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Original Research

Distal Scaphoid Excision for Chronic and Nonchronic Scaphoid Fracture Nonunion



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Purpose: The indications for distal scaphoid excision are limited to localized wrist arthritis surrounding the scaphoid, as a result of scaphoid nonunion advanced collapse or scapho-trapezio-trapezoid joint arthritis. The procedure historically has led to relief of symptoms and improvement in strength. Our aim was to examine the outcomes of this procedure in patients with scaphoid fracture nonunion.

Methods: This is a single-center retrospective case series of 12 consecutive patients who underwent distal scaphoid excision after scaphoid fracture nonunion. Patients were divided into the following two groups based on nonunion chronicity: chronic (more than a year) and nonchronic (less than a year). Clinical and radiographic data were examined using descriptive statistics.

Results: Our cohort consisted of 12 patients, 10 men (83%) and 2 women (17%), with a mean age of 37.6 ± 13.6 years. Eight patients had a chronic scaphoid fracture nonunion (six had a neglected scaphoid fracture and two had a nonunion after scaphoid open reduction and internal fixation with bone graft), and four patients had a nonchronic fracture nonunion (two had failed cast treatment and two had nonunion after scaphoid open reduction and internal fixation with bone graft). Before surgery, all patients complained of pain and four had numbness (all in the chronic group). After an average of 21 weeks after surgery, seven patients (58%) reported continued pain, two patients reported ulnar side pain, and one underwent arthroscopic synovectomy. All patients who started with a normal radiolunate angle continued to have a normal angle, whereas patients who had dorsal intercalated segmental instability prior to surgery persisted with it after surgery, except for a patient who underwent midcarpal fusion and had their radiolunate angle corrected.

Conclusions: Distal scaphoid excision is an effective procedure for carefully selected patients with periscaphoid wrist arthrosis. Patients with recent scaphoid fractures that failed treatment may also be treated with distal scaphoid resection.

Type of study/level of evidence: Therapeutic V.

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Distal scaphoid excision is generally considered a procedure for the treatment of wrist arthritis caused by a scaphoid nonunion advanced collapse or scapho-trapezio-trapezoid (STT) joint osteoarthritis.^{1,2} Therefore, the indication for this procedure is mainly early-stage wrist arthritis.^{3,4} A common concern regarding the use of distal scaphoid excision is the risk of wrist instability due to changes in wrist joint kinematics that shifts force toward the radiolunate joint rather than the STT joint.⁵ Despite these reported

kinematic changes, symptomatic radiolunate joint arthritis has not been reported as a common complication after distal scaphoid excision.^{6,7} In fact, a long-term study by Malerich et al⁷ reported good clinical outcomes despite the development of midcarpal arthrosis in some patients.

Previous reports have shown improved pain and function after distal scaphoid excision.^{1,8} Recovery after this procedure is markedly shorter than other surgical options, such as proximal row carpectomy or fusion.⁹ The purpose of this cohort study was to assess postoperative pain by reviewing patients who underwent distal scaphoid excision for neglected scaphoid nonunion as well as less chronic indications including failed scaphoid fixation and recent scaphoid fracture.

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Table 1
Demographic, Clinical, and Radiographic Characteristics

Variable	Total (n = 12)	Nonchronic Scaphoid Nonunion (4, 33.3%)	Chronic Scaphoid Nonunion (8, 66.7%)
Age (y)*	37.6 (13.6)	33.1 (16.5)	39.8 (12.6)
Male [†]	10 (83%)	4 (100%)	6 (75%)
Laterality [†]			
Right	6 (50%)	2 (50%)	4 (50%)
Left	6 (50%)	2 (50%)	4 (50%)
Symptom duration [†]			
Less than 1 y	4 (33%)	4 (100%)	0
1–5 y	1 (8.3%)	0	1 (12.5%)
More than 5 y	7 (58.4%)	0	7 (87.5%)
Diagnosis			
Neglected scaphoid nonunion	6 (50%)	0	6 (75%)
Failed scaphoid fixation	4 (33.3%)	2 (50%)	2 (25%)
Failed conservative treatment	2 (16.7%)	2 (50%)	0
Preoperative numbness [†]	4 (33.3%)	0	4 (50%)
Scaphoid fracture line position [†]			
Proximal	6 (50%)	1 (25%)	5 (62.5%)
Waist	4 (33.3%)	1 (25%)	3 (37.5%)
Distal	2 (16.7%)	2 (50%)	0
Lunate type [†]			
1	6 (50%)	3 (75%)	3 (37.5%)
2	6 (50%)	1 (25%)	5 (62.5%)
Arthritic changes [†]			
Radioscaphoid narrowing	6 (50%)	0	6 (75%)
Radial styloid beaking	8 (66.7%)	0	8 (100%)
STT narrowing	7 (58.3%)	0	7 (87.5%)
STT osteophyte	6 (50%)	0	6 (75%)
STT cyst formation	5 (41.7%)	0	5 (62.5%)
Scaphocapitate arthritis	6 (50%)	0	6 (75%)
Radiolunate angle	21.5 (12.8)	21.7 (10.6)	21.4 (14.5)
DISI [†]	8 (66.7%)	3 (75%)	5 (62.5%)
Scapholunate angle*	60.1 (12.8)	58.2 (12.8)	61 (13.6)

* Data presented as mean (standard deviation).

[†] Data presented as frequency (%).

Materials and Methods

We conducted a retrospective chart review of patients who underwent distal scaphoid excision. After obtaining approval from the institutional review board, patients were identified from the medical records based on the Current Procedural Terminology code 25210 (carpectomy, one bone). The query included 304 patients in the period between January 2010 and October 2023. To be included in this analysis, patients needed to have received the specific procedure (distal scaphoid excision) for scaphoid fracture nonunion. Patients also needed to have at least one radiographic evaluation before and after surgery. Exclusion criteria were as follows: patients who received distal scaphoid excision for STT osteoarthritis, patients who received a different carpal bone excision or wrist reconstruction procedure, and/or patients with a wrist condition caused by syndromic, infectious, or malignant pathologies.

A total of 24 consecutive patients were identified as having undergone distal scaphoid excision. Five patients received distal scaphoid excision for STT osteoarthritis, a 20-year-old patient with immune deficiency polyendocrinopathy X-linked syndrome, and six other patients did not have radiographs before or after surgery and were subsequently excluded. Our final cohort consisted of 12 patients. Data recorded for each patient included demographics and clinical data (diagnosis, symptoms, wrist range of motion, and surgical procedure).

The scaphoid fracture line location was determined on radiographs and was classified into distal, waist, and proximal pole fractures. Lunate type was identified based on the presence or absence of distal lunate–hamate articulation.¹⁰ The following radiographic measurements were recorded on pre- and

postoperative radiographs: scaphoid nonunion advanced collapse stage (when indicated), radioscaphoid narrowing, STT narrowing, STT osteophyte, STT cyst formation, radiolunate angle, scapholunate angle, and carpal height ratio. The presence of dorsal intercalated segmental instability (DISI) was defined as a radiolunate angle greater than 15° of extension.⁸ Measurements were performed on a digital picture archiving and communication system using the “ruler” and “angle” tools. Two sets of radiographic measurements were performed by one investigator for validation without doing intrarater reliability, and the average values were used for descriptive analysis. The primary outcome was pain at the last follow-up. The secondary outcomes included the development of secondary arthritic changes and the need to return to operating room.

Patients were grouped based on scaphoid nonunion chronicity: chronic scaphoid nonunion (more than 1 year) group had eight patients and nonchronic scaphoid nonunion (less than 1 year) group had four patients. Data were then stratified and analyzed using descriptive statistics. Continuous variables and categorical variables were portrayed as mean (SD) and number (percentage), respectively. Descriptive statistics were performed using Stata version 17 (StataCorp LP, College Station).

Results

Our cohort included 12 patients, 10 men (83%) and 2 women (17%). The average age at the time of surgery was 36.6 ± 13.6 years, ranging from 18 to 60 years.

All patients were right hand-dominant, and right and left sides were involved in six patients (50%) each (Table 1). Within the chronic scaphoid nonunion group, six patients (75%) had a



Figure 1. A 47-year-old patient with right scaphoid fracture. **A** Anteroposterior (AP), lateral, and scaphoid-specific radiographic view showing a nondisplaced distal pole scaphoid fracture. The patient was managed conservatively with casting for 8 months. **B** AP and lateral views after failed casting treatment. **C** Coronal CT cut shows distal scaphoid fracture nonunion. **D** AP and lateral views after distal scaphoid excision.

neglected scaphoid nonunion (all had symptoms for more than 5 years) and two patients (25%) had a scaphoid nonunion after open reduction and internal fixation (ORIF) with bone graft (one patient was symptomatic for more than 5 years). Patients in the nonchronic scaphoid nonunion group presented within 1 year of the scaphoid fracture (two after failed casting treatment and two nonunion failed surgical fixation). These patients demanded quick post-operative recovery and elected to proceed with distal scaphoid excision (Fig. 1).

Pain was the main symptom in all patients. Four patients complained of numbness, and all were exclusively in the chronic scaphoid nonunion group. Wrist extension was markedly reduced across both groups at $31.7^\circ \pm 11.2^\circ$ and mean wrist flexion was $60.8^\circ \pm 11.1^\circ$.

The location of scaphoid fracture was proximal in six patients, waist in four patients, and distal in two patients. Six patients (50%) had type 1 and six (50%) had type 2 lunate. Most patients in the chronic group and none in the nonchronic group presented with arthritic changes in the wrist as shown in Table 1. Overall, the mean preoperative radiolunate angle was $21.5^\circ \pm 12.8^\circ$. Eight patients had DISI before surgery, and all had a radiolunate angle of less than 45° , except for two patients in the neglected scaphoid nonunion group.

Surgery was performed through a volar approach in 11 (92%) patients and dorsal approach in one patient (8%). The distal non-united segment of scaphoid was completely resected in all patients. Capsular repair was performed in all patients. In addition to distal scaphoid excision, two patients in the chronic group received carpal tunnel release, and none received partial excision of the radial



Figure 2. A 29-year-old patient with a left scaphoid fracture 10 years prior to presentation. **A** AP and lateral views showing neglected scaphoid nonunion with radioscaphoid narrowing, radial styloid beaking, STT, and scaphocapitate joints arthrosis. **B** AP and lateral views after distal scaphoid excision, note lunate extension (DISI). **C** AP and lateral views after four-corner fusion and correction of DISI. **D** AP and lateral views at the last follow-up.

styloid. After the surgery, patients were immobilized in a plaster thumb spica splint.

After an average follow-up of 21 weeks, seven patients (58%) complained of pain. Within the nonchronic group, one patient had pain and numbness and subsequently received surgery for carpal tunnel release. Within the chronic group, six patients had pain at the last follow-up, in two of these patients, pain was on the ulnar side of the wrist. Wrist extension and flexion at the last follow-up were $48^\circ \pm 3^\circ$ and $48^\circ \pm 27^\circ$, respectively. Seven patients (53%) had DISI on the latest radiograph. Patients who had DISI prior to surgery persisted with it after surgery, except for one patient who underwent midcarpal fusion and had their radiolunate angle corrected. In contrast, all patients who started with a normal radiolunate angle continued to have a normal angle. Importantly, none of the patients developed additional osteoarthritis after distal scaphoid excision. Two patients received additional surgery. One patient fell and had ulnar side pain and underwent wrist arthroscopic synovectomy. The other patient continued to have dorsal wrist pain that responded partially to cortisone injections and eventually underwent surgery for midcarpal fusion (four-corner fusion without residual scaphoid excision; Fig. 2).

Discussion

The ideal candidate for distal scaphoid excision per Malerich is a young individual with scaphoid nonunion and arthritic changes between the scaphoid and radial styloid.^{4,6} The indication of this procedure has been expanded to include patients with midcarpal joint arthritis.³ In addition, patients with idiopathic STT arthritis are also considered candidates for distal scaphoid excision in the setting of no midcarpal instability.^{2,9} Our study presents a series of 12 patients with scaphoid fracture nonunion and most importantly introduces the concept of performing distal scaphoid excision in a relatively acute setting within 1 year from the time of scaphoid fracture (four patients). Notably, the scaphoid fracture location was distal in two patients after a failed casting treatment and two with persistent nonunion after scaphoid ORIF. The drive to pursue this treatment plan as reported in our study was patients' demand for a short recovery and return to work. These patients reported no pain after surgery except for one who needed carpal tunnel release after 6 months. The leading benefit of distal scaphoid excision compared with other reconstructive wrist procedures is short recovery time.⁹ In our study, most patients discontinued bracing and were able to gradually return to full activities within 4–6 weeks after surgery. In

contrast, the minimum time required for scaphoid nonunion after ORIF with bone graft is 12 weeks, and longer immobilization is possibly needed if the scaphoid does not show radiographic signs of bone union.¹¹

The ultimate goal of this surgery was to manage pain, and this was achieved in 42% of patients in our study. Some patients reported numbness and tingling in the hand in the postoperative period, which was consistent with carpal tunnel syndrome. These symptoms could be caused by reactive tenosynovitis from early return to wrist motion. Importantly, there are studies that also reported symptoms of occasional pain even after a longer follow-up period.^{1,3} Malerich et al¹ reported improved pain in 68% of their group of patients after an average of 49 months. Soejima et al³ reported occasional pain in 55% after an average of 28.6 months.

The biomechanical consequence of distal scaphoid excision is the alteration in midcarpal stability and transfer of force load toward the scapholunate-capitate and radiolunate joints.^{2,3,8} An important step after distal scaphoid excision is to repair the capsule and remove any redundancy.^{1,2} In our study, capsular repair was performed in all patients. We found that patients who had no DISI before surgery continued to have a normal radiolunate angle at the last follow-up. Similarly, patients who had DISI before surgery continued to have DISI after surgery, and one of these patients eventually required midcarpal fusion. In addition, the lunate bone morphology may influence the surgery results after distal scaphoid excision. The carpal bones' morphology, specifically the lunate and the capitate, has been examined in association with radiographic patterns of wrist arthritis.^{10,12,13} Patients with type 2 lunate have a higher risk of scaphoid nonunion, regardless of the type of treatment.¹⁴ Soejima et al³ also reported less favorable outcomes of distal scaphoid excision in patients with type 2 lunate. In our study, we did not observe an association between lunate type and last follow-up pain or DISI deformity.

Our study is limited by the nature of being retrospective and inability to record all needed clinical and radiographic data points. We were unable to document the functional outcomes specifically, return to work, and ability to perform activities of daily living. A larger sample size and longer follow-ups are needed for a better assessment of wrist arthritic changes and function after surgery. We believe, however, that this case series presents a valuable concept of utilizing distal scaphoid excision in a relatively acute setting after failed treatment of scaphoid fracture. Distal scaphoid excision can be carefully considered specifically for patients with a distal pole fracture without

intercarpal instability. This treatment option can be considered if quick recovery is needed.

Disclaimer

Given his role as Editor-in-Chief of *The Journal of Hand Surgery Global Online*, Dr. Fowler had no involvement in the peer-review of this article and has no access to information regarding its peer-review. Full responsibility for the editorial process for this article was delegated to Aviram M. Giladi, MD, MS.

Conflicts of Interest

No benefits in any form have been received or will be received related directly to this article.

References

- Malerich MM, Clifford J, Eaton B, Eaton R, Littler JW. Distal scaphoid resection arthroplasty for the treatment of degenerative arthritis secondary to scaphoid nonunion. *J Hand Surg Am.* 1999;24(6):1196–1205.
- Garcia-Elias M. Excisional arthroplasty for scaphotrapeziotrapezoidal osteoarthritis. *J Hand Surg Am.* 2011;36(3):516–520.
- Soejima O, Iida H, Hanamura T, Naito M. Resection of the distal pole of the scaphoid for scaphoid nonunion with radioscaphoid and intercarpal arthritis. *J Hand Surg Am.* 2003;28(4):591–596.
- Malerich MM, Littler JW, Eaton R. Distal scaphoid resection arthroplasty for the treatment of patients with degenerative arthritis secondary to scaphoid nonunion. *Tech Hand Extrem Surg.* 2002;6(2):98–102.
- Garcia-Elias M, Lluch A. Partial excision of scaphoid: is it ever indicated? *Hand Clin.* 2001;17(4):687–695, x.
- Ruch DS, Papadonikolakis A. Resection of the scaphoid distal pole for symptomatic scaphoid nonunion after failed previous surgical treatment. *J Hand Surg Am.* 2006;31(4):588–593.
- Malerich MM, Catalano LW, Weidner ZD, Vance MC, Eden CM, Eaton RG. Distal scaphoid resection for degenerative arthritis secondary to scaphoid nonunion: a 20-year experience. *J Hand Surg Am.* 2014;39(9):1669–1676.
- Garcia-Elias M, Lluch A, Saffar P. Distal scaphoid excision in scaphoid-trapezium-trapezoid arthritis. *Tech Hand Extrem Surg.* 1999;3(3):169–173.
- Wu JC, Calandruccio JH. Evaluation and management of scaphoid-trapezium-trapezoid joint arthritis. *Orthop Clin North Am.* 2019;50(4):497–508.
- Viegas SF, Wagner K, Patterson R, Peterson P. Medial (hamate) facet of the lunate. *J Hand Surg.* 1990;15(4):564–571.
- Ammori MB, Elvey M, Mahmoud SS, et al. The outcome of bone graft surgery for nonunion of fractures of the scaphoid. *J Hand Surg Eur Vol.* 2019;44(7):676–684.
- Tesoriero P, Becker J, Passano B, Huang S, Petchprapa C, Wollstein R. Does midcarpal joint structure affect development of arthritis in the wrist. *J Wrist Surg.* 2023;12(1):28–31.
- Yazaki N, Burns ST, Morris RP, Andersen CR, Patterson RM, Viegas SF. Variations of capitate morphology in the wrist. *J Hand Surg.* 2008;33(5):660–666.
- Hein RE, Fletcher AN, Tillis RT, Pang EQ, Ruch DS, Richard MJ. Association of lunate morphology with progression to scaphoid fracture nonunion. *Hand N Y N.* 2022;17(3):452–458.