Long-Term Outcomes of Scaphoid Malunion

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Abstract

Background: The optimal treatment of patients with a scaphoid malunion remains controversial. The long-term outcomes of operative and nonoperative management have not been established. **Methods:** We conducted a retrospective review of the outcomes of all scaphoid malunions treated at single institution over a 30-year period. This included patients who underwent corrective osteotomy, salvage procedures (ie, dorsal cheilectomy, radial styloidectomy, and scaphoidectomy with midcarpal fusion), and those who refused operative intervention. The Mayo Wrist Score was determined at the time of surgical evaluation. Patient-Rated Wrist Evaluation (PRWE) and Disabilities of the Arm, Shoulder and Hand (QuickDASH) surveys were sent to all patients for long-term follow-up. **Results:** Seventeen patients had follow-up at a mean 21.4 years (range, 12–30 years). The mean initial lateral intrascaphoid angle was 58°. Of the 17 patients, 11 proceeded with surgery and 6 opted for nonoperative management. A corrective osteotomy was performed in 4 patients. Of the remaining 7 surgical patients, 5 patients underwent procedures such as cheilectomy and radial styloidectomy, whereas 2 patients had a scaphoidectomy with midcarpal fusion. The final mean PRWE and QuickDASH scores for corrective osteotomy, salvage procedures, and nonoperative treatment were 23 and 6, 18 and 10, and 33 and 22, respectively. **Conclusion:** Long-term outcomes were similar between operative and nonoperative management.

Keywords: malunion, osteotomy, scaphoid, scaphoid malunion

Introduction

The incidence of scaphoid fractures is estimated to be 1 of every 10 000 emergency department visits and is one of the most common wrist injuries.³ The majority of these fractures occur at the waist of the scaphoid (65%–75%). Although most nondisplaced fractures heal uneventfully with immobilization, displaced or unstable fractures are prone to nonunion and potentially malunion if not reduced and stabilized.¹¹ More specifically, unstable fractures in the waist region may fall into a humpback deformity as opposing flexion forces on the distal fragment and extension forces on the proximal segment (via the lunate and scapholunate ligament complex) occur. The resulting scaphoid height loss, flexion, and potential dorsal intercalated segment instability (DISI) deformity result in alteration of wrist biomechanics, which may have long-term deleterious effects.^{4,6,17}

Patients with a scaphoid malunion may have an acceleration of radiocarpal arthritis and significant wrist symptoms. Amadio et al reported that patients with a lateral intrascaphoid angle (LISA) >45° had satisfactory outcome in only 27% and posttraumatic arthritis in 54% of cases.¹ Eighty-three percent of patients with a LISA <45° had satisfactory outcomes and only 22% had radiographic changes of arthritis at a mean 45 months after union.¹ However, Jiranek et al

found that 12 of 13 patients treated with Russe bone graft for nonunion that healed with a LISA >45° returned to functioning at a high level subjectively although objective scores were lower.¹⁰

Lynch and Linscheid reported a corrective osteotomy technique with tricortical iliac crest autograft in 5 patients with DISI deformity and scaphoid malunion.¹³ Range of motion, grip strength, and Mayo Wrist Scores all improved, with all patients uniting without avascular necrosis. Multiple small case series in the literature have presented similar good outcomes with corrective osteotomy without reports of subsequent nonunion.^{5,8,9,14,15} However, the treatment of scaphoid malunion remains controversial. In particular, concern remains about the long-term outcomes of osteotomy patients and the potential risk of avascular necrosis.

The purpose of this study was to report the long-term outcomes of scaphoid malunion at our institution comparing a corrective osteotomy with other salvage procedures,

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such as cheilectomy or scaphoidectomy with a midcarpal fusion. In addition, we also report on the natural history of this condition when managed nonoperatively.

Materials and Methods

After obtaining institutional review board approval, a 30-year retrospective review of all patients at a single institution diagnosed with scaphoid malunion was performed from 1981 to 2011. The diagnosis was made by radiograph, tomogram, or computed tomography. By convention and as an extension of previous scaphoid studies, all available imaging studies were reviewed to determine the preoperative LISA (see Figure 1).

Information pertaining to patient demographics, mechanism of injury, prior surgery, and type of surgery performed was recorded. Standardized preoperative assessments included a wrist range of motion, grip strength, and the Mayo Wrist Score as described by Cooney et al.⁷ In addition, Patient-Rated Wrist Evaluation (PRWE) and Disabilities of the Arm, Shoulder and Hand (QuickDASH) surveys were mailed to all patients, including the nonoperative group, for long-term follow-up. PRWE outcomes were defined as excellent for a score of less than 10 and poor if greater than 50. Patients with follow-up less than 10 years after surgery were excluded.

The corrective osteotomy technique utilized was as described by Lynch and Linscheid with tricortical iliac crest graft.^{12,13}

Results

Thirty patients were diagnosed with a scaphoid malunion during the study period; however, only 17 patients had long-term survey follow-up of greater than 10 years. Of the final cohort, 4 patients underwent corrective intrascaphoid osteotomy, and 7 patients proceeded with salvage procedures (scaphoid cheilectomy, radial styloidectomy, or scaphoidectomy with a midcarpal fusion). In addition, 6 patients elected for conservative management (see Figure 2). The mean preoperative Mayo Wrist Scores for corrective osteotomy, salvage procedures, and nonoperative treatment were 45.0, 55.7, and 61.7, respectively.

Of the 11 surgical patients, the mean clinical follow-up was 39.8 (range, 2.5-140) months and mean survey follow-up was 20.8 (range, 12.4-29.9) years. Eighty-two percent were males with a mean age of 29 (range, 15-55) years at presentation, and 70% of patients injured the dominant hand. The mean age of patients treated nonoperatively was 26.7 (range, 15-66) years with 66% males and 86% dominant-sided injury. The mean initial LISA was 58° (range, 55°-75°). Five patients had undergone previous surgical intervention with Russe bone grafting for treatment of scaphoid nonunion.

Patient treatment, follow-up, and PRWE and QuickDASH scores are summarized in Table 1. The mean PRWE and

Figure 1. Lateral intrascaphoid angle on computed tomography.

Figure 2. Patient cohorts.

QuickDASH scores by group are shown in Figure 3. With regard to the PRWE scores, the outcome for patients with a corrective osteotomy was excellent in 3 patients and with 1 poor outcome. Forty-three percent of patients with a salvage procedure had an excellent outcome, and there were no poor outcomes. Patients electing nonoperative treatment had 50% excellent outcomes and the other half had poor outcomes.

The mean time to radiographic union in the osteotomy group was 16.9 (range, 15.6-17.1) weeks. One nonunion was reported in the osteotomy group but did not require further treatment.

Discussion

Scaphoid malunion, although a less frequent complication of a scaphoid fracture than nonunion, may have significant implications for malalignment and altered biomechanics of

Table 1. Patient Demographics, Treatment, and Clinical Data.

Demographic (age at presentation)	Treatment	Follow-up, y	Preoperative Mayo Wrist Score	Postoperative PRWE	Postoperative QuickDASH
23 M, salesman	CO	22.3	35	78	18
28 M, therapist	CO	14.9	70	3	0
19 M, carpenter	CO	30.0	50	9	5
25 M, comp tech	CO (nonunion)	14.0	25	1	0
17 F, student	DSTE	20.3	80	4	7
25 M, farmer	DSC, PIN	25.7	50	29	30
35 M, electrician	RS, DSC	20.3	65	0	0
25 M, electrician	RS, DSC	25.5	45	36	5
27 M, laborer	DSC	25.0	45	30	9
55 M, mailman	SMCF, PIN	12.4	70	39	36
45 M, laborer	SMCF	18.5	35	7	7
20 M, laborer	Nonoperative	30.1	55	60	50
27 F, homemaker	Nonoperative	27.1	60	0	0
15 M, student	Nonoperative	27.9	55	9	5
15 F, student	Nonoperative	21.7	85	53	34
17 M, student	Nonoperative	12.5	55	73	36
66 M, farmer	Nonoperative	16.1	60	6	7

Note. PRWE = Patient-Rated Wrist Evaluation; DASH = Disabilities of the Arm, Shoulder and Hand; CO = corrective osteotomy; DSTE = distal scaphoid tubercle excision; DSC = dorsal scaphoid cheilectomy; PIN = posterior interosseous nerve neurectomy; RS = radial styloidectomy; SMCF = scaphoidectomy midcarpal fusion; M = male; F = female.

Figure 3. PRWE and QuickDASH scores.

Note. PRWE = Patient-Rated Wrist Evaluation; DASH = Disabilities of the Arm, Shoulder and Hand.

wrist motion.^{4,6,17,18} However, the treatment of scaphoid malunion remains controversial and concern exists about osteotomizing a healed scaphoid bone to correct a malunion in light of its retrograde, tenuous blood supply.

In 1990, Birchard and Pichora⁵ reported on 2 cases of iliac crest opening-wedge osteotomy in patients with symptomatic scaphoid malunion and lack of full wrist extension. Both patients united uneventfully and had full painless wrist

motion at 6 months postsurgery. Nakamura et al¹⁴ reported on 7 patients who underwent corrective osteotomies for malunion with DISI deformity with a mean follow-up of 29.7 (range, 24-42) months. Six patients were pain free, and there was a mean 40° wrist range of motion increase and mean grip strength increase to 89% of the unaffected side. Two patients were treated nonoperatively in this series but lost to follow-up. Lynch and Linscheid¹³ reported similar good results with 5 patients at a mean follow-up of 9 years (range, 1.5-19 years) who had a mean increase in wrist motion by 29°, grip strength by 16 kg, and Mayo Wrist Score by 56 points after a corrective osteotomy. Fernandez et al⁹ described a rotational correction along with the scaphoid osteotomy in 3 patients who were pain free and back to work at a mean follow-up of 4 years (range, 2-6.5 years). More recently, El-Karef⁸ treated 13 patients with a corrective osteotomy with a mean follow-up of 42 months (20 months to 10 years). The mean wrist motion and grip strength both improved from 50% preoperatively to 80% postoperatively compared with the unaffected side. According to the Mayo Wrist Score, 11 patients (85%) were rated excellent or good outcomes and 2 were rated fair. Five patients showed mild degenerative changes in the radiocarpal joint. Despite these small case series reporting good outcomes with a corrective osteotomy and without reports of nonunion or avascular necrosis, concern remains with the lack of long-term outcomes and controlled trials with larger patient cohorts.

In this study, long-term outcomes were similar between the corrective osteotomy, salvage procedures, and the non-operative group when comparing mean QuickDASH and PRWE scores. One concerning finding, however, in patients without surgical treatment was 50% had poor outcomes whereas the other half had excellent outcomes. This shows that some patients remain relatively asymptomatic despite a LISA >45°, and thus factors other than the altered wrist biomechanics may play a role in determining accelerated post-traumatic arthritis of the wrist. These factors may relate to the initial force or mechanism of injury, cartilage damage, concomitant ligamentous injuries, hereditary predisposition to arthritis, as well as the patient's ongoing work demand.

Our retrospective study has inherent limitations related to the difficulty to obtaining clinical and radiographic data with such a long follow-up. A low response rate for the survey data (57%) will have inherent patient reporting bias associated with it making formal statistical analysis less meaningful. Furthermore, the LISA has been shown to have poor interobserver reliability for measuring intrascaphoid angles compared with height to length ratios or dorsal cortical angle.^{2,16} Many imaging studies were used including tomogram scans, which are less accurate compared with modern, computed tomographic scans, which are more adept at obtaining the appropriate cross-sectional plane for measurement. However, by convention for this study, LISA was used for consistency as it had been recorded previously as part of the original study by Amadio et al.¹

The strengths of these data, however, are the long-term follow-up greater than 10 years and the natural history of patients treated nonoperatively with a diagnosed scaphoid malunion.

Scaphoid malunion continues to be a difficult dilemma particularly in the younger patients with minimal to moderate symptoms. Although a corrective osteotomy early in the clinical course of the malunion should optimize wrist biomechanics, correct the malalignment, and potentially increase the longevity of the wrist joint, patients in this series treated nonoperatively or with salvage procedures had similar long-term outcomes as those treated with a corrective scaphoid osteotomy. Treatment of scaphoid malunion remains controversial and determining which factors will most likely predict long-term outcomes needs to be further clarified with future randomized, controlled studies in larger cohorts.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

Informed consent was obtained when necessary.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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