

Percutaneous Fixation of Acute Scaphoid Fractures: A Research Article

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Received: July 06, 2020; **Published:** September 28, 2020

Abstract

Objectives: The goal of this study was to report and evaluate the method of percutaneous fixation with Herbert screw in the treatment of acute scaphoid fractures.

Background: Percutaneous fixation has been used for the management of fractures since a long period of time. Good fixation, mild blood loss and early mobilization are always the main advantages for this technique. Other advantages include it is simple, quick and causes minimal surgical trauma.

Materials and Methods: From May 2011 to January 2013, 20 patients, 18 males and 2 females, mean age 29.85 years, suffering from acute scaphoid fracture; were treated in orthopedic department, El-Menoufiya University Hospital by percutaneous fixation with Herbert screw and early mobilization. Technique was prescribed.

Results: Fracture union was achieved within 6 - 14 weeks; in 16 cases union was achieved 6:10 weeks and was delayed in three cases and achieved within 12 weeks (2 cases) and 14 weeks (one case), (Mean 8.3). There was only one case in which nonunion occurred. One case needs revision and screw protrusion were occurred in two cases.

Conclusion: Percutaneous Herbert's screw fixation is effective in achieving union and excellent functional outcome in acute scaphoid fractures.

Keywords: *Scaphoid Fractures; Acute; Percutaneous Fixation*

Introduction

The scaphoid bone is the most frequently fractured bone in the wrist [1]. In general, the bone is fractured through its relatively narrow waist [2].

Because there is a relatively poor blood supply to the proximal part of the bone, fracture healing can be compromised. It is generally accepted that immobilization in a short arm cast should continue until union is detectable on plain radiographs, which may require ten to twelve weeks [1]. When the proximal pole is involved, the immobilization period is often prolonged. Complications, including malunion or nonunion, are common; Additionally, there is generally increasing interest in primary (early) fixation of the scaphoid as a way of avoiding these late complications [3].

An open approach for scaphoid fixation facilitates accurate placement of the screw, because the bone and its surroundings are directly visible to the surgeon. However, even with open surgery, some of the joint surfaces are not visible and thus imaging is commonly used to help to verify screw location. Open surgery inevitably involves some degree of soft tissue damage and an increased risk of infection. The strong radioscaphocapitate and radiolunate ligaments must be cut as the surgeon exposes the fracture, which may negatively affect joint stability [4]. Additionally, the superficial branch of the radial artery is often intentionally sacrificed [5], which can cause bleeding and reduce blood supply to the scaphoid.

Performing the procedure percutaneously ameliorates many of the concerns associated with open approach. Percutaneous fixation of scaphoid fractures with headed cannulated screws was first performed in Germany by Strelt [6]. Beginning in 1962, As modification of the technique of open reduction with solid bone screws of McLaughlin. Both palmar and dorsal approaches can be used for fixation of scaphoid fractures. However, there has been controversy regarding the best approach for these fractures and many studies have been carried out to find out which one is the best [7].

Materials and Methods

Twenty patients, 18 males and 2 females, with acute scaphoid fractures were treated by percutaneous Herbert screw fixation between May 2011 to January 2013, our inclusion criteria were: undisplaced or minimally displaced acute fracture scaphoid, reducible displaced fracture scaphoid, Fractures of proximal pole and combined injuries of the scaphoid, including the distal radius or other carpal bones.

Exclusion criteria were: Irreducible fracture, nonunion with severe sclerosis or humpback deformity, pseudoarthrosis and osteonecrosis of the proximal pole.

As regard age in the study the youngest patient was 16 years old and the eldest patient was 52 years old, the mean age of the patients was 29.85. All patients were right-handed. 12 patients had their injury in Rt. Side (60%) and 8 patients had their injury in Lt. side (40%), for dominance 12 wrists (60%) were dominants and 8 wrists (40%) were the non-dominants. for mechanism of injury fall on outstretched hand was occurred in 13 cases (65%) and road traffic accident was the cause in 7 cases (35%).

According to Herbert classification: 16 cases were classified as type B2 and 2 cases were type B1 (acute unstable fractures) and 2 cases classified as A2 (acute stable fractures). 4 cases were present with associated injuries, Ipsilateral distal radius fracture was present in 3 cases (case of them having old styloid ulna injury), another case present with ipsilateral fracture of proximal phalanx of little finger.

We performed all cases through volar approach; the technique was based on the work of Slade., *et al.* with some modifications [8].

Volar technique

- Step 1: Under general or regional anesthesia, patient was placed supine on the operating table and the volar scaphotrapezium joint was identified as the bony prominence felt as the finger was moved across the distal wrist crease from ulnar to radial direction. Displaced fractures were reduced under fluoroscopy in a position of extension and supination while pulling the thumb manually.
- Step 2: A 0.45 mm Kirschner wire was introduced by free-hand under fluoroscopy and placed into the distal scaphoid along the central axis. Confirm its position under multiple views. The wire was directed across the fracture and then to the center of the proximal pole and stopped at the far cortex.
- Step 3: A transverse 5 mm skin incision was made around the Kirschner wire entry and then, a haemostat was used for blunt dissection down to the distal pole of the scaphoid. The length was assessed by using a depth gauge or by using a wire of the same

length and measuring the difference. A screw of 4 mm less than the actual measure was chosen to ensure that the screw will be well buried in the distal cortex and will not impinge the proximal cortex.

- Step 4: After assessment of screw length, the wire was further advanced across the proximal pole to prevent loss of the position of the wire after reaming around it.
- Step 5: A cannulated drill was inserted around the wire and advanced across the fracture site and stopped short of the far cortex under fluoroscopic guidance. A self-tapped Herbert screw was inserted in a free-hand manner. While the last turns of the screw produce compression, the traction force applied to the thumb was eliminated. The compression of the fracture site was identified. The distal end of the screw was buried beneath the surface.
- Step 6: After fixation, the position of the screw can be verified by moving the wrist under an image intensifier. Associated injuries were managed accordingly.

Post-operative regime

Period of immobilization varies according to the presence of associated injury, 6 weeks for cases of ipsilateral distal radius fractures (3 cases), 4 weeks for the only one case of ipsilateral fracture of proximal phalanx of little finger, rest of cases immobilized for two weeks in below elbow plaster of Paris slab, Active assisted finger exercises was encouraged immediately after surgery. The slab was removed and wrist exercise initiated two weeks after the operation. Resisted or weight bearing exercise was allowed after fracture union has been established.

The mean post-operative immobilization period was 19.44 days (range 14 - 42).

Postoperative X-rays were examined for fracture site compression, screw position e.g. clearance of the scaphotrapezium joint from the screw head and leading threads not penetrating the dorsal cortex into radioscaphoid articulation, screw direction and its relation to the plane of the fracture and assessment of the proper management of associated injuries. Serial radiological examinations at 4 and 8 weeks and every 2 weeks after till union.

Assessment of Union: Absence of fracture site tenderness and trabeculae that cross the fracture site in 5 scaphoid views were used as signs of union.

At 6 months follow up for assessment of screw position, carpal alignment and evidence of complications; arthritis or nonunion.

For evaluation of the functional outcome, (Mayo modified wrist score) was used.

Results

Twenty cases of acute scaphoid fractures were treated by percutaneous Herbert's screw fixation these cases were studied, there were no missed follow up cases and minimum follow up time was six months.

Volar Approach was used in all cases, three patients had associated with ipsilateral distal radius fracture, two of them were fixed by percutaneous K wires and the third one treated by below elbow cast. Another patient had ipsilateral fracture of the proximal phalanx of little finger, he was treated conservatively in a below elbow slab.

The results are analysed and revealed the following: Fracture union was achieved within 6 - 14 weeks; in 16 cases union was achieved 6:10 weeks and was delayed in three cases and achieved within 12 weeks (2 cases) and 14 weeks (one case), (Mean 8.3). There was only one case in which nonunion occurred.

In isolated scaphoid fracture, return to work or school ranged from 2 days to 8 weeks according to their occupation.

Patients were analyzed for the functional outcome using Modified Mayo Score (MMS): 16 patients were graded as excellent, three patients graded as good and one patient graded as fair.

Plain radiographs of postero-anterior and lateral views was obtained for each case. The axes and angles were measured manually. The long axis of the scaphoid in the posteroanterior defined as a line between the center of the distal tuberosity and the most convex point of the proximal pole of the scaphoid, and the long axis of the scaphoid determined as the palmar out line in the lateral view.

The radiological assessments stressed finding the relationship between the long axis of the Herbert screw with respect to the long axis of the scaphoid and the fracture line. Fractures of the scaphoid are considered to be united in the presence of trabeculae bridging the defect and increased density at the site of or on each side of the fracture line. In 15 cases, the screw was central and in 5 cases, the screw was slightly in ulnar position.

As regard time from injury to surgery it ranged from (2 - 14 days), Mean 5.90. Time of fracture to union rang from (6 - 14 weeks), Mean 8.3. Follow up time rang from (6 - 12 months), Mean 6.60. Time of post-operative immobilization range from (2 - 6 weeks), Mean 2.7.

Loss of reduction and the need for revision through dorsal approach occurred in one patient. Nonunion occurred in one case with Herbert's B1oblique fracture of the scaphoid (patient refuse further interventions). Screw protrusion was observed in two cases after the end of the follow up, but there was no great effect on the clinical outcome. Mild osteoporosis as a sign of reflex sympathetic osteodystrophy occurred in two patients with associated fracture distal radius due to immobilization and was responsive to physiotherapy after removal of the cast and the K-wires.

Pain	
No pain	25
Mild occasional	20
Moderate	15
Severe	0
Work status	
Regular job	25
Restricted job	20
Able to work but unemployed	15
Unable to work due to pain	0
Range of motion (flexion and extension)	
> 120°	25
110 to 119°	20
90 to 99°	15
60 to 89°	10
30 to 59°	5
0 to 29°	0
Grip strength (% of normal side)	
90 to 100	25
75 to 89	15
50 to 74	10
25 to 49	5
0 to 24	0

Table 1: Mayo modified wrist score.

Associated injuries	No. of patients	Management	Percentage	
Associated	4	3 cases ipsilateral distal radius	2 cases percutaneous K wires	10%
			1 case conservative	5%
	1 case ipsilateral proximal phalanx of little finger	Conservative	5%	
No associated	16	Percutaneous Herbert screw	80%	

Table 2: Associated injuries.

	Number	Range		Mean	STDV
		Min	Max		
Time from inj. to surgery (d)	20	2	14	5.90	3.35
Time to union (w)	20	6	14	8.3	2.24
Follow up time (m)	20	6	12	6.60	1.47
Time of post-operative immobilization/week	20	2	6	2.7	1.49

Table 3: Statistical analysis.

Authors	Year	No.	Approach	Instrument	Union (%)	Union Time (Mean, Weeks)	Functional Outcome
Ledoux, et al.	1995	23	Volar	Herbert screw	100	ND	95% of unaffected side
Inoue and Shionoya	1997	40	Volar	Herbert screw	100	6 +/- 2.1	Satisfactory wrist function in 37 of 40
Taras., et al.	1999	5	Volar	Herbert screw	100	8.2	ND
Brutus., et al.	2002	30	Volar	Herbert screw	90	ND	86.6% screw perpendicular to fracture line
Bushnell et al	2007	24	Dorsal	Acutrak or Twin-fix	96	ND	29% complication rate
Jeon., et al.	2007	22	Volar	Herbert screw	100	9.36	18 of 22: excellent 4 of 22: good (Mayo score)
Jeon., et al.	2007	19	Dorsal	Herbert screw	100	9.50	15 of 19: excellent 4 of 19: good (Mayo score)
McQueen., et al.	2008	30	Volar	Acutrak	97	9.2	100% excellent/ good (Green/ O'Brien score)

Table 4: Selected reports on percutaneous fixation of scaphoid fractures. ND: Not Described.

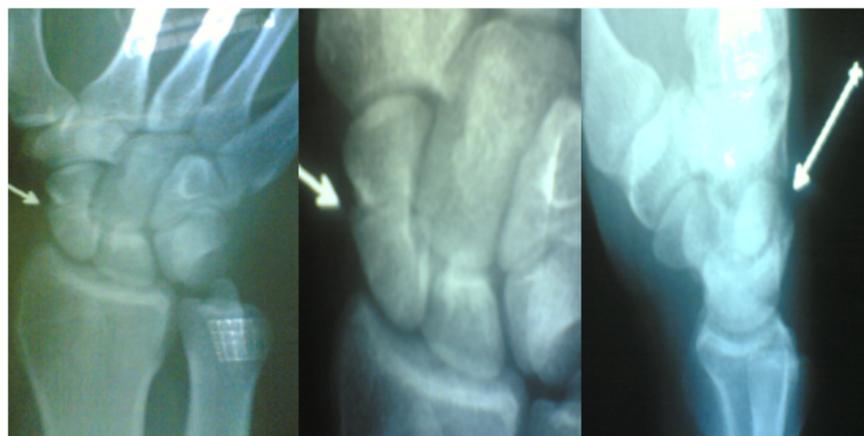


Figure 1: Pre-operative X rays.

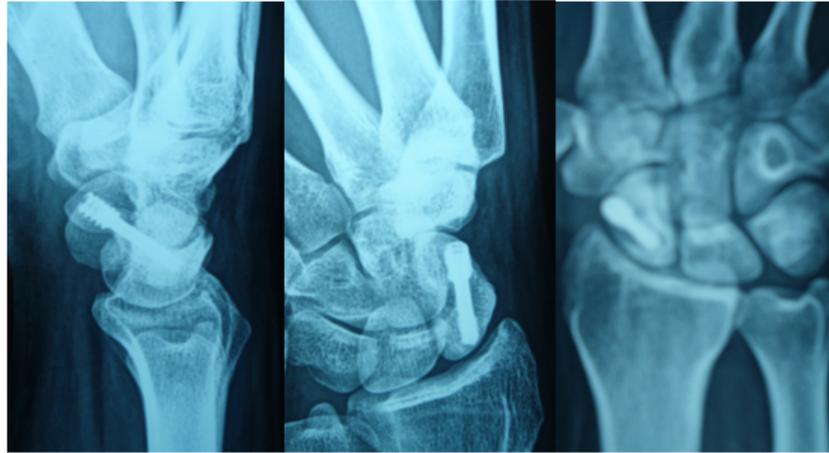


Figure 2: 12 months post-operative x rays.



Figure 3: Range of motion at the end of follow up.

Discussion and Conclusion

Fractures of scaphoid are common, and many times are difficult to diagnose and treat. Fracture scaphoid can cause prolonged morbidity and absences from work in young adults in which they are most common [9].

Recently, there has been an increased trend toward percutaneous fixation for displaced scaphoid fractures. This procedure bears the inherent advantages of limited soft tissue dissection and it hastens fracture healing [10]. Also, long term immobilization and its inconveniences are therefore avoided. This technique is reported to allow early free use of the hand and to shorten the period of work and sports inability.

Percutaneous treatment of scaphoid fractures has long been investigated as an alternative to open techniques. Streltsov first described the use of the percutaneous technique in 1970.

Respecting the anterior ligaments of the wrist is important to preserve the normal dynamics of the carpus. Garcia Elias, *et al.* [11] have demonstrated that the classic anterior approach to the scaphoid, which damages the radiocapitate and radiolunate ligaments results in increased scapholunate angle values, which constitutes evidence of modified carpal stability and consequently augmented carpal collapse.

Percutaneous Herbert screw fixation of scaphoid fractures is a reliable technique but accurate positioning of the screw, however, is technically demanding therefore there is a strong correlation between outcome and technical success in screw placement.

Risk factors of unsatisfactory functional results are scaphoid fractures with concomitant injuries in the same limb which impeded the rehabilitation and the occurrence of infection [12].

Since Streltsov 1970 introduced the concept of percutaneous fixation of scaphoid fracture, many additional reports have described the use of percutaneous fixation of scaphoid fractures, including several recent series [13] with low complication rates.

In our study, 20 patients with less than 14 day-old fractures were fixed percutaneously by Herbert screws and followed up for a minimum of 6 months. Patients were 18 men and 2 women with an average age of 34 years. According to Herbert's classification, 18 fractures were classified as acute unstable (B Type) and 2 fractures as acute stable (A Type).

We used volar approach in all cases. Most of the fractures occurred in young men who wanted to use their hands early. The patients in this study had to operate computers or desired to participate in their exams. Patients refused to immobilize the wrist for long periods because of the economic impact. In this study only 2 weeks immobilization was used for isolated scaphoid fractures, which enabled the patient to return to work earlier. This study has shown that there were no complications related to soft tissue stripping and instability at a minimum of a 6-month follow-up period. Even with acute unstable fractures, this method is considered an effective alternative to open techniques.

Closed reduction under image intensifier was an excellent technique for anatomic reduction without soft tissue dissection. The average time for return to school or work in isolated scaphoid fractures in our series was 7 days and the average time for union was 7 weeks.

Three patients were associated with ipsilateral distal radius fracture, two of them were fixed by percutaneous K wires and the third one treated by below elbow cast, another fourth patient had ipsilateral fracture of the proximal phalanx of little finger, he was treated conservatively in a below elbow slab.

There were three cases of delayed union which achieved union within 12 weeks (2 cases) and 14 weeks (1 case), loss of reduction and the need for revision through dorsal approach occurred in one patient who was presented with B2 type fracture scaphoid following a fall on outstretched hand, percutaneous retrograde Herbert's screw was inserted, postoperative X-rays showed rotation and displacement of the fracture site. Revision surgery was performed using the antegrade dorsal percutaneous approach to insert cannulated Herbert's screw and supplementary K wire. Union occurred six weeks after the revision surgery, dorsal approach was used in revision to allow exact targeting of the central axis of the scaphoid, perform more precise placement of the screw within the scaphoid and also to prevent more damage through repeated drilling of the volar and distal aspect of the scaphoid.

There was only one case of nonunion occurred in patient presented with Herbert's B1 oblique fracture of the scaphoid. patient was informed that he needed revision of surgery but he refused further intervention as regard he was nearly pain free and with good range of movement.

Radiographic analysis in our study confirmed that screws were inserted in a more favorable position (i.e. perpendicular to the fracture line) this might have biomechanical advantages in terms of fracture healing. In addition, 45° semipronated oblique view confirmed that the screws were placed more parallel to the long axis of the scaphoid.

Based on our observations, we conclude that percutaneous Herbert's screw fixation is effective in achieving union and excellent functional outcome in acute scaphoid fractures.

Conflict of Interest

No conflict of interest.

Funding

No fund.

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Volume 11 Issue 10 October 2020

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