PERCUTANEOUS SCREW FIXATION FOR FRACTURES OF SCAPHOID

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ABSTRACT

BACKGROUND

On displaced scaphoid fractures treated with prolonged cast immobilisation may result in temporary joint stiffness and muscle weakness in addition to a delay in return to sports or work. Fixation of scaphoid fractures with a percutaneous screw has resulted in a shorter time to union and to return to work or sports. The purpose of this study was to evaluate the results of percutaneous screw fixation scaphoid fractures with respect to time to radiographic union and to return to work.

MATERIALS AND METHODS

In 18 patients with fracture of the scaphoid, fixation with a percutaneous screw was done. Time to fracture union, wrist motion, grip strength and return to work as well as overall patient satisfaction at the time of a two-year follow-up were evaluated.

RESULTS

Of the 18 patients in the study, mean radiological fracture union time was 10 weeks (range 8-15 weeks). Wrist function was excellent in 10 cases, good in remaining 5 cases and poor in 3 cases. The mean DASH score in all patients at the end of one year was 23.16. Patients had returned to work after an average of 1 month.

CONCLUSION

Percutaneous screw fixation of scaphoid fractures resulted in faster radiographic union and return to function. The specific indications for and the risks and benefits of percutaneous screw fixation of such fractures must be determined in larger randomised prospective studies.

KEYWORDS

Percutaneous Fixation, Herbert Screw, Scaphoid.

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BACKGROUND

Most acute fractures of scaphoid heal with conservative management, but nonunion is not uncommon in unstable fractures with communition and displacement. Eddeland et al reported a pseudoarthrosis rate of 63.6% in a series with displacement of less than 1 mm, which were treated with plaster.[1] Other disadvantages of conservative treatment are the duration of immobilisation and the loss of ability to work.

The prerequisites for rapid union are anatomical reduction and compression of fracture surfaces. Stable screw fixation maintains apposition of fragments, promotes rapid revascularisation and permits wrist movements throughout the healing period.

The introduction of screw is not easy, even in the widely exposed scaphoid, but under fluoroscopy, a guidewire can be inserted into the scaphoid percutaneously without any difficulty. The osteosynthesis can then be performed with cannulated instruments and only minimal operative trauma. In 1970, Streli published details of this technique for the first time; we here report our clinical observations, problems and results with this method.[2]

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MATERIALS AND METHODS

The following instruments are needed: a guidewire 1.0 x 80 mm; a cannulated drill bit 3.3 mm; a cannulated tap; Herbert screws (shaft 2.9 mm, thread 4.8 mm, length 14 to 32 mm) and a cannulated screwdriver for countersunk cross-slit screws.

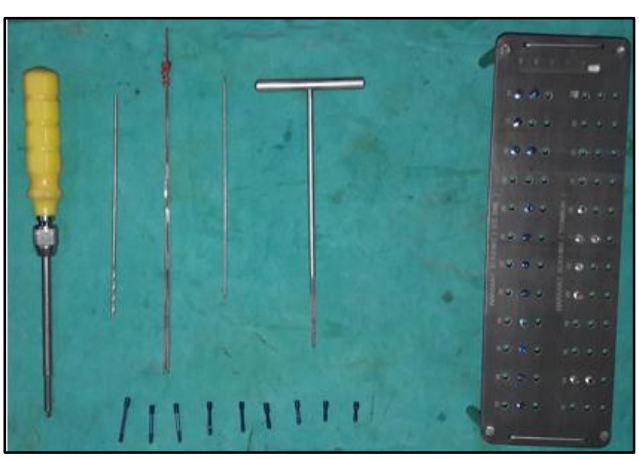

Figure 1

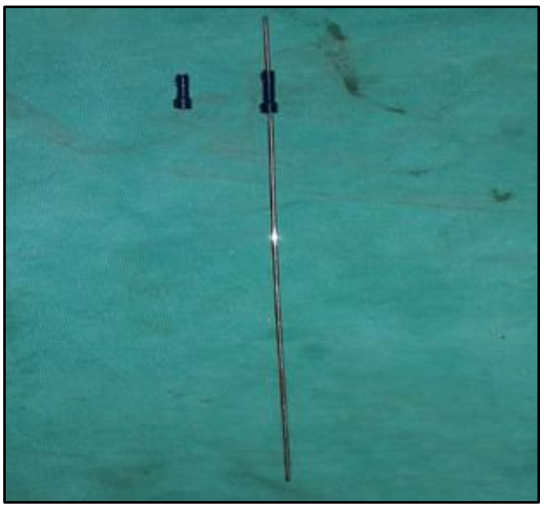

Figure 2

The operation is performed under general brachial plexus anaesthesia. The patient is placed supine on the operating table. His hand is suspended by the thumb in a Japanese finger trap on an extension frame or simply placed in prone or supine position on an extension frame to permit visualisation of the scaphoid with the image intensifier in all positions between full pronation and supination. Ulnar deviation of the wrist causes the scaphoid to slide out from under the radial styloid process.

Figure 3

The guidewire is introduced in the axis of the scaphoid tubercle just between the articular surfaces facing the radius and the trapezoid.

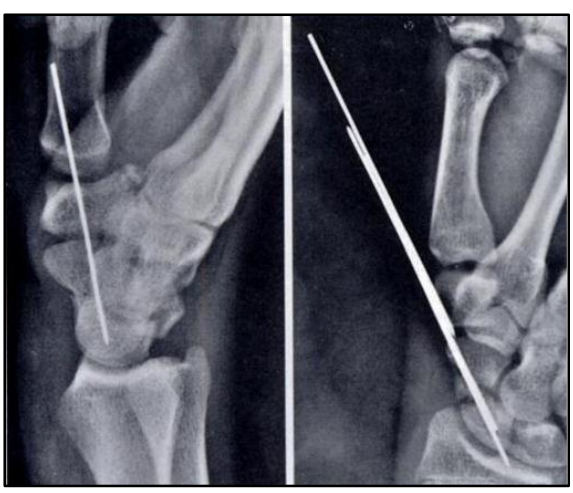

Figure 4

Depending on the obliquity of the fracture, the point of insertion can be moved to the palmar or the dorsal side to be more nearly at right angles to the fracture and thus achieve more stable fixation. The lateral radiograph does not show the entire proximal outline of the scaphoid. The guidewire is directed towards the middle of the proximal pole of the scaphoid. This is the most critical part of operation. At the point, where the guidewire enters, a 10-mm skin incision is made and the soft tissues are divided down to bone. The length of screw required is then determined by the difference in length between a correctly placed wire with its tip at the proximal pole and a second parallel pin of the same length with its tip at the distal pole. A pilot hole is then drilled with a cannulated drill and a thread is cut with a screw tap. The screw is then inserted over the correctly positioned guidewire.

The last turns of the screw generate compression and should close the fracture cleft. While this is being done, the traction produced by the weight of the arm is eliminated by resting the patients elbow on the table. Screw lengths at 2 mm intervals from 14 to 32 mm are enough to cover all sizes of scaphoid. To achieve compression, the threaded portion is always entirely within the proximal fragment and must not cross the fracture line. After the removal of guidewire, two or three skin sutures complete the operation.

When fixation appears absolutely stable, which can be verified by moving the wrist in all directions under the image intensifier, a cock-up cast is applied.

PATIENTS

From May 2014 to August 2015, 18 patients were treated and were followed up. The average age of the patients was 40 years. Most patients had sustained fractures due to forced dorsiflexion of wrist. The fractures were classified using Herbert's classification. The results were assessed radiologically and subjectively using DASH score.

SCORING THE DASH

DASH system of scoring was selected as the convenience of scoring does not compromise with score outcome.

The DASH is scored in two components- the disability/symptom questions (30 items, scored 1-5) and the optional high performance sport/music or work section (4 items, scored 1-5).[3]

Disability/Symptom Score

At least, 27 of the 30 items must be completed for a score to be calculated. The assigned values for all completed responses are simply summed and averaged producing a score out of five. This value is then transformed to a score out of 100 by subtracting one and multiplying by 25. This transformation is done to make the score easier to compare to other measures scaled on a 0-100 scale. A higher score indicates greater disability.

DASH disability/symptom score=

$$\left[\frac{\text{(sum of n responses)}}{n} - 1\right] \times 25,$$

Where n is equal to the number of completed responses.

Each optional module consists of four items, which may or may not be used by individuals because of the nature of the questions. The goal of the optional modules is to identify the specific difficulties that professional athletes/performing artists or other groups of workers might experience, but which may not affect their activities of daily living and consequently may go "undetected" in the 30-item portion of the DASH.

The same procedure described above is followed to calculate the optional four-item module score. All four questions must be answered in order to calculate the score. Simply add up the assigned values for each response and divide by four (number of items), subtract one and multiply by 25 to get a score out of 100.

Missing Items

If more than 10 percent of the items (that is, more than three items) are left blank by the respondent, you will not be able to calculate a DASH disability/symptom score. By this same rule (that is, no more than 10 percent of the items can be left blank), no missing values can be tolerated in the high-performance sports/performing arts or work module because the module consists of only four items. This missing data "rule" applies to both the original and revised scoring methods.

RESULTS

Of the 18 patients in the study, 13 were males and 5 were females. The mean age was 43.5 years (range 22-50 years). 12 of the 18 patients had dominant side fractured (66.6%). We had 9 cases of B2 type (50%); 5 cases of B1 type (27%) and 4 cases of A2 type (23%). Mean surgical time was 51.5 minutes (range 40-60 mins). Mean radiological fracture union time was 10 weeks (range 8-15 weeks). Wrist function was excellent in 10 cases, good in remaining 5 cases and poor in 3 cases. The mean DASH score in all patients at the end of one year was 23.16. In complications, there was avascular necrosis of scaphoid in one patient, nonunion in two patients, which were managed later with bone grafting. Patient with nonunion had history of alcohol and tobacco abuse. There was no difference in postoperative treatment in a heavy labourer and an office employee. Patients had returned to work after an average of 1 month. There was no associated neurovascular deficit in any of the patient.

Patients	Follow up (Months)	DASH Score	Mayo Wrist Score			
			Pain	Range of Motion	Pinch Strength	Functional Status
Sumit	12	24	25	25	25	25
Prakash	14	25	25	25	25	25
Hazarilal	13	25	25	25	25	25
Mukesh	12	24	25	25	25	25
Ramprakash	16	22	25	25	25	25
Vijay	14	25	20	25	25	20
Kailash	15	26	20	25	25	20
Rajaram	14	21	25	25	25	25
Ashok	13	20	25	25	25	25
Suresh	15	22	25	15	25	20
Kalulal	14	22	25	15	25	10
Gopilal	12	23	25	25	25	25
Sugam bai	14	25	25	25	25	20
Radha	13	24	20	25	25	25
Madhu	15	26	25	25	25	25
Rakesh	16	22	25	25	25	25
Ramabai	14	21	25	25	25	25
Jyoti	12	20	25	25	25	25

Case 1

Figure 1. Preop

Figure 2. Postop

Figure 3. 1 Month Postop

Figure 4. 3 Months Postop

Case 2

Figure 1. Preop

Figure 2. Postop

Figure 3. 3 Months Postop

Case 3

Figure 1. Preop

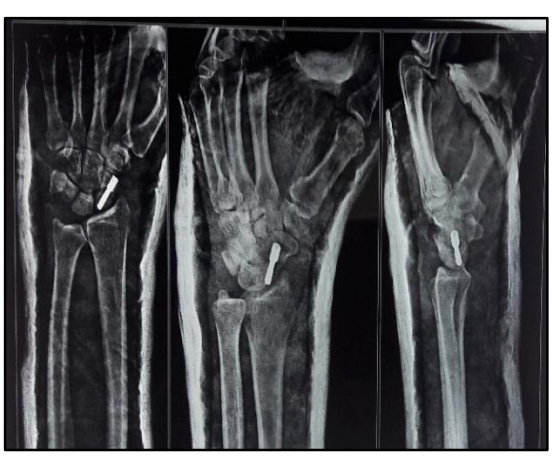

Figure 2. Postop

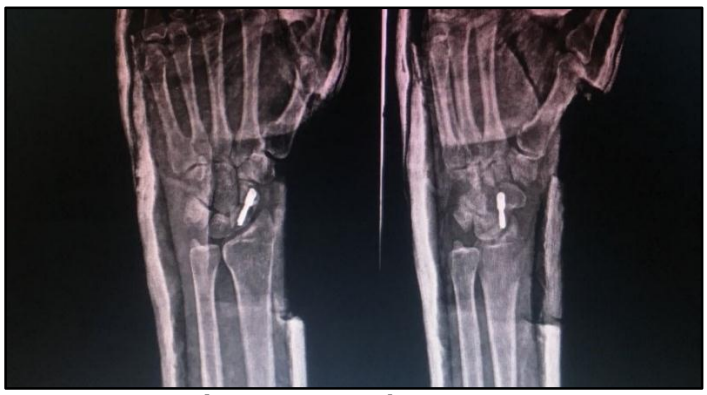

Figure 3. 1 Month Postop

Figure 4. 3 Months Postop

DISCUSSION

The scaphoid like the talus has an almost complete cartilaginous surface except for small bands on its dorsal and palmar aspects. Consequently, it does not have the capacity for periosteal healing, but depends on an intraosseous process. Moreover, the circulation in the proximal third of the bone depends on intraosseous vessels (Taleicnik and Kelly 1966; Gelberman and Menon 1980; Gelberman and Gross 1986).[4] Therefore, the more proximal the fracture, the greater the probability of a prolonged healing period or of nonunion.

The basic principles of management of the fractured scaphoid are early diagnosis, anatomical reduction and adequate immobilisation. Displacement or comminution increases the risk of nonunion and requires closed reduction or if this is not possible open reduction.

Herbert and Fisher (1984) reported union in 100% of acute unstable fractures, which is comparable to our results, 84.6% of those with delayed union in 88.2% of those with fibrous nonunion and in 76% of those with sclerotic nonunion.[5] Another multicentre study of 50 scaphoid fracture treated with Herbert's differential pitch screw showed very similar results (Bunker, McNamee and Scott 1987). In study conducted by Wozasek and Moser, 89% of the acute fractures showed union treated percutaneously with Herbert screw comparable to our study of union rate 83.3% and 81.9% of the delayed and established nonunion united (graded 1 and 2); 85.7% of the patients with sclerotic nonunion graded their result subjectively good, although only 42.9% showed radiological union. In this sclerotic nonunion group, there was a high incidence of scaphoid shortening. Although, the false joint can be resected percutaneously with the cannulated reamer, normal scaphoid length can only be restored by an open graft.

M.M. McQueen, MK. Gelbke, A. Wakefield did a study in 2007 in which 60 consecutive patients with fractures of the waist of the scaphoid were subjected to percutaneous fixation or immobilisation in a cast.[6] The range of movement, the grip and pinch strength, the modified Green/O'Brien functional score, return to work and sports and radiological evidence of union were evaluated at each follow-up visit. Patients were followed sequentially for one year.

Those undergoing percutaneous screw fixation showed a quicker time to union (9.2 weeks vs. 13.9 weeks, $p<0.001$) than those treated with a cast. There was a trend towards a higher rate of nonunion in the nonoperative group, although this was not statistically significant. Patients treated by operation had a more rapid return of function and to sport and full work compared with those managed conservatively. There was a very low complication rate. The union time in this study is comparable with our study in which union time is 10 weeks and patients returned to their functional status earlier.

F. S. Haddad and N. J. Goddard did a study in 1998 and reported that fractures of the scaphoid are most commonly seen in young males where immobilisation in a cast will lead to a prolonged period away from work and from athletic activities. They advocated to promote a rapid functional recovery.[7] They found that open reduction and internal fixation of the scaphoid was technically demanding and it damaged the anterior radiocarpal ligaments violated the scaphotrapezial joint further endangered the already compromised blood supply of the scaphoid and not infrequently lead to troublesome hypertrophic scars. They found that these problems can be overcome in minimally displaced or undisplaced fractures by percutaneous fixation. They presented 50 cases from their study, which were treated by percutaneous fixation. No cast immobilisation was used and the patients were allowed to mobilise immediately postoperatively. Union was obtained in all cases after an average of 55 days (37-79). Range of movement at the time of fracture union was equal to that of the contralateral limb at three months and grip strength was 98% of the contralateral side at three months. Patients returned to sedentary work within 4 days and to manual work/sports within 5 weeks. They found that percutaneous scaphoid fixation for acute fractures a rapid and very satisfactory intervention, which leads to a rapid functional recovery. In this study, union rate and time to return to functional status is comparable with our study.

R. Arora, M. Gschwentne, D. Krappinger, M. Lutz, M. Blauth, M. Gabl did a study in 2006 in which twenty one patients were included in the group of screw fixation and 23 patients were included in the group of cast immobilisation. At final follow-up, there was no significant difference in the range of motion of the wrist or in grip strength. The operatively treated group had a better mean DASH score than the conservative group. Fracture union was seen in the

screw fixation group at a mean of 43 days and in the cast immobilisation group at a mean of 74 days (P <0.5). The average time of return to work was 8 days for patients who had an internal screw fixation while those treated with a cast returned to work at a mean of 55 days (P <0.5). In total, the internal fixation of undisplaced scaphoid fractures was less expensive than conservative treatment. This study also supports our conclusion in term of union rate, rapid return to function and cost effectiveness to patients.

CONCLUSION

Percutaneous screw fixation is currently one of the most widespread treatments for scaphoid fractures, types B1 and B2 according to Herbert, as presented by Streli in 1970. It has indeed replaced treatment involving exposure of the fracture, which may lead to serious complications and several authors agree in considering that open reduction and internal fixation is contraindicated.

An extensive open exposure of a fractured scaphoid damages the blood vessels and the radiocarpal ligaments. By contrast, percutaneous fixation requires minimal operative trauma. Good results can be anticipated if the fracture is anatomically reduced and the screw correctly placed. Cannulated implants and instruments permit precise drilling, tapping and screw insertion. In fresh fractures without comminution, no plaster cast support is necessary and early return to full function can be allowed. Hence, we can conclude that percutaneous fixation is an excellent method for osteosynthesis of scaphoid fracture of B subtypes. This method provides reduced time for fracture to unite and much earlier return to work. The functional results over the long term are comparable to other treatment options.

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