Two-Screw Fixation of Scaphoid Waist Fractures

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Optimal fixation strategy for scaphoid waist fractures remains a contentious topic with options including using a single screw, 2 screws, or a scaphoid plate. Biomechanical studies favor 2-screw fixation with regards to higher load to failure, load to 2-mm displacement, energy absorbed, rotational stability, and stiffness. Furthermore, recent retrospective studies found increased union rate with 2 screws. Although conclusive clinical data are lacking, 2-screw fixation of a scaphoid waist fracture may theoretically allow the patient to start earlier range of motion and strengthening with greater confidence. Our experience with 2-screw fixation has been promising with all acute waist fractures healing and nonunions treated with 2 screws having high union and low reoperation rates. *(J Hand Surg Am. 2020;45(8):783.e1-e4. Copyright © 2020 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Open reduction internal fixation, scaphoid, scaphoid fracture, scaphoid waist fracture.

Online Exclusive

SCAPHOID FRACTURES MOST commonly affect young, active men as a result of a fall onto an outstretched and pronated hand. Untreated or inadequately treated scaphoid fractures can result in nonunion, avascular necrosis, flexion deformity, advanced arthritis, or carpal collapse.

Treatment of scaphoid fractures remains a contentious topic and depends greatly on fracture location and degree of displacement. Fracture location is typically subdivided into the distal pole, waist, and proximal pole. Most scaphoid fractures occur at the scaphoid waist (64%).[1] Owing to the retrograde blood supply of the scaphoid and increased incidence of osteonecrosis of proximal fractures, proximal fractures are generally treated surgically. Distal pole scaphoid fractures are commonly treated non-surgically, whereas proximal pole fractures are generally treated with dorsal screw fixation. Whereas displaced scaphoid waist fractures are frequently treated with surgical fixation, management of non-displaced waist fractures is more controversial.

The surgical approach to the scaphoid is based on fracture location and displacement.

Approaching the scaphoid from the side of the smaller fragment can assist with anatomical reduction and maximize fixation. However, both volar and dorsal approaches may be used for scaphoid waist fractures.

In simulations of scaphoid waist fractures treated with percutaneous fixation, the dorsal approach proved to be the most precise for screw placement perpendicular to the fracture plane.[2] With regards to open approaches to displaced scaphoid waist fractures, both the volar and the dorsal approaches were equal with regards to perpendicular screw placement. For nondisplaced waist fractures, these authors recommended the dorsal approach for optimal screw placement.[3]

Surgical options can be further categorized into open reduction internal fixation, percutaneous screw

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fixation, and miniopen screw fixation. These all can be utilized to achieve maximal union rates while minimizing surgical morbidity and complications. Percutaneous technique is only indicated in acute nondisplaced fractures or if the reduction can be achieved by percutaneous manipulation. The miniopen dorsal technique is a modification of the dorsal percutaneous technique popularized by Slade et al.[4] It is thought to allow for easier and more accurate screw placement, have less likelihood of prominent hardware or iatrogenic tendon injury, and assist with direct evaluation of the scapholunate ligament. Miniopen and open techniques aim to decrease these risks and achieve fracture reduction by direct visualization.

Recent biomechanical studies for 2-screw fixation have been encouraging. The theoretical advantage to using 2 screws is to achieve absolute stability by maximizing compression across the fracture site while minimizing shear or rotational forces that could impede primary bone healing. With this method, the patient can theoretically start earlier range of motion (ROM) and strengthening with greater confidence in the repair. This can be especially valuable in high-level athletes and scaphoid nonunions. A biomechanical study comparing 1 3.0-mm, 2 2.2-mm, and plate fixation strategies found that 2-screw fixation had higher load to failure, load to 2-mm displacement, energy absorbed, and stiffness.[5] Another biomechanical study found 2-screw and plate scaphoid fixation was superior to single-screw fixation when checked for rotational stability.[6] A retrospective study of 32 displaced scaphoid waist fractures fixed with 1 versus 2 screws found an increased union rate with 2 screws, but no difference in ROM, grip strength, pain, and outcome scores.[7] Another retrospective study of scaphoid nonunions treated with 2 screws found the technique to be safe and effective.[8] The authors[8] concluded that 2-screw fixation can be used successfully with a variety of bone grafting techniques. We have noticed that 2-screw fixation is technically more demanding, although less so than plate fixation.

INDICATIONS AND CONTRAINDICATIONS

Indications

The primary indication for using 2-screw fixation is a displaced scaphoid waist, proximal pole fracture, or scaphoid fracture in a high-level athlete.

Contraindications

Although no definite contraindications exist to this method, displaced distal pole of the scaphoid fractures are typically fixed through a volar approach to assist with anatomical reduction and maximize fixation.

SURGICAL TECHNIQUE

The standard dorsal miniopen approach to the scaphoid is used. The patient is placed supine on the operating room table with the surgical extremity on a hand table and a nonsterile tourniquet. After induction of regional or general anesthesia, the extremity is prepared and draped in standard sterile fashion. The extremity is then exsanguinated and the tourniquet elevated to 250 mm Hg. A 2- to 3-cm dorsal incision over the wrist is made in line with the third compartment and scapholunate interval. Blunt dissection is carried down and a branch of the superficial sensory branch of the radial nerve may be identified and protected. The distal aspect of the third compartment is then opened and the contents of the second and third compartments are retracted. A T-shaped arthrotomy is made in the dorsal wrist capsule to expose the proximal scaphoid, sparing the dorsal intercarpal ligament. Any intracapsular hematoma can be evacuated and the integrity of the scapholunate ligament assessed. The capsule incision can be extended to visualize the fracture site to confirm reduction, but carefully so that the dorsal vascularity to the scaphoid is minimally disrupted.

The appropriate start points must be identified for antegrade screw placement. A 0.86-mm guide pin is placed down the long axis of the scaphoid in antegrade fashion with appropriate trajectory and length confirmed under fluoroscopy. A second pin is placed in a similar trajectory and confirmed with fluoroscopy, ensuring that both screws would be placed well past the fracture site. The pins should be placed in parallel in either the anteroposterior or the lateral plane depending on the size of the scaphoid. Convergence of the screws should be avoided. The guidewires are overdrilled using an appropriate size drill under continual irrigation with a cannulated cortex perforating drill, followed by the cannulated intraosseous drill. Demineralized bone matrix can then also be placed into the screw holes. Fully threaded headless compression screws are placed and advanced incrementally in an alternating fashion to avoid the risk of an asymmetrical reduction or compression. Size of the screws is dependent on the size of the scaphoid and location of the fracture. We have been able to put in two 3.5-mm screws in large scaphoids. The wound is then copiously irrigated. The dorsal capsulotomy is then closed in a watertight manner with 3-0 nonabsorbable suture. The extensor pollicis longus tendon should remain well

seated within the third dorsal compartment, and the wound is closed in a standard layered fashion. After application of a sterile dressing, a thumb spica orthosis is applied.

POSTOPERATIVE MANAGEMENT

These patients follow-up in the clinic 2 weeks after surgery for suture removal and thumb spica orthosis or cast placement. For acute fracture treatment, initiation of hand and wrist ROM and grip strengthening exercises with a removable thumb spica orthosis is started at 3 weeks after surgery. Then, the patients are progressed to unprotected sport activities at 2 to 3 months after surgery once healing is confirmed, with initiation of full axial loading 6 months after surgery.

PEARLS AND PITFALLS

The primary pearls and pitfalls of this technique involve choosing appropriate start points and trajectories for the 2 screws to remain perpendicular to the fracture plane and ensure that both screws will be placed in parallel well past the fracture site. Furthermore, using a mini-open approach decreases the risk of prominent hardware or iatrogenic tendon injury and assists with direct evaluation of the scapholunate ligament.

COMPLICATIONS

Complications of 2-screw fixation are similar to other techniques utilizing the dorsal approach, including nonunion, hardware failure, injury to the superficial sensory branch of the radial nerve, the radial artery, and the extensor pollicis longus tendon. Our experience in the past 4 years with 2-screw fixation has been promising. All acute waist fractures treated with 2 screws healed, whereas nonunions treated with 2 screws had higher union rates and lower reoperation rates than single-screw constructs. No other complications have been observed.

CASE ILLUSTRATION

A 20-year-old right-handed high-level athlete presented to the clinic 3 days after sustaining a fall on an outstretched left hand. His examination revealed tenderness to palpation at the anatomical snuff box and dorsal wrist. Imaging confirmed a nondisplaced scaphoid fracture with possible strain of the scapholunate ligament. Treatment options were discussed with the patient including nonsurgical treatment, delayed surgical treatment (after the end of the season), and prompt surgical treatment. After the patient's consideration of personal goals and return to activity, he elected to proceed with prompt surgical management of his injury.

FIGURE 1: Miniopen view after removal of the guidewires.

The patient was taken to the operating room within a few days for open reduction with internal fixation as described. During surgery, the dorsal scapholunate ligament was noted to be intact. Throughout wrist ROM, no gapping was appreciated at the fracture site and the scaphoid and lunate moved as a unit, further suggesting ligament competency. Excellent purchase of the screws and adequate burial of the screw heads under the chondral surface proximally were confirmed. Figure 1 demonstrates the intraoperative photograph after removal of the wires, confirming screw placement below the chondral surface. Figure 2 demonstrates the intraoperative fluoroscopy images. A thumb spica orthosis was applied and the patient was discharged home with postoperative management as described previously. After fracture healing was confirmed, the patient returned to modified training at 2 months after surgery and full sports activities at 3 months after surgery. At the final 6-month appointment, he was asymptomatic with full ROM of his wrist and had resumed his full sports activity with initiation of axial loading (Fig. 3).

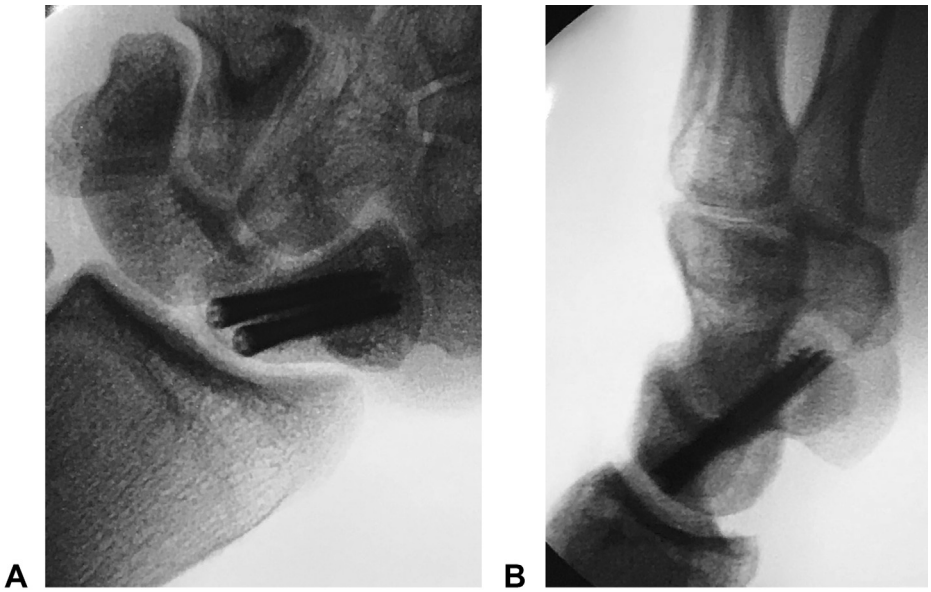

FIGURE 2: Intraoperative **A** posteroanterior and **B** lateral radiographs.

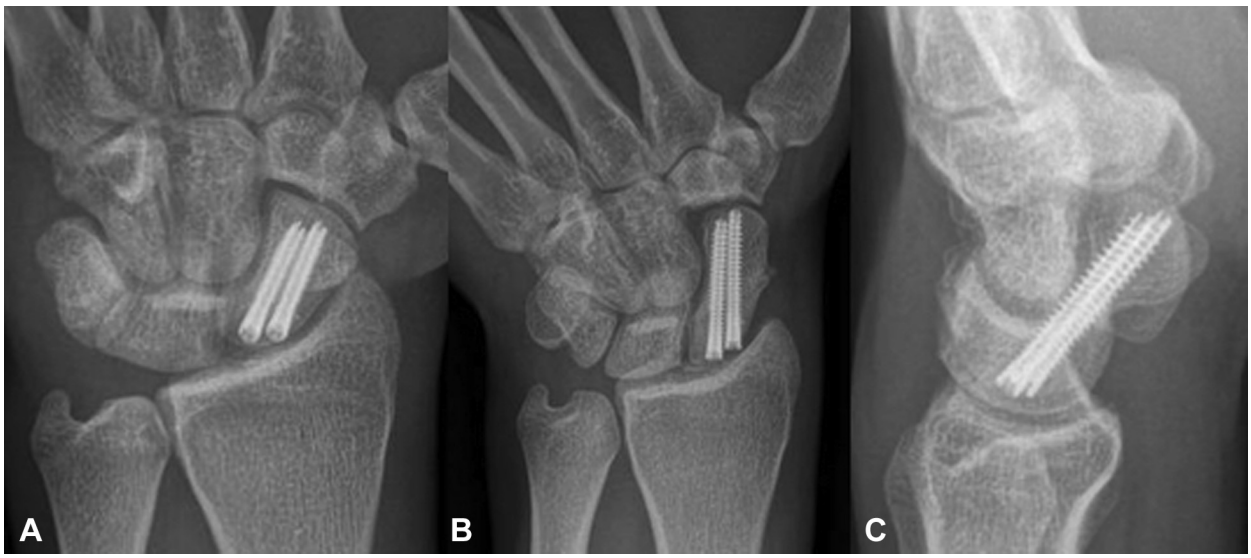

FIGURE 3: Six-month follow-up **A** posteroanterior, **B** navicular, and **C** lateral radiographs show healed fracture without complication.

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