Original Article

ANATOLIAN CURRENT MEDICAL

DOI: 10.38053/acmj.1756959

Anatolian Curr Med J. 2025;7(6):900-905

Analysis of mid-term radiological and functional results of conservative versus surgical intervention in non-displaced and minimally displaced scaphoid fractures

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Cite this article as: Erdoğan E, Güneş Z. Analysis of mid-term radiological and functional results of conservative versus surgical intervention in non-displaced and minimally displaced scaphoid fractures. *Anatolian Curr Med J.* 2025;7(6):900-905.

Received: 02.08.2025 ◆ **Accepted**: 15.10.2025 ◆ **Published**: 26.10.2025

ABSTRACT

Aims: In patients with non-displaced or minimally displaced scaphoid fractures (Herbert and Fisher types A1-2, B1-3), we compared radiographic union time, functional outcomes, complication rates, and time to return to work between conservative treatment and percutaneous screw fixation.

Methods: From 2013 to 2023, a study examined patients aged 18 to 65 who had recently undergone treatment at one large hospital for non-displaced or minimally displaced scaphoid fractures. Patients were divided into conservative and surgical (percutaneous fixation with headless compression screw) groups. The study looked at clinical and radiographic outcomes including as range of motion (ROM), grip strength, radiographic union, Visual Analog Scale (VAS), Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH) scores, scaphotrapezoid arthritis, complication rates, and return-to-work time. The statistical significance level was set at $p<0.05$.

Results: A total of 107 patients (average age 34.87 years; 58.9% male) were included, with a mean follow-up time of 15.8 months. The surgical group had significantly shorter radiographic union and return-to-work durations ($p<0.05$). ROM and grip strength were higher in the surgery group, though not statistically significant. The surgical group had considerably decreased Q-DASH and VAS scores three and six months after surgery, but not twelve months. There were no significant variations in rates of delayed union, nonunion, malunion, or scaphotrapezoid arthritis across the groups.

Conclusion: Both treatment methods improved union rates in non-displaced or minimally displaced scaphoid fractures. Percutaneous fixation has been linked to faster fracture healing, quicker return to work, and improved early function. Functional outcomes remained similar one year later. Surgical intervention may be useful for young, energetic persons who require quick mobilization, but conservative therapy is a viable and cost-effective option for compliant patients.

Keywords: Scaphoid fractures, percutaneous fixation, herbert and fisher classification

INTRODUCTION

Scaphoid is the most often fractured carpal bone. It accounts for 60% of carpal fractures, 11% of hand fractures, and 2% of all fractures.[1-3] Previous studies have shown that scaphoid fractures are the most common in patients with post-traumatic radial-sided wrist discomfort.[1,4]

Scaphoid fractures are well-known for their diagnostic difficulty and problematic fracture union.[4] The X-ray beam's ability to detect a non-displaced or minimally displaced scaphoid fracture is limited to 70%.[5] Standard X-rays cannot distinguish between stable and unstable fractures, as determined by the Herbert classification; thus, a computed tomography (CT) scan is required.[6] Alternatively, several recent studies recommend an early MRI in suspected scaphoid fracture cases.[7,8] Furthermore, MRI can reveal further fractures or ligament damage in the afflicted wrist.[9]

The classification of fractures is critical for deciding treatment and expected outcomes. Contemporary classification systems, such as Herbert and Russe's, are based on radiographic examination and assume fracture instability.[10-12] Mayo, a more practical and reliable strategy, is based on the fracture location and elements that contribute to instability. Proximal pole fractures, on the other hand, lack a consistent definition,[13-16] and Prosser has developed a separate classification system for distal scaphoid fractures.[17]

Proximal pole fractures are unstable because of their tiny size and uneven attachment to the scapholunate (SL) ligament.[18] Fractures have a frail blood supply, resulting in longer healing timeframes and higher non-union rates. Conservative treatment can result in nonunion rates ranging from 10 to 14 percent.[19] In approximately 90% of non-

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displaced or minimally displaced (≤0.5 mm) scaphoid waist fractures, union occurs after six weeks of adequate cast treatment.[20] Fracture comminution, defined as a discrete cortical or cortico-spongeous fragment on the radial aspect of the scaphoid, has been associated to instability and longer union length in non-displaced fractures.[20,21] The adoption of minimally invasive, percutaneous methods has resulted in a shift in surgical treatment for non-displaced waist fractures, allowing for an instantaneous return to work or sporting activity.[22] A scaphoid waist fracture with displacement greater than 1 mm is normally considered unstable and therefore a candidate for internal fixation.[13] Scaphoid fractures with minor displacement (0.5-1.5 mm) require extended cast immobilization for eight to ten weeks.[20] Surgical intervention is recommended for fracture instability, which includes fracture comminution, DISI configuration, lateral intra-scaphoid angle more than 35 degrees, and scaphoid fracture associated with perilunate damage.[4] The distal portion of the scaphoid has robust vascularization, and fractures in this region are typically non-displaced or little displaced, leading to the widespread belief that these fractures mend adequately with conservative therapy.[23]

Numerous studies compare the efficiency of surgical versus conservative treatment for scaphoid fractures; nevertheless, opinions differ on how to manage non-displaced and mildly displaced scaphoid fractures.[4,24,25] The purpose of this study was to determine whether there is a significant difference in radiographic union, range of motion (ROM), grip strength, scaphotrapezoid (ST) arthritis, and mid-term functional outcomes between patients with non-displaced or minimally displaced scaphoid fractures classified as types A1, A2, B1, B2, and B3 (according to the Herbert and Fisher classification) who underwent percutaneous fixation with a headless compression screw and those treated conservatively.

METHODS

The study was approved by the Clinical Researches Ethics Committee at Ankara Training and Research Hospital (Date: 17.04.2024, Decision No: 90/2024), and was carried out in compliance with the Declaration of Helsinki's ethical criteria and principles. Participants in the study were given thorough information about the research, and each patient signed an informed consent document. The study received no financial backing from any institution or organization, and the scientists covered all of the research expenses themselves.

From 2013 to 2023, this study retrospectively examined people diagnosed with scaphoid fractures in the Ankara Training and Research Hospital data system. Patients outside of these years were not included in the study, and all other patients were evaluated. The study included patients with non-displaced or mildly displaced fractures (types A1-2 and B1-2-3, according to the Herbert and Fisher classification) who had complete data available for analysis.

Our study included male and female patients aged 18-65 with acute non-displaced or minimally displaced (<1 mm) scaphoid fractures. They were treated conservatively or surgically, attended regular follow-ups, had pre- and post-treatment X-ray and CT results, and were monitored for at least one year. Individuals under 18 and over 65 years old, those with inconsistent follow-ups, those without pre/post-treatment imaging method data, patients with displaced scaphoid fractures (Herbert, Fisher type B4, C, D), and those who underwent revision surgery due to nonunion were excluded from the study (**Table 1, Figure 1**).

Table 1. Patient demographic characteristics

Group Characteristic		Surgery n=43 (40.2%)	Conservative n=64 (59.8%)	Total n=107 (100%)
Age (mean)		34.12	35.38	34.87
Gender	Female	21 (48.8%)	23 (35.9%)	44 (41.1%)
	Male	22 (51.2%)	41 (64.1%)	63 (58.9%)
Side		R: 26 (60.5%) L: 17 (39.5%)	R: 25 (39.1%) L: 39 (60.9%)	R: 51 (47.7%) L: 56 (52.3%)

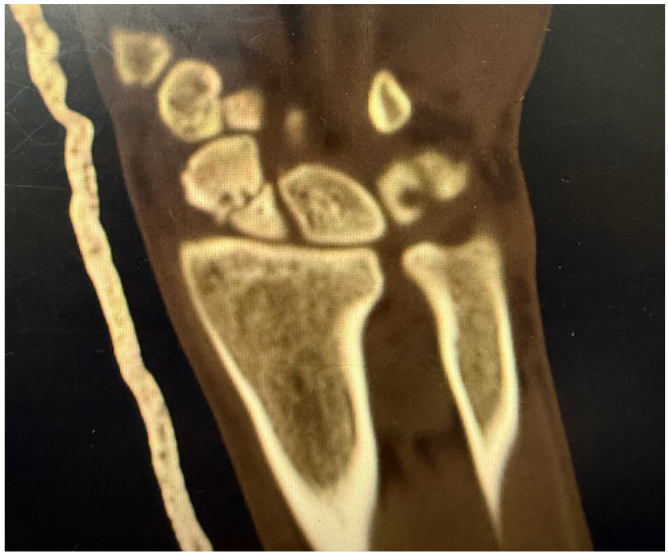

Figure 1. Preoperative coronal computed tomography image of a patient with a scaphoid waist fracture (according to Herbert and Fischer classification type B2)

The study's participants were divided into two groups: those receiving conservative treatment and those undergoing surgery. Patients who were treated conservatively were placed with a short arm cast, including the thumb, for 6–8 weeks. After the cast was removed, passive movements were initiated, followed by active joint movements. The goal was to restore full wrist ROM within 3-4 weeks after removing the cast. After 8–10 weeks, individuals were permitted to resume sporting or strenuous work activities. Patients in the surgical group were treated surgically by inserting a headless cannulated screw anterogradely (distal to proximal) under fluoroscopy. A short arm splint was used to immobilize the patient for two weeks following surgery. After the splint was removed, passive movement of the fingers and wrist began. Active joint movements and grip exercises were introduced in the third week. After 8–10 weeks, individuals were permitted to resume sporting or strenuous work activities.

A minimum 12-month follow-up period was used to compare the radiological union time, ROM, grip strength, Q DASH score, VAS, presence or absence of ST arthritis, and the presence of complications in both groups. Data such as the

patients' age, gender, AO type, side of the affected extremity, time back to work, and smoking status were also compared between groups.

Delayed union is defined as the absence of significant radiographic signs of healing after 12 weeks. Clinically, persistent pain or sensitivity on palpation, as well as functional pain during gripping, are both indicators of delayed union. The absence of radiological evidence of union beyond 24 weeks is labeled non-union. Radiological signs of nonunion include sclerotic edges at the fracture line on CT, a gap between fracture ends (≥1 mm), a pseudoarticulation line or cyst formation, and no callus formation. Signs of non-union include clinically prolonged discomfort, soreness, decreased grip strength, and functional restrictions. Nonunion of the scaphoid is characterized by a disruption of the geometry and carpal alignment. Radiologically, the presence of a "Humpback deformity" (scaphoid dorsal angulation >45°), a 5–10% shortening of the scaphoid length compared to the healthy side on CT, an increase in the SL angle >60° (dorsal intercalated segment instability, DISI), and lunate extension are findings of malunion. Even clinically, pain or a "clicking" sensation with wrist movements, decreased grip strength, and the development of scaphoid nonunion advanced collapse (SNAC wrist) in the long term are signs of malunion.

Statistical Analysis

The data analysis was carried out using SPSS (Statistical Package for the Social Sciences) version 30 software. The Shapiro-Wilk test was used to determine the normality of the data. Categorical data were statistically analyzed using the Fisher exact test, while quantitative data were examined using the Unpaired t-test and one-way ANOVA, depending on the normality of the distribution. A p-value less than 0.05 was considered significant for the statistical difference.

RESULTS

The study included 58.9% (n=63) males and 41.1% (n=44) females, with an average age of 34.87 years (**Table 1**). The average follow-up period was 15.8 months.

There was no statistically significant difference in age or gender between the conservative and surgical groups. The average age, gender distribution, affected side, hand dominance, and follow-up period were similar in both groups (**Table 1**).

Individuals' radiological union duration (as measured by X-Ray and CT), return-to-work time, and smoking status were compared between groups. There was a statistically significant difference favoring the surgical group in both union time and return to work (**Table 2**). No statistically significant difference in smoking status was found between the two groups.

At three and six months, the surgical cohort had significantly reduced Q-DASH and VAS scores; however, there was no significant difference between the two groups at one year (**Table 2, Figure 2, 3, 4**).

Figure 2. Preoperative AP X-ray image of a patient with a scaphoid waist fracture

Complications such as delayed union, nonunion, malunion, and soft tissue arthritis were compared between groups. A 35-year-old female patient in the conservatively treated group developed complex regional pain syndrome after 8 weeks of short-arm casting. A 52-year-old male patient with a 36-year history of smoking two packs of cigarettes per day underwent revision surgery for scaphoid nonunion in the surgically treated group. The treatment involved employing a unique sort of bone graft coupled to a blood supply, which

Table 2. Variations among groups in union duration, range of motion, grip strength, time to return to work, QDASH score, and VAS score

	Surgery n=43	Conservative n=64	p value	SED	95% CI of the difference upper	lower
Union time (week)	11.34	12.89	.000	.997	-12.769	-8.816
Range of motion (°)	134.37	136.22	.120	1,178	-4.182	.488
Grip strength (kg)	38.81	37.84	.231	.806	-.627	2.568
Return to work (week)	12.34	13.61	.000	1.324	-11.534	-6.285
QuickDASH (3rd month)	20.53	23.30	.000	.997	-12.769	-8.816
QuickDASH (6th month)	12.93	15.09	.000	.316	-2.791	-1.536
QuickDASH (1st year)	7.98	8.58	.076	.336	-1.267	.065
VAS (3rd month)	25.70	28.00	.011	.890	-4.066	-.538
VAS (6th month)	14.79	18.53	.000	.334	-4.403	-3.079
VAS (1st year)	9.47	9.28	.482	.261	-.333	.701

QDASH: Quick Disabilities of the Arm, Shoulder, and Hand, VAS: Visual Analog Scale CI: Confidence interval

Figure 3. AP X-ray image with ulnar deviation of the patient in Figure 1 after percutaneous screwing

Figure 4. Lateral X-ray image of the patient in Figure 1 after percutaneous screwing

successfully repaired the bone. During follow-up, two patients from the surgical cohort developed ST arthritis. There were no cases of malunion in either cohort. There was no statistically significant difference between the groups for delayed union, nonunion, and malunion.

DISCUSSION

The treatment of scaphoid fractures is challenging due to the risk of delayed or nonunion. Timely diagnosis and appropriate treatment are crucial to prevent long-term complications.[24] However, there is still no consensus on the management of acute non-displaced or mildly displaced scaphoid fractures.[25] The development of minimally invasive percutaneous techniques has influenced the operative management of these injuries.[4] In this study, patients were divided into two groups: those who received conservative treatment and those who underwent percutaneous screw fixation. Radiological union time, ROM, grip strength, Quick Disabilities of the Arm, Shoulder, and Hand (Q-DASH) score, Visual Analog Scale (VAS), incidence of scaphotrapeziotrapezoidal (STT) arthritis, and complication rates were assessed after at least one year. Demographic and clinical data such as age, gender, AO type, side of involvement, smoking status, and time to return to work were also compared.

Conservative cast treatment for mildly displaced scaphoid fractures remains reliable and cost-effective, with low complication rates. Approximately 85–90% of these fractures heal when diagnosed early and treated promptly with cast immobilization. Nevertheless, its disadvantages include prolonged immobilization, joint stiffness, reduced grip strength, and delayed return to work.[24,26,27] Percutaneous fixation, by contrast, preserves vascularity and soft tissues, allowing early wrist motion and quicker functional recovery.[24,26,28]

Although ROM and grip strength were slightly higher in the surgical group, the difference was not statistically significant. We attribute this trend to early mobilization after internal fixation. Similar findings have been reported in randomized studies and meta-analyses, which showed no significant long-term differences in ROM or grip strength between surgical and conservative groups.[29-33] Vinnars et al.[27] likewise observed better—but not statistically significant—ROM and grip strength in the nonoperatively treated cohort, consistent with our results showing no difference in limb-specific functional outcomes between the two treatments.

Consistent with previous research, our data show that, when compared to conservative treatment, surgical intervention significantly improved Q DASH and VAS ratings during the early post-fracture fixation period; nevertheless, comparable scores were obtained at the one-year follow-up. This may be related to the enhanced stability provided by screw fixation, promoting early motion, whereas long immobilization in casts leads to stiffness and muscle atrophy.[26,27,29-36]

The operated group returned to work significantly earlier, reflecting the benefits of reliable fixation and earlier rehabilitation. These findings align with previous meta-analyses reporting shorter return-to-work durations after percutaneous fixation of stable scaphoid fractures.[29-34,36,37] Thus, young laborers performing physically demanding tasks may particularly benefit from surgical intervention that minimizes immobilization and expedites functional recovery.

The conservative cohort demonstrated a longer healing time, though union rates were high in both groups. Our results support the use of surgical fixation to reduce the risk of delayed union in acute non-displaced or minimally displaced fractures. Previous studies also reported shorter healing durations after surgical fixation.[26,27,29-34,36,37] The improved early function observed in the surgical group likely results from earlier union and faster rehabilitation, enabling a quicker return to work.

Limitations

This study has limitations, including its retrospective design, relatively small sample size, and absence of cost-effectiveness analysis. Future prospective randomized controlled trials with larger cohorts and economic evaluations are warranted. Our

findings contribute to the literature supporting minimally invasive fixation for scaphoid fractures with at least one-year follow-up.

CONCLUSION

Our study compared the radiographic union, functional outcomes, and complication rates in conservatively treated non-displaced or mildly displaced scaphoid fractures versus those treated with percutaneous screw fixation. The findings show that, while both treatment modalities produce high union rates, surgical intervention has advantages such as faster fracture healing, faster return to work, and better early functional outcomes. At one year, both groups had equivalent ROM, grip strength, and patient-reported functional scores.

Percutaneous fixation provided appropriate support, allowing for early mobilization while reducing the risks associated with prolonged immobilization, such as stiffness and muscle atrophy. For young patients in physically demanding employment, surgical intervention may be the better option due to shorter recovery times and faster reintegration into the workforce. Nonetheless, conservative therapy remains a reliable and cost-effective option, particularly for patients who can tolerate prolonged immobilization.

Despite its retrospective design and small sample size, our study adds to the growing data supporting less invasive surgical surgery for some scaphoid fractures. Future prospective, randomized studies with larger cohorts and cost-effectiveness analyses are required to improve treatment techniques and optimize patient outcomes.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was approved by the Clinical Researches Ethics Committee at Ankara Training and Research Hospital (Date: 17.04.2024, Decision No: 90/2024).

Informed Consent

Because the study was designed retrospectively, no written informed consent form was obtained from patients.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Acknowledgement

The authors would like to extend their heartfelt appreciation to Yusufhan ASLAN for his invaluable support and assistance during the development of this study. Although he does not satisfy the criteria for authorship, his contributions to the organization and coordination of data were greatly valued.

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