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Original Article

Treatment of Unstable Scaphoid Fractures by Internal Fixation using Cannulated Screws: A retrospective study

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ABSTRACT

Background and Aim: Scaphoid bone fractures are common, as they represented 50%-75% of all carpal bone fractures in young active adults. However, no standard treatment protocol is widely accepted. Unstable fractures represented an additional challenge. This study retrospectively evaluated the outcome of open reduction fixation of unstable scaphoid fractures using cannulated screws.

Patients and Methods: Thirty-two patients' files met the inclusion criteria and were included in final analysis. Data was collected from patients treated in Damietta General and Specialized hospitals between January and June 2022. All were treated by internal fixation with cannulated screws. Collected data included patient demographics, perioperative details and outcomes (clinical, radiological and functional).

Results: Patient's age ranged between 21 and 39 years (28.53±4.10 years), with male sex predominance (81.2%) and the right side was the commonly affected side (75.0%). Injuries were mainly due to falling on outstretched hands (56.3%). The follow up duration ranged between 15 to 18 weeks, (16.96±1.06 weeks). The complete union was achieved in 90.6%, with good functional outcome. The overall response (outcome) was graded as excellent (68.8%), good for 21.9% and poor for 9.4%. Excellent outcome was significantly associated with low fracture classification grade, higher postoperative range of motion (ROM), grip strength and activity scores.

Conclusion: Open reduction with fixation by cannulated screws seems to be a reasonable (safe with high success rate) option for treatment of unstable scaphoid fractures.

Keywords: **Fractures; Open Reduction; Cannulated Screws; Range of Motion; Visual Analogue Scale.**

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INTRODUCTION

Scaphoid bone is significantly contributed to the wrist biomechanics. However, it is the most common carpal bone subjected to fractures. It comes after the distal radius fracture in the incidence. Thus, early diagnosis and reasonable treatment are of utmost importance [1-3].

The highest incidence rate of scaphoid fractures is around 75% of all carpal bone fractures in young active adults. It is usually due to falling on to the outstretched hand with the bend back wrist. The fracture may be associated with severed blood flow to the bone itself leading to slow healing or delayed or non-union. Thus, early diagnosis and treatment is so important to avoid complications (e.g., carpal collapse or avascular necrosis). The non-union rate in un-displaced scaphoid fractures is about 5-10%, which increased to 90.0% of displaced fractures of the proximal pole [4-6].

Surgical treatment with specifically designed implants is increasingly used for treatment of scaphoid fractures, with different techniques (internal fixation, percutaneous fixation with or without bone graft, etc..). A suitable treatment approach should achieve stable fixation with minimal complications [7-9]. However, the unstable fracture is an indication of internal fixation. This is absolutely defined as any fracture with displacement ≥1 mm, or a scapholunate angle >60°, capitolunate angle >15°, lateral intrascaphoid angulation >25±5° or a posteroanterior intra-scaphoid angulation >35 ± 5° and proximal pole fractures or avascular proximal fragment [10,11].

Many types of screws are available for fixation of scaphoid fractures. The aim is to reduce the duration of postoperative immobilization and non-union rates. In addition, these screws were used for acute displaced scaphoid fractures [12].

It had been shown that cannulated screws could provide better internal fixation of scaphoids and shorten the duration of union of acute displaced scaphoid fractures. However, there was no sufficient literature on their value in treatment of acute displaced scaphoid fractures. Thus, the current work was designed as a retrospective analysis of the clinical, functional and radiological functional outcome of open reduction of acute unstable scaphoid fractures using cannulated screws.

PATIENTS AND METHODS

Thirty-two patients were included in the current work. Data was collected from Damietta General and Specialized hospital over a complete one and half year (January 2021 to June 2022). We collected data about patients if the following criteria were fulfilled. First the patient was an active adult, aged at least 18 years of age, with a sole displaced scaphoid fracture. In addition, they were treated within the first month after injury (not more than 1 month).

On the other side, the files were excluded if the patient had an injury of the contralateral hand (prevent functional comparison), or if the patient had a fractured proximal pole of the scaphoid. In addition, if the patient had another associated wrist injury or submitted to previous surgery for the treatment of acute displaced scaphoid fracture. The preoperative assessment included plain radiography of the scaphoid bone (PA, lateral, oblique views of the wrist). Surgical technique was done as described previously by **Patel and Richard [13].**

In short, all surgeries were performed under general anesthesia. The patient was positioned with a well-padded non-sterile tourniquet to the arm with a radiolucent arm table. The scaphotrapeziod joint was recognized and marked on the volar side. A transverse stab incision was made 1 cm distal to the scaphotrapeziod joint. After blunt dissection of the scaphoid distal end, a 1.4-mm K-wire was used temporarily to facilitate fracture stabilization. The length of the guide wire within the scaphoid was determined and a drill was inserted, parallel to the guide wire followed by tapping. Then, a Herbert screw introduced. Compression was confirmed and the end of the screw was buried beneath the distal surface of the scaphoid to avoid any further damage to the scaphotrapeziod joint. Postoperatively, a scaphoid cast was applied with a window at surgical wound site. Sutures were usually removed two weeks after surgery. However, the cast continued for another four weeks (then removed after six weeks). A removable wrist immobilizer brace replaced the cast for another 4 weeks with physiotherapy. All patients were evaluated at a regular visit until union of fracture. At each visit, patients were evaluated by clinical as well as radiological examination. Union was defined by absent tenderness at the anatomical snuff box or scaphoid tubercle.

In addition to the presence of trabeculae crossing fracture on at least three radiologic views [14].

The final available clinical assessment using Modified Mayo Wrist Score (MMWS) [15] was included in analysis. Grip strength was assessed and compared to contralateral side [16] and graded according to Medical Research Counsel (MRC) grading scale. Finally, range of motion was measured using goniometer [17], while pain was evaluated using the visual analogue scale (VAS) after explanation and instruction for each patient how to express their pain [18].

The outcome was classified as excellent if MMWS was≥ 90; good if MMWS (60-89) and poor if < 60.

Data analysis: the collected data were fed to personal computer running windows 7. The statistical package for social sciences (SPSS) version 16 was used to compute all analysis. Continuous data were expressed by their mean and standard deviation, while categories were summarized by frequency and percentages. Groups were compared by one way analysis of variance or Chi square test according to the type of data. P value < 0.05 was set as the value of significance.

RESULTS

The current work included data of 32 adult subjects, treated by internal fixation of unstable scaphoid fractures using cannulated screws. Patient's age ranged between 21 and 39 years, and most of them are in their thirties (the mean±SD age was 28.53±4.10 years), with male sex predominance (males represented 81.2%) and the right side was the commonly affected side (75.0%). Injuries were mainly due to fall on outstretched hands (56.3%) then motor car accidents (MCA) (37.5%). More than 90.0% were grade (B2) and the delay time between injury and surgery ranged between 3

to 15 days (mean±SD was 8.34±3.27 days). The follow up duration ranged between 15 to 18 weeks, the mean±SD was 16.96±1.06 weeks. The complete union was achieved in 90.6%. Postoperative pain scores ranged between 1 and 3, while ROM ranged between 15 and 25 and similarly each of grip strength and activity scores ranged between 15 and 25, while total MMWS score ranged between 45 and 100. The overall response (outcome) was graded as excellent among 68.8%, good for 21.9% and poor for 9.4% (Table 1).

The association between overall response and other variables showed that, excellent outcome was significantly associated with fracture classification grade (all subjects with B2 grade had excellent and good outcome, while subjects with B4 grade had poor outcomes). In addition, the better outcome was associated with higher ROM, higher grip strength and activity score. Finally, the excellent outcome was associated with the highest total MMWS. Unexpectedly poor outcome was associated with lower pain scores. The fact that only 3 patients had poor outcome can explain these unexpected results. However, the excellent outcome had lower pain than those with good outcome (Table 2).

Table (1): Summarized statistics of studied variables

Variable		Statistics (n=32)
Age (years) (mean±SD; Min. – Max.)		28.53±4.10; 21-39
Sex (n, %)	Male Female	26(81.2%) 6(18.8%)
Affected Side	Right Left	24(75.0%) (25.0%)
Cause	Fall on outstretched hand Motor car accident (MCA) Sport-related injury	18(56.3%) 12(37.5%) 2(6.3%)
Fracture grade classification)	B2 B4	29(90.6%) 3(9.4%)
Delay (days) (mean±SD; Min. – Max.)		8.34±3.27; 3 - 15
Recorded Follow up duration (weeks) (mean±SD; Min. – Max.)		16.96±1.06; 15-18
Complete union	Yes No	29(90.6%) 3(9.4%)
PO VAS Pain score (mean±SD; Min. – Max.)		2.19±0.58; 1-3
PO Range of motion score (mean±SD; Min. – Max.)		22.66±3.35; 15-25
PO Grip strength score (mean±SD; Min. – Max.)		24.06±2.96; 15-25
PO Activity score (mean±SD; Min. – Max.)		23.13±3.76; 15- 25
PO Total MMWS (mean±SD; Min. – Max.)		89.06±13.34; 45 - 100
Overall response	Excellent Good Poor	22(68.8%) 7(21.9%) 3(9.4%)

Table (2): Factors associated with overall response

Variable		Excellent	Good	Poor	Test	P value
Age (years)		28.77±3.77	27.85±5.11	28.33±5.50	0.128	0.880
Sex	Male Female	17(77.3%) 5(22.7%)	6(85.7%) 1(14.3%)	3(100.0%) 0(0.0%)	1.018	0.603
Affected Side	Right Left	16(72.7%) 6(27.3%)	5(71.4%) 2(28.6%)	3(100.0%) 0(0.0%)	1.108	0.575
Cause	Fall on outstretched hand Motor car accident Sport-related injury	11(50.0%) 9(40.9%) 2(9.1%)	6(85.7%) 1(14.3%) 0(0.0%)	1(33.3%) 2(66.7%) 0(0.0%)	4.177	0.383
Fracture classification	B2 B4	22(100.0%) 0(0.0%)	7(100.0%) 0(0.0%)	0(0.0%) 3(100.0%)	**32.0**	**0.007***
Delay (days)		7.68±3.27	10.0±3.51	9.33±1.15	1.529	0.234
Follow up duration (weeks)		17.18±1.01	16.42±1.13	16.67±1.54	1.519	0.236
Complete union	Yes No	22(100.0%) 0(0.0%)	7(100.0%) 0(0.0%)	0(0.0%) 3(100.0%)	**32.0**	**<0.001***
Pain score		2.22±0.40	2.43±0.78	1.33±0.58	4.925	0.014*
Range of motion score		23.86±2.14	22.14±2.67	15.0±0.00	21.812	<0.001*
Grip strength score		25.00±0.00	24.28±1.89	16.67±2.88	69.95	<0.001*
Activity score		25.00±0.00	20.71±4.49	16.67±2.88	25.449	<0.001*
Total MMWS		95.45±3.42	85.00±0.00	51.67±5.77	242.026	<0.001*

DISCUSSION

This study reflected our experience with the outcome of the internal fixation using cannulated screws for fixation of unstable scaphoid fractures. Results showed that, patient age ranged between 21 and 39 years (the mean±SD age was 28.53±4.10 years), with male sex predominance and there was no significant association between outcome and each of age or sex of the patient. These results are supported by previous studies. **Krasin *et al.*** [19] reported that scaphoid fractures are common in young adults, and it usually affect their work due to its morbidity.

In addition, **Parajuli *et al.*** [20] registered only 2 patients (13.3%) above the age of thirty years of age. Others were below this age. This confirmed that scaphoid fractures are more common in young adults. This may be due to the activity of patients at this age, with exposure to different types of traumas.

The union was successful for 29(90.6%). This was comparable to **Rettig *et al.*** [21] who reported complete union for 93.0% of patients treated open reduction and internal fixation at 8-20 weeks after surgery (mean 11.5 weeks). **Filan and Herbert** [22] achieved 88% union rate (slightly lower than the current rate) with internal fixation by screws for displaced fractures of the scaphoid. Furthermore, **Parajuli *et al.*** [20] achieved 93% union rate with minimal complications and early return to daily activities.

Interestingly, **Trumble *et al.*** [23] reported 100% union rate. They attributed this to strict criteria for inclusion. This was associated with selection of ideal groups of patients (they excluded fractures of the proximal pole, osteoarthritis, or carpal instability) (i.e. they excluded cases with known decreased rate of union**.**

The functional results (e.g., grip strength and ROM) compared with previous studies. **Filan and Herbert** [22] reported a recovery of grip strength of more than 90% compared to contralateral side. They noted regain of >90 percent of the normal ROM of the wrist. In addition, their pain scores are comparable to the current work. They noted 14% of their patients (n=431) had mild non-specific pain at the last follow up visit.

No complications were recorded in the current work. However, previous studies demonstrated that open fixation is not without risks and complications, as it requires soft tissue dissection with violation of ligaments (volar or dorsal ligaments) [24,25]**.** A high success rate (95%) can be achieved after adequate screw fixation. But malpositioning can result in nonunion of scaphoid fractures [26,27]**.**

Zhang *et al.* [28] included 103 patients in a retrospective study. They were treated for scaphoid waist fracture nonunion with the tripod fixation and bone grafting (n = 45) or with single cannulated screw and bone grafting (n = 58), with minimum follow up of 12 months. Results demonstrated bony union for all patients in tripod fixation group within 14.8 ± 3.8 weeks compared to 94.8% bony union in single cannulated screw fixation group within 17.6 ± 3.6 weeks. The difference was significant for time to union but not for union rate. However, at last visit, no significant difference was found with respect to any outcome measures (clinical and/or radiographic measures). They concluded that, fixation with screw and K-wires is a safe and effective treatment option for scaphoid fractures or nonunion. **Hegazy *et al.*** [29] included eighty-nine patients treated by cancellous iliac bone grafting and internal fixation with a Herbert screw (*n* = 46) or multiple Kirschner wires (*n* = 43). The rate of bone union in the K-wire group was 98% versus 89% in the screw group. There was no significant difference between the two groups regarding correction of deformity, clinical outcomes, and Quick DASH (Disabilities of the Arm, Shoulder, and Hand) scores or union rate.

The current work had some limitations. It included the retrospective nature (liable to bias) and small sample size (reducing the power of the results), with absence of comparison to other surgical techniques. However, we could conclude that, open reduction and internal fixation using cannulated screws is a safe and effective treatment option for unstable scaphoid fractures with an accepted rate of success and minimal complications. However, comparison with other techniques is highly recommended in future studies.

Conflict of interest: None

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