

Screw Fixation Without Bone Grafting for Delayed Unions and Nonunions of Minimally Displaced Scaphoids

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Take-Home Points

- Scaphoid nonunions can occur in minimally displaced fractures.
- If there is no deformity of the scaphoid delayed or nonunion, then a percutaneous screw fixation without bone grafting can reliably lead to bony union.
- Not all scaphoid delayed unions and nonunions require bone grafting.

Scaphoid nonunions or delayed unions with displacement, humpback deformities, or dorsal intercalated segmental instability deformities require open exposure with reduction of the fracture and autogenous bone grafting (structural or nonstructural and vascularized or nonvascularized).^{1,2} However, in the absence of displacement or deformity, compression and internal fixation without bone grafting may be sufficient to achieve union.

Several reports have described the use of internal fixation alone in the management of scaphoid nonunions with both minimal and extensive bone loss.³⁻⁷ These studies have shown that screw fixation alone affords less morbidity to the patient while allowing high rates of union.

Previous reports of internal fixation alone included limited numbers of patients for review. Therefore, we aim to

review a large consecutive series of scaphoid delayed unions and nonunions without osteonecrosis or deformity managed by only internal fixation. Our hypothesis is that drilling combined with compression and rigid stabilization would allow for bony union in these cases.

Materials and Methods

After Institutional Review Board approval was obtained, a retrospective review of prospectively collected data was performed on consecutive patients with a delayed union or nonunion of the scaphoid. All injuries had failed conservative treatment of casting for at least 12 weeks and ultrasound stimulation, and were subsequently treated by compression screw fixation by 1 of 2 fellowship trained hand surgeons. The database comprised the data of patients who presented to a single, Level 1 trauma center between 2000 and 2012.

Delayed unions and nonunions were defined as a lack of radiographic trabecular bridging and pain on clinical examination at 3 and 6 months, respectively. All fractures were nondisplaced or minimally displaced (<2 mm), and patients with carpal malalignment or humpback deformity (based on scapholunate angle on plain radiographs) were excluded. Clinical outcome measures included evidence of radiographic union, revision surgery, pain, and reported complications.

Inclusion criteria were all patients who sustained a minimally displaced scaphoid fracture and were treated conservatively with casting for at least 12 weeks and ultrasound stimulation, and progressed to delayed unions or nonunions.

Patients younger than age 18 years or with radiographic evidence of arthrosis or humpback deformity were excluded. Any fracture with >2 mm of gapping on original injury radiographs was not considered as minimally displaced and was also excluded. Furthermore, patients with a previous ipsilateral scaphoid injury or hand surgery were also excluded.

Compression screw placement was recorded as being either central or eccentric based on Trumble and colleagues⁸ criteria. Posteroanterior (PA), lateral, and scaphoid view radiographs were reviewed by the first author (DS) and the treating hand surgeon (AS). Central screw placement was substantiated if the screw was in the middle third of the proximal pole in all 3 views.

The final set of postoperative radiographs was reviewed for unions. Union was defined as bridging trabeculation with near or complete obliteration of the fracture line on PA, lateral, and scaphoid radiographic views. Computerized tomography (CT) was performed at the discretion of the treating surgeon, and its use was not required if there was near obliteration of the fracture line on the 3-view radiographs and in the absence of patient-reported pain. Patients with bone loss or sclerosis were included as long as no deformity existed.

After surgical intervention, a short-arm cast was applied for 6 weeks, followed by a wrist splint for 4 to 8 weeks depending on patient comfort.

Surgical Technique

Either a 1-cm to 2-cm transverse incision distal to Lister's tubercle or a longitudinal incision just ulnar was utilized. The extensor pollicis longus was identified and retracted. A longitudinal or an L-shaped capsulotomy was made to identify the proximal pole of the scaphoid. With the wrist flexed, a guide wire was inserted down the central axis of the scaphoid and confirmed by fluoroscopy. The measurement was made off the guidewire and 4 to

6 mm was subtracted. The scaphoid was then drilled, and the variable pitch compression screw (Acutrak Headless Compression Screw, Acumed) was inserted. Compression and position of the screw were confirmed by fluoroscopy before closure.

Results

A total of 23 patients (19 males, 4 females) with acute scaphoid fractures who were treated conservatively with casting for at least 12 weeks and ultrasound stimulation, and progressed to delayed unions or nonunions were identified in this study. The ages of the patients ranged from 19 to 50 years. Of the 23 patients, 6 were smokers. The majority of patients sustained fractures in the scaphoid waist (18 patients) (**Figure 1**). Two patients had distal third fractures, and 3 had proximal third fractures.

The average time from the sustained injury to the surgical intervention was 8.2 months (range, 3.1-27.6 months). There were no patients with delayed diagnoses. Three fractures were identified as delayed unions with failure of union and pain after 3 months of conservative treatment, whereas the other 20 were identified as nonunions with at least 6 months of failed conservative treatment.

Of the 23 patients, 21 were found to have centrally placed variable compression screws based on Trumble and colleagues⁸ criteria. Of the 23 patients, 19 had a complete follow-up course with radiographs at 6 months after surgery. All of these 19 patients had evidence of radiographic union defined as bridging trabeculation with near or complete obliteration of the fracture line on PA, lateral, and scaphoid radiographic views (**Figure 2**). Of the 6 smokers, 5 progressed to radiographic union and 1 patient had <6 months of postoperative return visits and could not be contacted. At the final clinic visit, all of the 19 patients denied wrist pain on direct palpation over the scaphoid tubercle, and no complications were reported. There were no repeat or revision surgical interventions.

Four patients had limited follow-up with <6 months of postoperative return visits. Their final set of radiographs did not demonstrate complete bridging trabeculation. One patient who moved away from the area was lost to follow-up but was contacted. The patient stated that he had a pain-free wrist with no further surgical interventions on his scaphoid. The other 3 patients could not be contacted.

Discussion

The management of scaphoid nonunions and delayed unions has dramatically evolved over the past 20 years.^{1,3-8} Historically, semi-rigid stabilization using Kirschner wires and casting afforded a 77% union rate in these cases.⁹ More recently, several authors have reported that stabilization without bone grafting can predictably unite scaphoid nonunions. Treating patients with uncomplicated scaphoid nonunions and delayed unions by internal fixation alone may be all that is required to achieve union.

The definitions of a scaphoid nonunion and delayed union are complex. The exact time when a scaphoid fracture heals varies between patients.^{2,5,10} However, the majority of hand surgeons believe that failure to see clear signs of healing (in waist fractures) after 3 months from the injury would suggest a failure to heal and a “delayed” union, whereas failure after 6 months from the injury and without clear signs of healing indicate a nonunion.^{5,6,10,11} Any resorption at the fracture site suggests that the fracture will not heal by continued immobilization alone and will require surgery.¹⁰

Hand surgeons have several surgical options when managing scaphoid injuries. Mahmoud and Koptan⁴ used a volar approach to percutaneously deliver a headless compression screw into 27 nonunions. Postoperative CT scans

demonstrated fracture union in all 27 patients, and no patient underwent revision surgery. Interestingly, 14 of their patients had extensive preoperative resorption (but no deformity) of >5 mm.

Although volar percutaneous approaches for internal fixation have been cited to provide high rates of union and high patient satisfaction in acute scaphoid fracture fixation, this study utilized a dorsal approach. Both Wozasek and Moser¹² and Haddad and Goddard¹³ reported excellent results and high union rates using a volar approach in consecutive acute scaphoid fractures. Despite these results, there are concerns that using a volar approach may damage the scaphotrapezial joint and may be prone to eccentric placement of compression screws.^{8,14}

Slade and colleagues³ did utilize the dorsal approach with arthroscopic assistance to deliver a compression screw into scaphoid nonunions in 15 consecutive patients without any evidence of deformity, sclerosis, or resorption. Similar to our investigation, they treated patients with both delayed unions and nonunions. CT scans were used to confirm unions in all their patients. Using a dorsal approach, Yassaee and Yang¹⁵ treated 9 consecutive patients using a compression screw without bone grafting for both delayed and nonunion scaphoid injuries. Other authors have used both volar and dorsal approaches in 12 consecutive delayed and nonunion scaphoid injuries and found that 11 of the 12 injuries progressed to unions.⁶

Although these authors and several others advocate the use of CT scans to assess unions, our investigation used bridging trabeculation obliteration of the fracture line on 3 standard radiographic views to confirm unions in addition to the absence of pain clinically.^{16,17} CT scans expose the patient to increased radiation that, in our experience, does not alter the postoperative clinical course.¹⁸ If there is clear evidence of bridged callus and no pain on physical examination, a CT scan performed to reconfirm the union affords little benefit to clinical management.¹⁹

All these previous studies have demonstrated excellent union rates but using a limited series of patients. We reviewed a large number of consecutive patients with scaphoid delayed unions and nonunions treated by screw fixation without bone grafting. Our hospital is a safety net institution for a large urban catchment area and had complete radiographic and clinical data for 19 of our 23 patients. One patient was contacted by telephone and he reported no pain and no revision surgical interventions.

The limitations of this study include not only its retrospective design but also its limited secondary outcome measures. However, our primary outcomes of union, pain, and complications are of utmost importance to clinicians and patients alike. Similar to other authors, we used radiographs to confirm unions. Although bridging trabeculation in radiographs has been demonstrated as soon as 1 month after the injury, there may be problems with interobserver reliability.^{4,13,15,20,21}

Patients being lost to follow-up is not uncommon in the orthopedic trauma literature and can influence results.^{22,23} It is speculative to infer that the 3 patients who did not complete a follow-up course did not return because their pain had mitigated.

Conclusion

Like several fractures, the lack of stability and the absence of micro-motion are believed to contribute to fibrous nonunions in scaphoid fractures.¹³ This study provides a large consecutive cohort of patients with minimally displaced scaphoid delayed unions and nonunions that were successfully treated by rigid internal fixation without bone grafting. These results confirm previous reports that bone grafting is not required to provide predictable unions for the majority of scaphoid nonunions.

This paper will be judged for the Resident Writer's Award.

Key Info

Figures/Tables

Figures / Tables:

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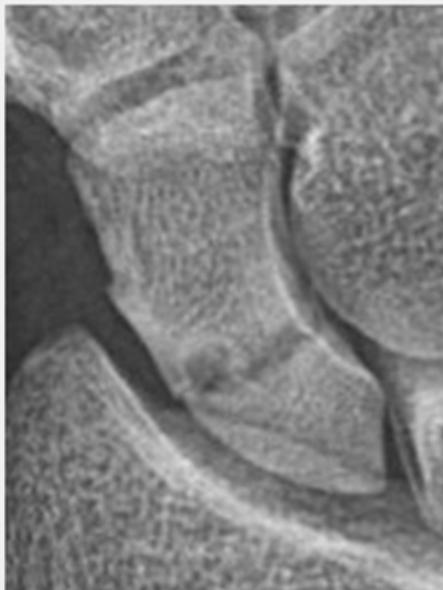


Figure 1. Posteroanterior radiograph of the wrist demonstrating a transverse scaphoid waist nonunion in a 25-year-old man, 9 months after his sustained injury.

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Figure 2. Postoperative posteroanterior radiograph of the wrist demonstrating bridging trabeculation and union 6 months after rigid stabilization using a compression screw.

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