Percutaneous fixation of acute scaphoid fractures

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Background
Fractures of the scaphoid are common in young men. Cast immobilization usually means a long period away from work and athletic activities. Early rigid fixation has been shown to promote a rapid functional recovery, but open reduction and internal fixation is technically demanding with the risk of damage to the radiocarpal ligaments, the scaphotrapezial joint, and the blood supply of the scaphoid.

Purpose
The aim of this prospective case series study was to evaluate percutaneous scaphoid fixation for minimally displaced or undisplaced B1 or B2 fractures with respect to time to radiographic union and return to work.

Patients and methods
We report our technique and the results of a prospective study in 12 patients with acute scaphoid fractures. Patients were assessed functionally using the Mayo wrist score and by radiography. The patients were followed up until evidence of radiologic union (35–70 days), with an average of 55 days.

Results
Ten patients had excellent score and two patients had good score according to the Mayo wrist score. According to patients' occupations, return to work ranged from 14 to 40 days. With respect to radiologic union, fractures were united at a mean of 55 days (35–70 days).

Conclusion
Percutaneous fixation for acute scaphoid fractures using Herbert screws is a satisfactory method and gives rapid functional recovery.

Keywords:
Herbert screws, percutaneous fixation, scaphoid fractures
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Introduction

Fractures of the scaphoid bone are common but the management is controversial [1]. For displaced fractures and for nonunion, Herbert screw fixation is an accepted method of treatment [2], but for minimally or undisplaced fractures the role of surgery remains controversial [3].

The scaphoid bone is a boat-shaped bone in the human wrist and is the largest bone of the proximal row of the carpus on the lateral (radial) side, articulating with the radius, lunate, capitate, trapezium, and trapezoid. The scaphoid is surrounded on 80% of its surface by joint fluid containing fibrinolysin, a substance that dissolves blood clots. Because blood clots are necessary for healing of bone fractures, the substantial presence of fibrinolysin around the scaphoid inhibits healing of the fracture of that bone unless the fracture fragments are fixed in sufficiently good apposition such that joint fluid is prevented from entering the fracture site [4]. Failure to properly fix the bone fragments into apposition will result in a nonunion because of the presence in the fracture site of joint fluid [5].

In addition to an undesirable nonunion resulting from poor apposition, a fracture of the scaphoid through its waist often leads to avascular necrosis or death of the distal pole of the bone. This is because the blood supply to the bone is chiefly through the proximal pole and an unhealed fracture at the bone waist cuts off the blood supply to the distal pole, resulting eventually in severe arthritis and deformity of the wrist [4].

The closed (cast) treatment of acute scaphoid fractures generally has good outcome, with bony union; however, closed treatment can result in delayed union, nonunion, malunion, cast-induced joint stiffness, and lost time from employment and avocations [6].

The traditional conservative treatment of a fractured scaphoid includes the application of a cast to the hand and thumb with the hand in radial deviation in an effort to oppose the fracture ends of the bone. Surgical intervention to fix the scaphoid bone typically includes the use of a Herbert screw, which requires the expertise of a hand surgeon specialist and results in an extended exposure of the scaphoid bone [7].

Most scaphoid fractures are seen in young men who may be manual workers or athletes. In such cases, the avoidance of prolonged cast immobilization is an advantage, and nonunion can occur making this hand

disabled giving physical and economic morbidity [8]. Early fixation allows early mobilization and return to full function. However, open fixation is associated with extensive soft-tissue stripping and damage to the anterior radiocarpal ligaments [9], and infection and painful scars may be troublesome postoperative problems and reflex sympathetic dystrophy may be catastrophic [1]. A closed procedure allows day case surgery for scaphoid fixation and early mobilization with fewer complications. Percutaneous screw fixation of the scaphoid was first reported by Streli [10], but reservations were expressed after poor preliminary results [11]. Cosio and Camp [12] used multiple percutaneous pins for scaphoid nonunion with 77% success. Wozasek and Moser [13] reported a percutaneous technique with cannulated 2.9-mm screws and had a success rate of 89%. Ledoux *et al.* [14] reported union in 23 patients, with 95% range of movement compared with the other side and a better key pinch than in the contralateral hand. Inoue *et al.* [15,16] had published excellent results for Herbert screw fixation through limited access but warned that a considerable degree of surgical skill was necessary. To complement such limited approaches, Whipple [17,18] has advocated scaphoid stabilization under arthroscopic control.

The percutaneous method used to fix a scaphoid fracture with a screw in the absence of the surgical procedures of the past leads to minimization of surgical exposure of the wrist, with the attendant increased risk for infection and limitation of wrist movement [7].

We describe our percutaneous technique using the Herbert screw to stabilize acute scaphoid fractures and present the short-term results of our prospective study to determine its safety and efficacy.

Patients and methods

The aim of this study was to assess the outcome of percutaneous fixation of scaphoid fractures. It was a prospective case series study conducted at Suez Canal University Hospitals from January 2007 to January 2010. Patients with scaphoid fracture of all age group and of both sexes were involved in this study. Fractures were classified according to the Herbert classification [8]. Twelve patients were involved in this study, with age ranging from 18 to 40 years and a mean age of 29 years. Eleven patients were male and one patient was female. Ten patients had fracture in the dominant hand and two had fracture in the nondominant hand. According to the Herbert classification, four patients had type B1 and eight had type B2. The mean time from injury to surgery was 4 weeks (11 days to 5 weeks). Plain radiographs showed the fracture in 11 patients, and one patient needed computed tomography scan for the confirmation of scaphoid fracture. However, two more computed tomography scans were performed to exclude other injuries before surgery. Preoperatively, all patients had been immobilized in below elbow scaphoid casts and they were removed at night before surgery to try to improve the skin condition. The patients were followed up for 35–70 days until evidence of radiologic union, with an average of 55 days. The clinical outcomes were assessed using the Mayo wrist score [19], and radiologic union was defined as cross-trabeculation on all three standard views.

Operative technique

Under general or regional anesthesia, the patient is placed supine, no tourniquet is used, with ulnar deviation of the wrist to give access to the distal pole of the scaphoid. Ulnar deviation of the wrist slides the scaphoid out from the radial styloid process and, in this position, under image intensifier control, a longitudinal incision less than 0.5 cm is made at its most distal radial aspect. Blunt dissection is used to expose the distal pole of the scaphoid (Figs 1 and 2). A percutaneous K-wire 1.8 mm in size is introduced into the scaphotrapezial joint. It is directed in two views toward the center of the proximal pole of the fractured scaphoid and advanced until it arrives in an adequate position on both views. This requires an appreciation of the 45° obliquity of the scaphoid in both anteroposterior and lateral planes. Anatomic reduction of the scaphoid with correction of any palmer flexion before fixation has been emphasized using the thick guide wire to correct any minimal

Figure 1

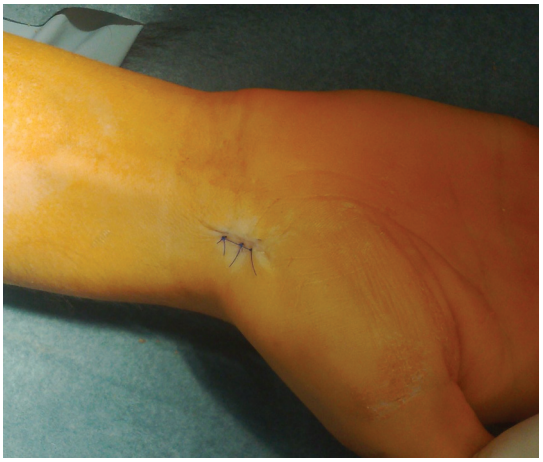
Positioning and wire insertion.

angulations or displacement before passing into the proximal fragment by the joystick technique. While applying traction to the wrist with keeping ulnar deviation, the thick wire is removed and thin 1.1-mm guide wire is inserted by hand instead through the same path. The position of the guide wire is checked by the image intensifier (Fig. 3). The length of the guide wire within the scaphoid is determined by a depth gauge. In this study, we did not use the 2-mm drill pit because the 1.8-mm K-wire was enough, as it will cause less rotation in the proximal fragment. A self-tapping headless Herbert screw is then introduced using intensifier control and the wire is removed. One size smaller screw is used and then measured by the depth gauge so that the screw can be fully buried below the cartilage and cortical surface (Figs 4 and 5). If resistance is found during passage of the screw in the proximal fragment, the screw is removed and the guide wire is advanced to the far cortex; this helps to keep the guide wire in the bone when removing the drill, and a 2-mm cannulated drill pit is advanced in the proximal fragment before reinserting the screw again. The end of the screw is buried beneath the distal surface of the scaphoid to avoid more damage to the scaphotrapezial joint. Skin closure by single suture is performed. Plaster immobilization in scaphoid cast is made for 2 weeks.

Patients were discharged on the same day and were encouraged to begin active finger exercises before discharge. They were reviewed after 2 weeks for removal of cast and sutures, and radiography was performed to confirm the position of the screw. Patients were advised to wear a wrist support. They were then given physiotherapy to mobilize the wrist, but no full weight bearing on the wrist was allowed. They were reviewed 4 weeks later and further radiographs were taken. Return to sedentary work was allowed when the patient felt ready or when 75% of the contralateral range of movement had been achieved, but manual work and athletic activity were not permitted until there was evidence of union.

Figure 2

Figure 3

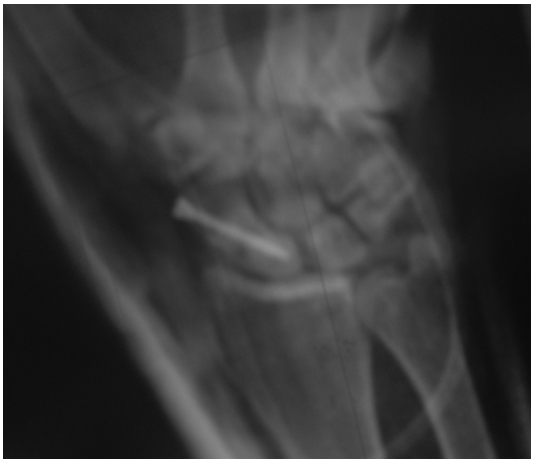


Wound after closure.

Figure 4

Preoperative radiograph.

Figure 5



Postoperative radiograph.

Results

The mean operating time was 25 min (15–45 min) and there were no intraoperative complications. All patients were discharged within 24 h of admission. There were no cases of wound infection, reflex sympathetic dystrophy, scar pain, or hypertrophy. All patients were assessed clinically using the Mayo wrist score, and radiologic union was assessed using three standard views of plain radiographs. Ten patients had excellent score and two patients had good score according to the Mayo wrist score. According to patients' occupations, return to work ranged from 14 to 40 days. With respect to radiologic union, fractures were united at a mean of 55 days (35–70 days). Herbert screws were central in 11 patients and peripheral in one patient, and they were crossing the fracture site in all patients. There were no radiologic signs of avascular necrosis.

Discussion

Fractures of the scaphoid bone are common (incidence is 23–43 per 100 000 person per year) but the management is controversial [1]. The closed (cast) treatment of acute scaphoid fractures generally has good outcome, with bony union; however, closed treatment can result in delayed union, nonunion, malunion, cast-induced joint stiffness, and lost time from employment and avocations [6]. Early internal fixation of the scaphoid avoids the dilemma of when to discontinue cast immobilization. It has been clearly shown by Dias *et al.* [20] and Barton [4] that the diagnosis of union can be very difficult. The results of this series showed that all patients achieved excellent and good scores, and this is consistent with the results of Herbert and Fisher [8] who reported a much higher rate of union for acutely stabilized scaphoid fractures and with the results of O'Brien and Herbert [21] who reported 97% success in a series of acute scaphoid fractures treated by primary internal fixation. The patients showed rapid return to work and activities, as the return to work ranged from 14 to 40 days. This was supported by the later study by Bunker *et al.* [22], Wozasek and Moser [13], and Inoue and Shionoya [16] who showed a shorter time to union and an earlier return to manual work when acute fixation is compared with conservative treatment. Early intervention is also supported by Filan and Herbert's [2] operative findings; in 82 acute fractures, they noted that they were often in a worse position than that suggested by radiographs and there was soft-tissue interposition in 28 fractures. With respect to the damage to the scaphotrapezial joint, Lange *et al.* [23] showed satisfactory cartilage healing over the head of the Herbert screws, provided that they are implanted deep into the osteochondral junction according to the method described. The importance of anatomic reduction of the scaphoid with correction of any palmar flexion before fixation has been emphasized by Viegas *et al.* [24], and a method of closed reduction has been reported by King *et al.* [25]. This is similar to the use of finger traps and allows reduction in some displaced fractures. The patients' fractures showed radiologic union with 11 screws placed central and only one screw was peripheral. Malposition of the screw is an important problem; Adams *et al.* [26] noted a strong correlation between the outcome and technical success. Imperfect placement of the screw was commonly associated with failure to realign the scaphoid. Cannulated screws allow the position to be checked radiologically in several planes before drilling. Shaw [27] showed that there were greater compression forces with the ASIF screw but accepted the biological advantages of the headless Herbert screw, which can be buried within the scaphoid without disrupting its bony architecture. Rankin *et al.* [28] later confirmed his findings, but Newport *et al.* [29] found better compression with the Herbert screw.

Conclusion

Percutaneous fixation of acute scaphoid fractures using Herbert screws is a safe, effective, reliable, and time-saving method of treatment.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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