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Functional outcome in surgical management of scaphoid fractures with k wire and headless compression screw

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Abstract

Background: Achieving stable fixation of scaphoid fractures and nonunions continues to be a challenge. Compression screw fixation has been the current standard surgical procedure.

Materials and Methods: A retrospective study was conducted of 8 patients having closed scaphoid fractures at our institution over a 3 year period. Out of these, 4 patients were operated with percutaneous k wire fixation and 4 patients with open reduction and fixation with Herbert's screw. A review of clinical as well as radiographic data was undertaken. The mechanism of injury, patient demographics, timing of surgery, initial displacement, fixation method, smoking status, and lunate morphology were recorded. Functional outcome measures were recorded.

Results: A total of 7 out of 8 patients (87 %) showed evidence of union at 12 weeks post-injury. Similarly, fractures sustained via low energy mechanisms had a higher rate of early union compared to high energy mechanisms.

Conclusions: Initial displacement and mechanism of injury have the most significant effects on early rates of union. early fixation of these fractures is recommended to prevent further displacement. One may prefer surgery because of an earlier return to work and mobility.

Keywords: Scaphoid fractures, ORIF, Herbert screw

Introduction

The scaphoid is the most commonly fractured carpal bone, accounting for 80–90 %^[8] of all carpal injuries and occurring most commonly in young, adult males. Traditionally, these fractures have been classified based on the anatomic location within the scaphoid into four categories: tuberosity (17 %), waist (66 %), and proximal (6 %) and distal poles (11 %)^[8]. This distinction is important because of the unique blood supply to the scaphoid which is retrograde via the palmar and dorsal branches of the radial artery^[4, 14]. The proximal pole is supplied entirely by branches entering the foramina along the dorsal ridge. The absence of significant vascular foramina proximal to the waist has been hypothesized to result in the high incidence of osteonecrosis and nonunion after scaphoid waist and proximal pole fractures^[5]. Rates of nonunion in acute proximal pole scaphoid fractures treated with conservative management are quite high^[7, 13]; therefore, open reduction internal fixation (ORIF) has been recommended^[11, 12].

Traditionally, non-displaced fractures of the scaphoid have been treated conservatively, with the immobilisation of the hand with a cast; hence, surgical fixation of the fracture has become increasingly popular because of quicker re-mobilisation and return to its original function.

A displaced fracture of the scaphoid is one in which the fragments have moved from their anatomical position or there is movement between them when stressed by physiological loads. Displacement is seen in about 20% of fractures of the waist of the scaphoid, as shown by translation, a gap, angulation or rotation. A CT scan in the true longitudinal axis of the scaphoid demonstrates the shape of the bone and displacement of the fracture more accurately than do plain radiographs. Displaced fractures can be treated in a plaster cast, accepting the risk of malunion and nonunion. Surgically the displacement can be reduced, checked radiologically, arthroscopically or visually, and stabilised with headless screws or wires. However, rates of union and deformity are unknown.

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Mild malunion is well tolerated, but the long-term outcome of a displaced fracture that healed in malalignment has not been established.

Much has been written regarding treatment of proximal pole scaphoid nonunions [3, 6, 16]; however, comparatively, little is known about the outcomes of ORIF of acute proximal pole fractures. To date, the largest and most highly referenced study examining the outcomes from ORIF of acute proximal pole fractures is a series of 17 patients by Rettig and Raskin [10]. In this study, no comparison was made regarding the effect of timing of acute ORIF or severity of injury (energy imparted on the scaphoid) on ultimate fracture healing. The purpose of our study was to identify the effects of initial fracture displacement, mechanism of injury, and delay in fixation on healing rates in ORIF of acute proximal pole scaphoid fractures.

However, open reduction and internal fixation increase the risk of complications associated with damage to important structures, leading to carpal instability and tenuous vascular supply [3, 6]. Thus, percutaneous screw fixation has increased in popularity with the use of new headless compression screws and better surgical techniques, for which the benefits offset the risks.

Materials and Methods

A retrospective study of skeletally mature patients who underwent open or closed reduction and internal fixation of the scaphoid was performed. Between January 2015 and December 2018, 8 patients treated at our institution met the above criteria. Patient selection was further restricted to those who reported to us within 4 weeks (28 days) of the initial injury and who were at least 16 years of age at the time of treatment. Patients with open fractures, previous injury to the scaphoid as an evidence of a nonunion or fractures beyond the proximal pole of the scaphoid were excluded from the study. Preoperative imaging was evaluated to assess fracture displacement, carpal displacement, and lunate morphology. All patients were evaluated with preoperative plain films of the wrist in Antero posterior, lateral and scaphoid views to assess fracture and carpal displacement, as well as lunate morphology (Fig. 1). Fracture displacement was defined as ≥ 1 mm of displacement. 2 of the patients underwent preoperative CT scans, 1 patient had an MRI to assist in the diagnosis of a scaphoid fracture. Any associated ligamentous injuries were noted along with dates of injury, presentation, and surgery.

Pre-op x-rays



AP view lateral view

Healing was verified by serial examination of plain films for the duration of the follow-up period by the lead author. Wrist range of motion (radial and ulnar deviation, flexion, and extension) was measured with a handheld goniometer.

Complications and any additional procedures required after the index operation were recorded.

Headless compression screws were used for fixation in 4 patients, while K-wires were used in the rest. No additional bone graft was used during the index procedure in any of the patients.

Post-op



Lateral view



AP view



Scaphoid view

All 8 patients were placed into a postoperative dressing, then thumb spica splint, or cast postoperatively with subsequent transition into a splint for an average duration of immobilization of 10 weeks. Healing was verified by serial examination of plain films for the duration of the follow-up

period. Union was defined as evidence of greater than or equal to 50 % union on both AP and lateral radiographs or both sagittal and coronal CT scans when available.

Patient operated with K-wire



Pre -OP x-rays: AP view, Lateral view, Scaphoid view.



Post OP x rays: Scaphoid view.



Post OP x rays: Lateral view.



Post OP x rays: AP view.

Bilateral grip strength was recorded from the last follow-up visit at which it was available with a JAMAR dynamometer (Patterson Medical, Bolingbrook, IL). Wrist range of motion (radial and ulnar deviation, flexion, and extension) was measured with a handheld goniometer.

Results

Patients demographics noted:

Age { yrs	:	20-55 yrs.
Mean age	:	32 yrs
M:f ratio	:	7:1
Headless screw: k wire	:	4:4

A total of 7 out of the 8 patients reviewed showed evidence of bony union at 12 weeks.

In the 1 patient with k wire did not exhibit evidence of union by 12 weeks, 4 went on to complete union at an average of 24 weeks all 4 were treated with headless compression screw. 2 patient with k wire had evidence of partial union at 8 weeks. 1 of k wire demonstrated partial union at the time of their final CT scan at 12 and 25 weeks, respectively, but were asymptomatic. Bone stimulators were used by two patients in the group who eventually went on to heal and by one of the patients who was asymptomatic with union at 24 weeks. The overall eventual union rate (including asymptomatic partial union not requiring revision) was 7 patients out of 8 (87 %) in that individual techniques consisting Of headless compression screw is 100% and of k wire 75%.

Grip strength measurements were available in 8 patients; the average grip strength of the 4 patients with k wire was 37.5 kg compared to 55 kg on the contralateral, uninjured side and that of headless compression screw was 48 kg. Wrist flexion and extension data were available on 4 patients with k wire and averaged 40° and 43°, respectively, while wrist radial and ulnar deviation (measured in nine patients) averaged 10° and 22°, respectively. Wrist flexion and extension data on 4 patients with Herbert screw is as follow averaged 45° and 53°, respectively, while wrist radial and ulnar deviation averaged 20° and 32°, respectively.

The average delay from injury to surgery for all patients was 10 days, with a median of 6 days and a range from 0 to 4 weeks.

Kaplan-Meier survival curve analysis showed a higher rate of early union in patients with fractures sustained via low energy mechanism. Fractures with no displacement also showed a higher rate of early union.

Discussion

In case of simple # one may go with conservative but in case of displaced simple # one may go with only k wire fixation but if compression require headless compression screw that is Herbert screw is best.

One can operate all scaphoid # with Herbert screw only will give better results, only problem that comes in that if it uses open reduction then, complication of orif may occur.

Immobilisation of the wrist using a plaster cast is a very safe treatment for non-displaced scaphoid fractures [8]. Between 90%–95% of fractures will heal following treatment with a cast [9]. However, patients must be able to accept the long length of immobilisation for 8–12 weeks in conservative treatment. Few studies have been published on the consequences of prolonged immobilisation. One significant drawback of casting is the stiffness of joints, particularly of the wrist following weeks of immobilisation and thus, requiring prolonged rehabilitation to return pre-injury levels

[10]. Prolonged immobilisation can also lead to muscle wasting [11]. However, a study has shown that fractures are very likely to heal, if given sufficient time for immobilization [5]. Although surgery does not require prolonged casting, it will still require protection of the wound site, with bandages for 4–6 weeks [6]. However, during this time, the patient is encouraged to mobilise the wrist to prevent stiffness.

Surgical treatment has been shown to quicken a patient's time to return to work, sports and other physical activity in comparison to conservative treatment [14, 16, 17, 18, 19, 20]. This is not only because of the immobilisation for 8–12 weeks for cast treatment, but studies have shown that surgical treatment has a better outcome in short term, when considering range of motion of the wrist, pain and grip strength

The largest previous series by Rettig and Raskin [10] demonstrated 100 % union of 17 proximal pole scaphoid fractures. Union occurred at an average of 10 weeks post-surgery, and all fractures were fixed with a headless compression screw and casted for variable time periods ranging from 10 days to 4 weeks with healing confirmed by a CT scan. The average time from injury to surgery in this series was 15 days. Four of the 17 fractures were displaced >1 mm, none had additional carpal or ligamentous injuries. The authors concluded that early surgical intervention with headless screw fixation of proximal pole scaphoid fractures presented a reasonable alternative to prolonged cast immobilization.

In our series, the rate of union by 12 weeks was 87 %—significantly less than the previous series. Univariate analysis of this population demonstrated that non-displaced fractures and those sustained via low energy mechanisms had a higher rate of union at 12 weeks. The detrimental effect of fracture displacement on healing of scaphoid fractures has been well known since Cooney defined scaphoid fractures as stable or unstable based on the presence of more than 1 mm of displacement [2]. In Cooney's series the nonunion rate for displaced fractures treated without surgery was 46 %.

Timing of surgery, within the 28 day window examined within this study, did not appear to significantly affect union rates; however, there were confounding variables in this data. Patients who were fixed within a day or two of injury were often victims of polytrauma or suffered significant damage to the carpus as a whole. These injuries tended to be operated on sooner, while the minimally displaced fractures presented with a longer interval time from the date of initial injury. Another counterintuitive finding was that shorter immobilization times corresponded to higher rates of union at 14 weeks. If radiographs on subsequent visits were concerning for nonunion, we tended to maintain immobilization in a cast. Thus, shorter immobilization time was likely a marker of increased healing and not necessarily the cause of such healing.

The overall union rate was 87.5% with an average union time of 12 weeks for the fractures that did eventually unite. However, the time to healing was slightly longer than the 12 to 13 weeks cited by Rettig and Raskin. Trumble examined a series of patients undergoing ORIF for acute, displaced waist fractures and found an average time to union of 4 months [15], a period longer than that described in the series of proximal pole fractures by Rettig. Within our study, we found that 87 % of fractures (7 out of 8) that eventually united did so by 12 weeks; thus, we suggest that if proximal pole fractures treated with internal fixation within the first 28 days of injury have not healed by 6 months, a secondary procedure should be performed to obtain union.

If Surgery is indicated, in displaced fractures, Open Herbert screw fixation has a better outcome as compared to percutaneous screw fixation and percutaneous K wires.

At the end we would like to conclude that although Surgical Treatment is favoured in terms of fracture union and decreased wrist stiffness and better wrist function, it is also associated with an increased risk of complications.

It is therefore suggested that routine surgical management should not be a rule and that conservative management should be undertaken for undisplaced or minimally displaced fractures. Thus, an aggressive conservative treatment, should be adopted whereby we carefully assess fracture healing and computed tomography scans after 6-8 weeks of cast immobilization and recommend surgical fixation with or without bone grafting at that time if a gap is identified at the fracture site. Such an approach should result in fracture union in 90 % of the cases.

We recognize the limitations of a retrospective study from a single center involving multiple surgeons over a period of 3 years. The patient population is as heterogeneous as the injuries sustained. Similarly, the period of follow-up varied dramatically between surgeons. A universal protocol was not followed as regards to timing of postoperative visits or data collected at each of these visits, another limitation inherent to retrospective studies. Additionally, there is not a comparative group of fractures treated conservatively to elucidate differences; however, this study demonstrates that early rates of union in scaphoid fractures are dependent on displacement and mechanism of injury and fixation technique. Fractures with low energy mechanisms of injury tended to heal more quickly and reliably, as did non-displaced fractures. Time to ORIF, within the 28-day window, did not appear to affect rate of union.

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