnar includes scaphoid, lunate, triquetrum, and finally pisiform, which could be barely considered as an individual bone. This is because it has no articular surface attachment to proximal or distal bony structures, and is engulfed by flexor carpi ulnaris tendon. The distal row from radial side to ulnar side includes trapezium, trapezoid, capitate, and hamate. The distal row has a direct articulation with metacarpal (MC) bones, trapezium with 1st MC, trapezoid with 2nd MC, capitate with 3rd MC, and at last hamate with 4th and 5th MCs. These structures have been supported by multiple

ligaments to support their stability and ensure the axial load would divide rationally through them (1-6).

Scaphoid fractures account for two-thirds of all carpal fractures, with the highest incidence in men in their 3rd decade of life. The incidence of this fracture based on sex is estimated at 8 per 100000 women and 38 per 100000 men (7). The scaphoid fracture usually occurs when the wrist is 95° dorsiflexed and 10° radially deviated (8) with axial loading and/or dorsal compression (Figure 1).

Due to its nature and unique blood supply, the scaphoid has a higher tendency for nonunion and delayed union among other carpal bones. Dorsal and volar divisions of the scaphoid branch from the radial artery are responsible for scaphoid nourishment. The dorsal branch is in charge of 70-80% blood supply, and the volar branch is responsible for the rest.

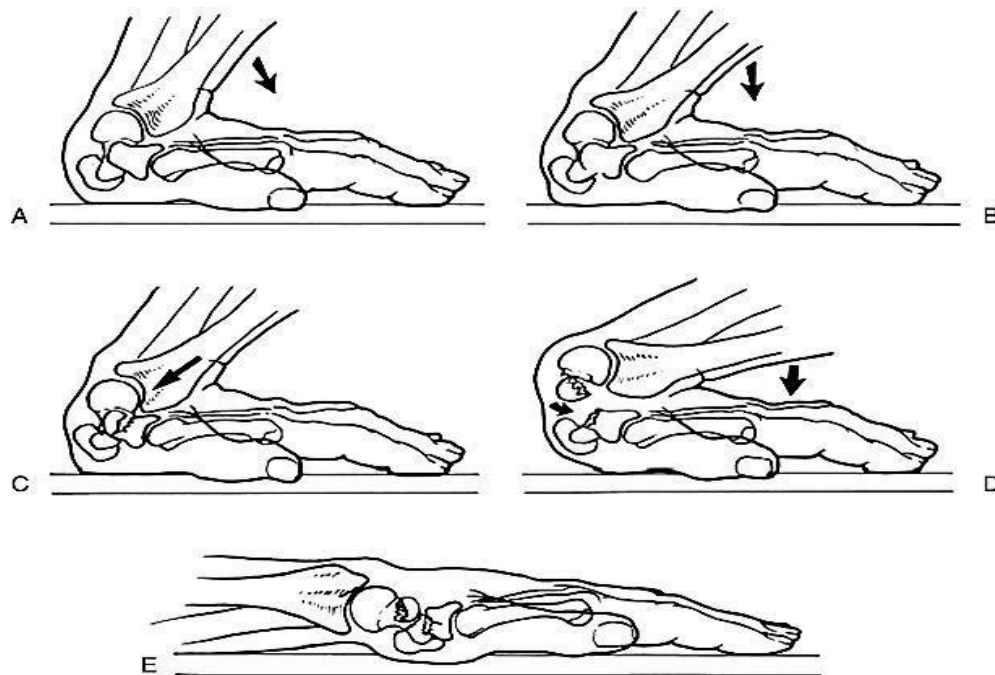


Figure 1. Mechanism of a scaphoid fracture

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Methods of Scaphoid Fracture Treatment

There are two different approaches to scaphoid fractures based on the fracture nature, non-operative and operative management.

Nondisplaced or Minimally Displaced Non-Operative Management: Several indications and contraindications have been prescribed for patients who deal with scaphoid fracture, based on fracture site, displacement, and patients' expectations, to elaborate whether they are suitable for non-operative management, as mentioned below. Indications:

1. Scaphoid tubercle fractures.
 2. Nondisplaced or minimally displaced acute fractures of scaphoid waist
 3. Displaced waist fractures in patients with multiple underlying diseases.
 4. Pediatric scaphoid fractures
- Contraindications:
1. Proximal pole fractures
 2. Scaphoid waist fractures accompanied by carpal instability
 3. Acute displaced scaphoid waist fractures

The union rate varies in each patient due to the broad spectrum of scaphoid fracture patterns and heterogeneous groups of the patients. Non-operative management is the backbone for most stable fracture patterns. Prior studies illustrated that cast immobilization could not provide expected rigid fixation, as micro motions could jeopardize unstable fracture primary grip and increase non-union rates (9). The fracture site, as mentioned earlier, is one of the major indicators to lead the surgeon for further decision making in non-operative management. Distal pole fractures and scaphoid tubercle fractures usually account for 35% of all scaphoid fractures and have the fastest period of healing. It is recommended that using a splint for 3 to 4 weeks followed by active mobilization could be beneficial (6). Isolated nondisplaced distal pole fractures are treated preferably with cast immobilization for 6 to 8 weeks. Nondisplaced acute fractures of the scaphoid waist account for 16.5% of all fractures and are treated by cast immobilization for 8 to 12 weeks. Stable proximal pole fractures which were used to be treated with nonoperative management had the longest period of time (12 to 24 weeks), but as revised in new studies, these fractures are now one of the operative indications (10, 11).

One of the main areas of debate in nonoperative management is the preferable method for cast immobilization. A multicenter prospective trial with 62 patients has confirmed by computed tomography (CT) scan within 10 weeks that casting with thumb immobilization could provide a higher average extent of union for about 85% versus 70% in patients who underwent casting without thumb immobilization (12).

Another controversy in nonoperative management is the comparison between using an above elbow cast or bellow elbow cast as the preferable method in nondisplaced scaphoid fractures for a favorable outcome. A recent meta-analysis of 523 patients with four randomized trials confirmed no difference between two groups in nonunion rates (4).

Percutaneous Fixation of Nondisplaced or Minimally Displaced Scaphoid Fractures: Percutaneous fixation is a more favorable method for minimally displaced and nondisplaced scaphoid fractures (Figure 2) rather than open reduction and internal fixation (ORIF), as it provides

faster union and maintain joint capsule and has lower surgical defects (complex regional pain syndrome, colloid formation, scars, surgical site infections, etc.) (2, 13).



Figure 2. Scaphoid waist fracture seen in the x-ray

Surgical Management: There have been several studies advocating operative management as a key role in displaced and unstable fractures. Several methods for these situations have been declared. Arthroscopy assisted fixation, ORIF, and bone grafting. Proximal pole fractures are of the main indications for operative management, and it is recommended in the literature that the preferable method to approach this type of fracture is compression screws applied with prior guidewire insertion (Figure 3). As it was discussed above, nonunion is a problem that inevitably occurs in some situations. Several themes are now declaring screw fixation only in nonunion scaphoid fractures with favorable outcomes in specific circumstances.



Figure 3. Scaphoid fracture fixed with a Herbert screw

- 1) Preserved intact cartilaginous envelope of the scaphoid (14)

- 2) Nonunion with slight or no bone resorption (< 1-2 mm) and sclerosis (< 1mm) or lack of humpback deformity, degenerative cyst, carpal instability (5)
- 3) Nonunion delayed surgery for less than one year (5)
- 4) Nonunion at the waist (5)
- 5) Nonunion in nonsmoker patients (15)
- 6) Nonunion with the absence of obvious vascular defect, especially in proximal section (5, 15, 16) [questionable finding on magnetic resonance imaging (MRI)]

Some other authors believe nonunion fractures for more than one year could also be treated with screw fixation only, understanding that it takes more time for complete union (5, 16). Avascular necrosis (AVN) due to vascular impairment scaphoid fracture can effectively diminish the healing process of fracture, especially in proximal pole fractures (17).

Therefore, a number of methods have been proposed to achieve union, for example, in humpback deformities, anterior wedge graft initialized with prior temporary pin fixation is suggested (18). Nonunion fractures leading to AVN are challenging to encounter, and lots of controversies in their management have been declared. A study by Arora et al. has been performed on the comparison of the effects of vascularized bone graft versus conventional bone graft, and in 21 patients who previously had a failure in union by a conventional method, 16 patients had complete union treated with vascularized graft (1). There has been announced several graft sites, distal radial, distal ulnar, pronator quadratus, second metacarpal bone, and medial femoral condyle; no superiority of these sites has been proved on others, however in a recently published meta-analysis, it has approved more favorable outcomes with medial condyle graft site (3).

Conclusion

Scaphoid fractures are the most common fractures in carpal bones. Male gender and athletes have higher rates of occurrence for this fracture type.

Conflict of Interest

The authors declare no conflict of interest in this study.

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