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Research Paper

Study of Clinical and Radiographic Outcomes of Patients With Acute Scaphoid Fractures After Union

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ABSTRACT

Background: There is no clear consensus on the best treatment option for scaphoid fractures.

Objectives: In this study, we aim to evaluate the short-term clinical and radiologic outcomes in patients with acute isolated scaphoid fractures treated with surgical or nonsurgical methods.

Methods: In a retrospective study, 31 patients with acute isolated scaphoid fracture (Mean±SD age: 28.9±9.9 years) treated with open reduction and internal fixation (n=15) or cast immobilization (n=16) methods were included. The fractures were classified according to Herbert & Fishers' classification system. Clinical outcome measures were the wrist range of motion, pinch strength, and grip strength. Radiographic outcome measures were the lunocapitate angle, scapholunate angle, and ulnar variance. The outcome were compared between the involved and uninvolved hands and between surgical or nonsurgical groups.

Results: The majority of fractures were type B2 (n=14). In a Mean±SD follow-up of 15.1±3.2 months, the mean extension, flexion, pinch, and grip strength of the involved hand averaged 81.3%, 80.7%, 90%, and 87% of the uninvolved hand. Accordingly, clinical outcomes were significantly lower in the involved hand. The scapholunate angle was significantly higher in the involved hand (P=0.002). Clinical and radiographic outcomes were not significantly different between the surgical and nonsurgical groups. Radiographic malalignment was detected in 25 scaphoids. No significant correlation was found between the clinical and radiographic outcomes.

Conclusion: After scaphoid fracture union, the decrease in wrist range of motion (extension, flexion) and grip/pinch strength has no correlation with radiographic results.

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1. Introduction

Scaphoid fractures are the most common fracture, accounting for 60-70% of carpal bone fractures. It is generally observed in young and active males following a traumatic event. Scaphoid fractures are frequently misdiagnosed because of the normal radiographic appearance of the scaphoid in the acute phase. For this reason, a high-level suspicion for scaphoid fracture is required in patients with traumatic radial wrist pain, and complementary investigations with computed tomography scanning and magnetic resonance imaging are needed [1]. Traditionally, treatment options of scaphoid fracture include conservative management for undisplaced fractures and surgical intervention for displaced fractures [2]. However, recent evidence suggests surgical treatment even for acute nondisplaced or minimally displaced scaphoid fractures owing to its favorable functional outcomes and sooner return to work, despite its higher rate of complications compared to the conservative treatment [3].

Open reduction and internal fixation (ORIF) with screws or wire is the classic surgical treatment of scaphoid fracture [4]. The advancement of minimally invasive surgery techniques for scaphoid fractures has even provided more predictable results and shorter periods of immobilization [5]. Despite satisfactory functional outcomes and healing rates, surgical treatment of scaphoid fracture can be associated with serious postoperative complications including nonunion, malunion, avascular necrosis, persistent pain, and increased risk for development of scaphotrapeziotrapezoidal (STT) joint osteoarthritis [3, 6]. In this study, we aim to evaluate the clinical and radiologic outcomes and complications following the treatment of scaphoid fracture in patients with an acute isolated injury.

2. Methods

This retrospective study was conducted after receiving approval from the Bone and joint Reconstruction Research Center, Iran University of Medical Sciences (Ethical code: IR.IUMS.REC.1400.366) and obtaining written informed consent from patients who were treated for acute scaphoid fracture in the university hospital during 2018- 2020. Patients were included in the study if they had isolated scaphoid fracture (type A and B based on Herbert and Fisher's classification), a minimum follow-up period of 12 months, and complete union of the fracture. Patients with scaphoid nonunion, nerve/tendon injury, open wrist wounds, or lost follow-up were excluded. Finally, 31 eligible patients were selected, 16 cases of casting with four fracture types (A1, A2, B1 and B2) and 15 cases of surgery with five fracture types (2 with B1, 5 with B2, 1 with B3, 4 with B4, and 3 with B5) based on Herbert and Fisher's classification [7].

Nonsurgical treatment was selected for fractures with no or minimal displacement, and included a long-arm thumb spica cast for three weeks, followed by a short-arm thumb spica cast for the next three weeks. Surgical treatment included ORIF surgery using Herbert screws or pin fixation. All surgery cases except those with type B4 fracture were treated with a volar approach. Type B4 fractures were treated using a dorsal approach. Bone graft augmentation was not used in any of the surgeries. A thumb spica splint was used for immobilization for six weeks after the operation. Union of the fracture was evaluated by serial radiographic assessments, and was defined as continuous trabecular bridging over ≥50% of the cross-section of the fracture site within six months of injury [1].

Clinicodemographic characteristics of the patients, including age, gender, smoking status, mechanism of injury, and fracture type was extracted from the patients' medical records. Base don Herbert and Fisher's classification, fractures were divided into four main types of stable fractures (A), non-stable fractures (B), delayed union (C), and nonunion (D). The main types of A and B were further categorized into the two and five subtypes based on the location of the fracture, including A1 (tubercle fracture), A2 (incomplete wrist fracture), B1 (distal oblique fracture), B2 (complete wrist fracture), B3 (proximal pole fracture), B4 (trans-scaphoid perilunate fracture), and B5 (comminuted fracture). Clinical outcomes included the wrist range of motion (ROM) and the pinch and grip strength. The ROM of both wrists was evaluated using a goniometer. The pinch and grip strength of both hands were evaluated using a dynamometer (Hydraulic Pinch Gauge Model SH5005, SAEHAN Co, Changwon, Korea). Standard anteroposterior and lateral radiographs of both wrists were also obtained for radiographic evaluation of outcomes which included measuring lunocapitate angle, scapholunate angle, and ulnar variance. A scapholunate angle of 30-60º [8] and lunocapitate angle <15º were considered as normal [9].

Statistical analysis

The statistical analysis was conducted in SPSS v. 16 software (SPSS Inc., Chicago, Ill., USA). Descriptive data were presented by Mean±SD, frequency, and percentage. The normal distribution of data was checked by Kolmogorov-Smirnov test. Comparison of the data

between the involved and non-involved hands was done using a paired t-test or its non-parametric counterpart (Wilcoxon signed-rank test). Pearson's or Spearman's correlation tests were used for the evaluation of the potential correlation between the clinical and radiographic measures. A P<0.05 was statistically significant.

3. Results

Participants were 31 patients who were treated for acute scaphoid fracture. of these, 23 (74.2%) were males and 8 (25.8%) were females with a mean age of 28.9±9.9 years (ranged 18-68 years). Non-contact sports were the most common mechanism of injury (n=10, 32.3%). Type B2 fracture was the most common type of fracture (n=14, 45.2%). Treatment was performed nonsurgically for 16 patients and surgically for 15 patients. Their Mean±SD follow-up period was 15.1±3.2 months (ranged 13-19 months). Demographic characteristics of the participants are detailed in Table 1.

At the final follow-up session, the mean wrist extension and flexion were significantly lower in the involved hand compared to the contralateral hand (P<0.001 for both). The mean pinch and grip strength of the involved hand was significantly lower than those of the contralateral hand (P=0.001 for both). The mean lunocapitate angle was not significantly different between the involved and non-involved hands (P=0.23). The mean scapholunate angle was significantly higher on the involved side (P=0.002). Ulnar variance was negative, neutral and positive in 5 (16.1%), 20 (64.5%), 6 (19.4%) of the involved hands and 2 (6.5%), 26 (83.9%), 3 (9.7%) of the non-involved hands (P=0.21). Clinical and radiographic characteristics are detailed in Table 2.

Clinical and radiographic factors were not significantly different between the patients treated nonsurgically and those underwent surgical treatment (Table 3). According to the lunocapitate and scapholunate angle, 25 scaphoids were malaligned in the final follow-up that led to Dorsal Intercalated Segment Instability (DISI). The rate of malalignment was not significantly different between those with surgical and nonsurgical treatments (68.7% vs. 93.3%, P=0.17). No significant correlation was found between the clinical and radiographic factors (Table 4).

Table 1. Clinicodemographic characteristics of the patients

Variables		No. (%)
Gender	Male	23(74.2)
	Female	8(25.8)
Injured hand dominancy	Dominant	19(61.3)
	Non-dominant	12(38.7)
Cause of injury	Motor vehicle accidents	8(25.8)
	Falling from height	7(22.5)
	Contact sports	6(19.4)
	Non-contact sports	10(32.3)
Smoking	Yes	16(51.6)
	No	15(48.4)
Fracture type	A1	1(3.2)
	A2	5(16.1)
	B1	3(9.7)
	B2	14(45.2)
	B3	1(3.2)
	B4	4(12.9)
	B5	3(9.7)
Treatment	Surgical	15(48.4)
	Nonsurgical	16(51.6)
Surgical fixation	Herbert screw	14(93.4)
	Pin	1(6.6)
Surgical approach	Volar	11(73.3)
	Dorsal	4(26.7)

Table 2. Clinical and radiographic characteristics of the patients

Variables		Mean±SD/No. (%)		P
		Involved Hand	Non-Involved Hand	
Wrist extension (degree)		61±16.9	75.5±7.8	<0.001
Wrist flection (degree)		63.1±15.1	78.3±7.3	<0.001
Pinch strength (Kg)		9.9±3.8	11±4.1	0.001
Grip strength (Kg)		33.5±11	38.6±12.6	0.001
Lunocapitate angle (degree)		19.3±11.4	16.8±10.5	0.23
Scapholunate angle (degree)		59.2±17.6	49.1±10.3	0.002
Ulnar variance	Negative	5 (16.1%)	2 (6.5%)	-
	Neutral	20 (64.5%)	26 (83.9%)	-
	Positive	6 (19.4%)	3 (9.7%)	0.21

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Table 3. Comparison of clinical and radiographic outcomes between patients with surgical and nonsurgical treatments

Variables		Mean±SD/No. (%)		P
		Nonsurgical treatment (n=16)	Surgical treatment (n=15)	
Wrist extension (degree)		64.8±19	56.9±13.6	0.06
Wrist flection (degree)		66.9±14	59±15.6	0.09
Pinch strength (Kg)		9.5±4	10.4±3.6	0.36
Grip strength (Kg)		31.7±10.6	35.5±11.5	0.37
Lunocapitate angle (degree)		20.7±13.2	17.7±92	0.6
Scapholunate angle (degree)		47.7±9.5	51.8±11.8	0.28
Ulnar variance	Negative	2 (12.5)	3 (20)	0.66
	Neutral	10 (62.5)	10 (66.7)	
	Positive	4 (25)	2 (13.3)	

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Table 4. Correlation test results between radiographic and clinical outcomes

Outcome Measure	Wrist Extension	Wrist Flexion	Pinch Strength	Grip Strength
Lunocapitate angle	R=13.8, P=0.46	R=0.067, P=0.72	R=-0.235, P=0.2	R=-0.251, P=0.174
Scapholunate angle	R=-0.084, P=0.66	R=-0.106, P=0.57	R=0.298, P=0.11	R=0.266, P=0.15
Ulnar variance	R=0.118, P=0.52	R=0.182, P=0.32	R=-0.042, P=0.82	R=-0.152, P=0.41

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Complications

Mild osteoarthritis was observed in three patients. All of these patients had type B4 fractures according to Herbert and Fisher's classification. In this patients, DISI and osteoarthritis caused further reduction in clinical outcome such as decrease in wrist ROM and grip/pinch strength in injured hand compared to other hand. We did not have any case of complex regional pain syndrome at the time of fallow-up and data curation. Other post-treatment complications such as infection, persistent pain, and hardware irritation was not recorded in the present series.

4. Discussion

In this study, we evaluated the clinical and radiographic outcomes of patients treated for acute scaphoid fracture. The clinical and radiographic measures were significantly lower in the injured hand compared to the contralateral hand. Malalignment of the wrist (DISI deformity) was reported in a significant number of patients (25 out of 31) at the final follow-up. No significant difference was seen between the outcomes of patients with surgical and nonsurgical treatments.

The outcome of acute scaphoid fracture has been reported in several studies. Kaiser et al. retrospectively reviewed the outcomes of surgically treated scaphoid fracture in 33 patients. The fracture was isolated in 23 patients and associated with concomitant injuries in 10 patients. Patients with an isolated fracture had a mean extension of 68º, a mean flexion of 64°, and a grip strength of 39 kg, that were corresponding to 87%-98% of the contralateral wrist. In patients with concomitant injuries, the mean extension-flexion and grip strength corresponded to 73%-98% of the contralateral wrist. They concluded that surgical treatment of an acute isolated scaphoid fracture has excellent mid-term outcomes. Concomitant wrist injuries adversely affect the outcomes of scaphoid fracture [10].

In the current study, the mean extension, flexion, pinch, and grip strength of the involved hand averaged 81.3%, 80.7%, 90%, and 87% of the uninjured hand. These results are consistent with the results of Kaiser et al. who reported the acceptable mid-term outcomes of surgical treatment for acute scaphoid fractures. Vinnars et al. in a randomized clinical trial, compared the outcomes of surgical and nonsurgical treatment in 83 patients with acute nondisplaced or minimally displaced scaphoid fracture. Surgical treatment included ORIF surgery using Herbert screw. In a follow-up of ten years, subjective outcomes were comparable between the two study groups. However, a high rate of STT joint arthritis was detected in the surgically treated group. The wrist ROM and grip strength were not significantly greater in the nonsurgically treated group. Their study did not prove a true long-term benefit of ORIF compared to cast immobilization for acute nondisplaced or minimally displaced scaphoid fractures [11].

The majority of fractures in the present study were also nondisplaced or minimally displaced. Similarly, we did not observe any significant difference in clinical and radiographic outcomes of the surgically and nonsurgically treated patients. The majority of patients with type B4 patients (3 out of 4) showed the signs of arthritis. However, the follow-up period of the study was not long enough to compare osteoarthritis incidence between the patients with surgical and nonsurgical treatments.

Dias et al. in a scaphoid waist internal fixation for fractures trial compared the efficacy of surgical fixation versus cast immobilization in 439 adults with scaphoid waist fractures displaced by 2 mm or less. In a 52-week follow-up period, pain and disability scores were not significantly different between the patients with surgical and nonsurgical treatments. Potentially serious complications were significantly more in the surgical group. They concluded that adults with scaphoid fractures displaced ≤ 2 mm should be initially managed with cast immobilization; in case of nonunions, they should be immediately fixed with surgery [12]. Similar results were observed in the present retrospective study regarding the comparability of outcomes between surgical and nonsurgical treatments. Kumar et al. in a prospective study, evaluated the clinical and radiologic outcomes of ORIF surgery in the treatment of 30 patients with displaced scaphoid fracture. The follow-up period of the patients was 18 months. Mayo wrist score and patient-rated wrist evaluation were significantly improved after the operation. The radiographic outcome of the operation (union) was acceptable, as well. They concluded that ORIF surgery using Herbert screw for the treatment of acute displaced scaphoid fracture has satisfactory clinical, functional, and radiological outcomes and provides early recovery [13]. Considering the prospective design of the present study, improvement of these outcomes could not be estimated.

The outcome of scaphoid fracture has also been evaluated in several systematic reviews and meta-analyses. For example, Shen et al. in a meta-analysis of randomized controlled trials, compared the outcomes of surgical and nonsurgical treatments for acute undisplaced or minimally-displaced scaphoid fractures. According to their results, surgical treatment provided significantly better short-term functional outcomes and a more rapid return to work. However, their analysis did not provide evidence supporting the routine use of surgical treatment for these fractures [14]. Alshryda et al. investigated the efficacy and safety of various treatments of acute scaphoid fractures. According to their analysis, surgical treatment was not associated with superior outcomes in undisplaced fractures but may be beneficial in displaced fracture [15]. Li et al. found no statistical difference in the patient satisfaction and pain level between patients with surgical and nonsurgical treatments of scaphoid waist fractures with slight or no displacement [16-18].

Overall, the results of the present study revealed that both surgical and nonsurgical treatments are effective for acute scaphoid fracture at least in short-term. Decrease in wrist ROM (flexion and extension) and grip/pinch strength occurred after treatment but all patients could go back to work and were satisfied. The present study had some limitations. The main limitation was its retrospective design which did not allow evaluating the improvement of outcomes over time. In addition, the number of patients was low in some fracture subgroups. This limitation did not allow the evaluation of type-specific outcomes.

Conclusion

Although the clinical and radiographic outcomes of acute isolated scaphoid fractures are significantly lower in the injured hand, it averaged 80-90% of the uninjured side. There is no significant difference between the patients with surgical and nonsurgical treatments of acute scaphoid fractures in clinical and radiologic outcomes at least in short-term. Therefore, both modalities can be used for the treatment of these fractures, particularly in un-displaced or minimally displaced cases. The displaced fractures can potentially benefit from open surgery; however, the evidence of the present study is not enough to recommend it. Future complementary studies are required to shed more light on the efficacy and safety of surgical and nonsurgical treatments of the acute scaphoid fracture.

Ethical Considerations

Compliance with ethical guidelines

This research was approved by the ethics committee of Iran University of Medical Sciences (Code: IR.IUMS.REC.1400.365).

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Authors' contributions

conceptualization and design, data collection and analysis, drafting the manuscript: Farhad Soltani and Hooman Shariatzadeh; conceptualization and design: Hamidreza Dehghani and Farid Najd Mazhar, Mohsen Barkam; conceptualization and design, data collection: Meysam Fathi Choghadeh

Conflict of interest

The authors have no any potential conflicts of interest.

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