Treatment of Delayed/Nonunion of Scaphoid Waist with Synthes Cannulated Scaphoid Screw and Bone Graft

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Received: 3 February 2008 / Accepted: 24 April 2008 / Published online: 10 June 2008
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Abstract Fracture of the scaphoid bone is the most common fracture of the carpus, and frequently, diagnosis is delayed. The unique anatomy and blood supply of the scaphoid itself predisposes to delayed union or nonunion. The Synthes scaphoid screw is a cannulated headed screw, which provides superior compression compared with some other devices used to internally fix scaphoid nonunions. Our aim was to conduct a retrospective study looking at the union rate, time to union, and complications and correlating the outcome of treatment against the delay between injury and surgery and location of the fracture within the bone. This study is a review of a cohort of 30 patients treated with a cannulated Synthes scaphoid screw and corticocancellous bone grafting for scaphoid waist delayed union and nonunion at our center. We achieved 86% overall union rate. The patients with delayed union achieved a 100% union rate. Three out of four patients with persistent nonunion after surgery reported no pain and improved function. The failure rate was 75% in patients who had sustained their fracture more than 5 years previously. Our study demonstrates that delayed union of scaphoid waist fractures and scaphoid waist nonunions present for less than 5 years can be successfully treated by fracture compression and bone grafting.

Keywords Scaphoid · Delayed union · Nonunion · Synthes scaphoid screw fixation · Bone graft

No support of any kind was received from anybody.

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Introduction

The reported incidence of nonunion for scaphoid fractures is about one in ten [3, 6]. Nonunion can be painful and, if left untreated, often leads on to osteoarthritis [8]. Surgical treatment of scaphoid nonunion by excision back to bleeding bone, insertion of a corticocancellous bone graft and stabilization, usually with a screw, can be highly successful at achieving union [5].

A variety of implants suitable for treating nonunion of the scaphoid are available. The Herbert screw, AO scaphoid screw, Heune scaphoid screw, and Richards's navicular screw have been compared in vitro with the AO scaphoid screw producing the most compression [14]. Correct placement of the screw used is also important to maximize compression and provide stable fixation. Because of the complex three-dimensional shape of the scaphoid, correct positioning of the screw within the bone can be difficult [4], and various cannulated screws are available allowing the position of a guide wire to be checked fluoroscopically before drilling and screw insertion. Most scaphoid fractures are perpendicular to the long axis of the bone, and maximum compression with a screw will, therefore, be achieved by inserting it along the long axis of the bone. With retrograde insertion, the ideal entry point is, therefore, going to be through the articular surface on the distal end of the scaphoid. This is only possible with a headless screw, but there are still some concerns that opening the scaphotrapezial joint and inserting a screw through the articular surface may cause osteoarthritis of the joint [7, 12].

The Synthes scaphoid screw (Stratec Medical, Welwyn Garden City, Hertfordshire) is a cannulated headed screw (Fig. 1), which the senior author has used to treat scaphoid nonunions since 1998. Before 2003, we used the 3.5-mm screw. In 2003, the manufacturer made a smaller screw

Figure 1 Synthes cannulated scaphoid screw.

(3.0 mm) available, which we used in the remaining of our series, as we felt that a smaller screw would retain more bone and give better results.

We have retrospectively reviewed our results looking at union rate, time to union, and complications and correlated the outcome of treatment against the delay between injury and surgery and location of the fracture within the bone.

Material and Methods

Between 1998 and 2005, the senior author treated a cohort of 30 patients with symptomatic delayed union or nonunion of the scaphoid by open reduction and internal fixation with the Synthes cannulated scaphoid screw and insertion of corticocancellous bone graft.

All fracture nonunions were diagnosed by both clinical and radiological methods. Those treated less than 6 months from injury were diagnosed as delayed union and those ununited more than 6 months from injury were diagnosed as nonunion. There were ten patients with delayed union and 20 with nonunion. Their average age was 30.5 years (range 16–59 years), and 27 out of 30 were males. The dominant hand was injured in 21 patients. The commonest mode of injury was a fall on outstretched hand, mostly during sports.

Seven patients presented late and nine other patients were not diagnosed at first presentation. Only seven out of 30 (23%) were diagnosed and treated conservatively on first presentation and then went on to delayed or nonunion.

The average time from injury to surgical treatment for delayed union was 3 1/2 months (range 2–5 months) and for nonunion, it was 38.1 months (range 6–132 months). The time interval between diagnosis and surgical fixation averaged 5.8 weeks (range 5 days to 17 weeks).

Technique A A standard volar approach was used. The proximal radial corner of the trapezium was removed to allow a more ulnar entry point of the screw so that it was more perpendicular to the fracture. The nonunion was exposed, and the bone was excised back to bleeding bone. No sign of union was seen in any of the scaphoid fractures intraoperatively. All the patients received an autologous corticocancellous bone graft harvested from the iliac crest. A guide wire was inserted under fluoroscopic control, the bone drilled with the cannulated drill, and the entry point in the distal pole overdrilled so that the head of the screw could be countersunk. The drill size for 3.0 mm screws was 2.0 mm and the countersink was 3.0 mm. For the 3.5 mm screws, the drill size was 2.7 mm and the countersink was 3.5 mm. Screw length was determined by measuring the guide wire with provided measuring device.

Postoperatively, all patients were immobilized in a scaphoid plaster for 6 weeks. They were reviewed at 2 weeks after surgery and then at 6, 12, and every 4 weeks until outcome were established. Final outcome, i.e., union at fracture site was assessed both clinically and radiologically (Fig. 2).

Figure 2 Internal fixation of scaphoid delayed union—union achieved.

Table 1 Outcome of patients who achieved scaphoid union with the 3.5-mm screw.

Pain grade	Functional outcome	Osteoarthritis	Number of patients
No pain	Normal	None	16 (76%)
Mild pain	Normal	1	4 (19%)
Moderate pain	Some restriction of daily activities	1	1 (5%)
Daily severe pain	Severe restriction of daily activities	None	None

Results

All patients were followed-up. One patient had undergone Herbert screw fixation at another center before presenting to us and was, therefore, excluded from this study. Twenty-five out of 29 patients (86%) achieved union in an average time of 19 weeks (range 8–85 weeks).

Out of 29 patients, 22 were treated with 3.5 mm screw and bone graft. All of them achieved union except one. Ten patients were treated for delayed union, i.e., had their surgery less than 6 months from injury. All these ten patients had scaphoid waist fractures, and all of them were diagnosed to have united both clinically and radiologically in an average follow-up time of 19 weeks (range 6–62 weeks; approximate 95% confidence interval for the true mean being 7 to 31 weeks). A typical example is shown in Fig. 2. Of the remaining 12 patients with nonunion, the interval between injury and surgery ranged from 6 to 132 months (mean 38 months). Eleven out of these 12 patients (91%) were diagnosed to have united in a mean follow-up time of 19 weeks (range 6 to 58 weeks; approximate 95% confidence interval for the true mean being 11 to 26 weeks).

Seven out of the total 29 patients presented after 2003 and were treated with 3.0 mm screw with bone graft. None of them had delayed union. The interval between injury and surgery for these patients ranged from 7 to 145 months (mean 64 months). Four out of these 7 patients (57%) were diagnosed to have united in a mean follow-up time of 7 weeks (range 6 to 8 weeks). The remaining three patients with persistent nonunion presented more than 5 years after the initial injury.

All the patients were assessed for any persistent pain including grade of pain, any restriction of daily activities, and

osteoarthritis. All the patients who achieved union were able to get back to normal life and only one out of 25 patients had some restriction of daily activities like carrying heavy weights and pushing heavy objects. The final clinical outcome of patients who achieved union with either screw is detailed in Tables 1 and 2.

Of the 29 scaphoid waist nonunions, four failed to unite radiologically. None of the four patients had received any treatment at the time of injury. Of these four patients, one patient presented 1 year after injury but achieved complete pain relief after surgery.

The second patient had presented 7 years after injury with a dorsal intercalated segment instability deformity and early osteoarthritis. After surgery, his pain improved and he had no restriction of movement or activity. The third patient also presented 7 years after injury but achieved complete pain relief after surgery. The fourth patient presented 13 years after injury. After his operation and failure to achieve union, he complained of mild pain. Three out of four (75%) patients with persistent nonunion had good pain relief and were able to return to normal activities after fixation. There were no cases of infection.

Discussion

Internal fixation of the scaphoid is recommended for acute fractures that are displaced and for those with delayed healing or established nonunion. The patients included in this study had delayed union or established nonunion.

Various screws are available for fixation of the scaphoid. Since its introduction, the Herbert screw has been a widely used implant for scaphoid fixation, and several series have

Table 2 Outcome of patients who achieved scaphoid union with the 3.0-mm screw.

Pain grade	Functional outcome	Osteoarthritis	Number of patients
No pain	Normal	1	4 (100%)
Mild pain	Normal	None	None
Moderate pain	Some restriction of daily activities	None	None
Daily severe pain	Severe restriction of daily activities	None	None

been reported with a high success rate of achieving union. Its compressive capability, however, is less than other available implants and little interfragmentary compression is achieved with this screw unless fracture fragments are intimately apposed and compressed using the jig before insertion [14]. Central placement of the screw in the proximal pole of the scaphoid is likely to be beneficial for increasing union rates. Trumble et al. [17] found that the rate of central placement is higher with cannulated screws than with Herbert screws. Biomechanical evaluation of screws used for scaphoid fixation have shown that the cannulated Synthes scaphoid screw has a more standard mechanism of achieving compression and provides greater compressive forces than the Herbert screw [9]. However, we were unable to find any biomechanical studies on the recently introduced screws in the market.

Because of these potential theoretical advantages of the Synthes cannulated scaphoid screw, the senior author has used this screw for treating delayed and nonunions of the scaphoid. The union rate after operative management for scaphoid nonunion varies in different studies from 77% to 94% [2, 5, 10]. In some reported series, authors have achieved high rates of union (up to 98%) by excluding proximal pole fractures [1, 15].

We are unable to find published clinical studies on Synthes cannulated screw fixation for scaphoid nonunion. In our series, union rate was high in all patients treated within 5 years of injury with Synthes screw and cancellous bone grafting viz. 21 out of 22 patients (95%) with 3.5 mm screw and all the four patients treated with 3.0 mm screw. The combined union rate for scaphoid waist nonunion for the series with both the screws was 86%, and this increased to 96% when only patients who had had a nonunion for less than 5 years are considered.

Three out of four patients with persistent nonunion had symptomatic improvement and were able to return to normal activities with minimal pain. It seems, therefore, that stabilization of the nonunion can be helpful in relieving symptoms even if union is not achieved. It is not yet clear whether this beneficial effect will persist in the longer-term, and we would endeavor to report our results of long-term follow-up of these patients.

There have been contradictory reports on the association between the union rate after surgery and the interval between original injury and subsequent nonunion surgery. Nakamura et al. [11] believed that the time interval between the original injury and subsequent surgery is one of the primary determinants of the outcome of surgical treatment for scaphoid nonunion, whereas Trezies et al. [16] claimed that there is no association between the two. In our series, none

of the patients with scaphoid waist fractures more than 5 years old achieved union.

We believe that better positioning and compression achieved with this screw helped achieve the good union rate in our series. However, it is just as likely that there were other factors which could have contributed to the result, namely, the surgical technique and the corticocancellous bone graft. The surgical technique we used has been well-described in the standard hand surgery textbooks. Treatment with bone graft alone has been shown to give good results but requires prolonged immobilization [13]. Unfortunately, it is beyond the scope of this paper to discuss all the factors helpful in the management of scaphoid nonunion.

One of the drawbacks of this screw is that it has no proximal thread and so, if the fracture fails to unite, there is a potential danger of the screw backing out into the scapho-trapezial joint. This disadvantage may not be seen in a double-pitched or continuous-pitch screw.

Our study demonstrates that delayed union of scaphoid waist fractures and scaphoid waist nonunions present for less than 5 years can be successfully treated by fixation with this device and bone grafting. Patients who present more than 5 years after injury have very high chances of persistent nonunion, but can improve symptomatically.

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