Acute percutaneous scaphoid fixation

A PILOT STUDY

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Fractures of the scaphoid are most common in young men; immobilisation in a cast 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 dangers of damage to the radiocarpal ligaments, the scaphotrapezial joint, and the blood supply of the scaphoid. For minimally displaced or undisplaced B1 or B2 fractures, these problems can be overcome by percutaneous fixation.

We report our technique and the results of a pilot study in 15 patients. There was no immobilisation; patients were allowed movement soon after operation, but union was obtained in all at a mean of 57 days (38 to 71). The range of movement after union was equal to that of the contralateral limb and grip strength was 98% of the contralateral side at three months. Patients were able to return to sedentary work within four days and to manual work within five weeks.

Our initial results show that percutaneous scaphoid fixation for acute fractures is satisfactory and gives rapid functional recovery.

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The management of scaphoid fractures is controversial. For displaced fractures and for nonunion Herbert screw fixation is an accepted method of treatment, but for minimally or undisplaced fractures the role of surgery remains unclear, although they are common and may give physical and economic morbidity. Most scaphoid fractures are seen in young men who may be manual workers or athletes. In such cases, the avoidance of cast immobilisation is an advantage since this may be prolonged and nonunion is common. Early fixation allows mobilisation and return to full function. Open fixation is associated with extensive soft-tissue stripping and damage to the anterior radiocarpal ligaments, while infection and painful scars may be troublesome postoperative problems and reflex sympathetic dystrophy may be catastrophic. Closed percutaneous fixation can be done as day-case surgery and allows earlier mobilisation and fewer complications.

Percutaneous screw fixation of the scaphoid was first reported by Strela in 1970, but reservations were expressed after poor preliminary results. Cosio and Camp used multiple percutaneous pins for scaphoid nonunion with 77% success. Wozasek and Moser reported a percutaneous technique with cannulated 2.9 mm screws and had a success rate of 89%. Ledoux et al reported 23 cases with union in all, 95% range of movement compared with the other side and a better key pinch than that in the contralateral hand. Inoue et al have published excellent results for Herbert screw fixation via limited access, but warned that a considerable degree of surgical skill was necessary. To complement such limited approaches, Whipple has advocated scaphoid stabilisation under arthroscopic control.

We describe our percutaneous technique using the Acutrak screw (Acumed, Alton, UK) to stabilise acute scaphoid fractures, and present the short-term results of our pilot study to determine its safety and efficacy.

 Patients and Methods

We treated 15 consecutive patients by percutaneous scaphoid fixation. All were men with a mean age of 26.3 years (18 to 41) and 13 were right-handed. Ten fractures were on the dominant side and five on the non-dominant side. Four were B1 and 11 were B2 on the classification of Herbert. The mean time from injury to surgery was four weeks (11 days to 5 weeks). Plain radiography showed the fracture in all cases, but six bone scans were also performed to confirm the lesion and to exclude other injuries.
Before surgery, all patients had been immobilised in below-elbow Colles-type casts or backslabs which, when possible, were removed in the 24 hours before surgery to try to improve the skin condition. Bone grafting was not used.

**Operative technique.** Under general or regional anaesthesia the patient is placed supine and the thumb suspended in a Chinese finger trap to place the scaphoid in traction (Fig. 1), with ulnar deviation of the wrist to give access to the distal pole of the scaphoid. This method allows free rotation of the hand and facilitates the use of image intensification. When necessary weights can be used to increase the traction. The C-arm of the image intensifier is available in a static horizontal position throughout the operation (Fig. 2).

Ulnar deviation of the wrist slides the scaphoid out from the radial styloid process and, in this position, under image-intensifier control, a longitudinal 0.5 cm incision is made at its most distal radial aspect. Blunt dissection is used to expose the distal pole of the scaphoid. A percutaneous guide wire 1.1 mm in size is introduced into the scaphotrapezial joint. Great care is needed to avoid bending the thin wire. It is directed in two views towards the centre of the proximal pole of the fractured scaphoid and advanced until it arrives in an adequate position on both views (Fig. 3). This requires an appreciation of the 45° obliquity of the scaphoid in both anteroposterior and lateral planes.

The length of the guide wire within the scaphoid is determined by a depth gauge and the drill is inserted, using a guide to protect the soft tissues. A self-tapping screw (Fig. 4) is then introduced with intensifier control and the wire is removed (Fig. 5). Compression can be confirmed by image intensifier and the end of the screw is buried beneath the distal surface of the scaphoid to avoid more damage to the scaphotrapezial joint (Fig. 6). Skin closure usually requires only a single suture covered with a sterile dressing.

**Figure 1** – The thumb is suspended in a Chinese finger trap. The wire is introduced through a stab incision. **Figure 2** – Position to allow screening of the scaphoid in all planes by rotating the forearm and hand.

**Figure 1** (a,b) shows the wire bridging a scaphoid fracture.
The tourniquet is then released and the arm elevated. Plaster immobilisation is optional.

Patients are encouraged to begin active finger exercises before discharge and were reviewed after ten days for removal of sutures and radiography to confirm the position of the screw (Fig. 7). They were then given physiotherapy to mobilise the wrist, but no full weight-bearing on the wrist was allowed. They were reviewed four weeks later and further radiographs 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. Patients were advised to wear a wrist support for contact sports.

We assessed the clinical outcome including pain, subjective satisfaction, subjective function, return to work, return to sports, range of movement, power grip and pinch grip. Radiological union was defined as cross trabeculation on all four standard views although the limitations of plain radiography in the assessment of scaphoid fractures are well recognised.

Results

The mean operating time was 24 minutes (13 to 41) and there were no intraoperative complications. All patients were discharged within 24 hours of admission. One patient had transient postoperative dysaesthesia in radial nerve distribution. There were no cases of wound infection,
reflex sympathetic dystrophy, scar pain or hypertrophy.

None of the patients had pain at rest at the time of the first review and all were satisfied at three months. A subjective functional assessment at three months gave an excellent result in 13 and a good result in two. Return to work ranged from 4 to 37 days depending on the patients’ occupation and return to active sports from 43 to 75 days. Most of the delay was due to the wait for radiological evidence of fracture union.

Full flexion, extension and ulnar deviation were achieved in all patients at six weeks, and radial deviation was equal to the contralateral side after three months in 12 patients, and after four months in another two. One patient lost 5° of radial deviation relative to the other (dominant) side; this caused no functional problems, and may well have been his preoperative state. Mean power grip was 90% of the contralateral hand at six weeks, and 98% at three months. Pinch grip rapidly returned to normal and the mean value was equal to the contralateral side at three months.

Radiographs showed the screw in a central position within the scaphoid in 12 patients, but somewhat peripheral in three. In all cases the fracture was bridged by the screw, and no migration or loosening was observed. Fracture union was seen at a mean of 57 days (38 to 71). There has been no evidence of avascular necrosis thus far, and none of the screws has been removed.

Discussion

Early internal fixation of the scaphoid avoids the dilemma of when to discontinue cast immobilisation. It has been clearly shown by Dias et al. and by Barton that the diagnosis of union can be very difficult. In some cases, a partial nonunion may be difficult to interpret even under direct vision and such patients may be ideal candidates for percutaneous fixation. Although it may not speed up union, the fixation would give stability to a partial nonunion and keep the scaphoid out to length.

Our results confirm previous findings that acute fixation of the scaphoid allows rapid return to full function and activity, including contact sports. Herbert and Fisher reported a much higher rate of union for acutely stabilised scaphoid fractures and O’Brien and Herbert reported 97% success in a series of acute scaphoid fractures treated by primary internal fixation. The average period to return to work was 3.7 weeks. This was supported by the later work of Bunker, McNamee and Scott and of Wozasek and Moser. Inoue and Shionoya have shown a shorter time to union and an earlier return to manual labour when acute fixation is compared with conservative treatment. Early intervention is also supported by Filan and Herbert’s operative findings; in 82 acute fractures they noted that they were often in a worse position than suggested by radiographs and that there was soft-tissue interposition in 28. In regard to damage to the scaphotrapezial joint Lange et al. showed satisfactory cartilage healing over the head of the Herbert screws provided that they are implanted deep to the osteochondral junction according to the method described.

Our study was limited to ‘undisplaced’ fractures although we consider that it may be possible to extend the technique to some displaced fractures. The importance of anatomical reduction of the scaphoid with correction of any palmar flexion before fixation has been emphasised, and a method of closed reduction has been reported by King, MacKenney and Elmur. This is similar to the use of finger traps and allows reduction of some displaced fractures. The role of percutaneous screw fixation in cases of nonunion remains controversial since open grafting is considered to be important by most surgeons.

Malposition of the screw is an important problem: Adams et al. noted a strong correlation between 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 radiographically in several planes before drilling. Trumble, Clarke and Kreder compared the use of a Herbert screw with a cannulated AO/ASIF screw for scaphoid nonunion. They showed more rapid union with the cannulated screw and that the time to union was significantly reduced when the screw was in the central one-third of the scaphoid. They advised the use of a second parallel wire during screw insertion to prevent rotation.

Screw fixation of the scaphoid has been extensively tested both clinically and biomechanically. The Herbert screw has long been used, but is by no means ideal. Shaw 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. later confirmed his findings, but Newport, Williams and Bradley found better compression with the Herbert screw. The Acutrak screw is a headless tapered, self-tapping and fully-threaded device designed to provide interfragmentary compression (see Fig. 4). Its variable pitch creates gradual compression with each turn. In a ‘bone-foam’ biomechanical study, Acutrak and AO screws were reported to have higher peak compressive forces than the Herbert/Whipple screw. The Acutrak screw may therefore have some of the advantages of the Herbert screw in being headless and having a variable pitch and also provide improved interfragmentary compression. Its cannulation helps to ensure a better position within the scaphoid.

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References