Resection of the Distal Pole of the Scaphoid for Scaphoid Nonunion With Radioscaphoid and Intercarpal Arthritis

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Purpose: The treatment of scaphoid nonunion with degenerative arthritis poses a clinical problem that is particularly challenging in cases of associated dorsal intercalated segmental instability collapse, radiocarpal and intercarpal degenerative changes, and poor scaphoid bone quality. The purpose of this study was to report our clinical experience performing a distal scaphoid resection for symptomatic scaphoid nonunion in patients with either radioscaphoid or intercarpal arthritis who have had multiple surgeries.

Methods: Nine patients with recalcitrant scaphoid nonunion and associated degenerative arthritis treated by resection of the distal scaphoid fragment were evaluated both clinically and radiographically. Eight patients were male and one patient was female; the average follow-up period was 28.6 months (range, 12–52 mo).

Results: Seven patients reported pain with daily use and the remaining 2 patients reported mild pain with light work before surgery, whereas after surgery 4 of the 9 patients had no wrist pain and the remaining 5 patients had only mild pain with strenuous activity. The wrist range of motion improved from 70° (51.4% of the opposite wrist) to 140° (94% of the opposite wrist) and grip strength improved from 18 kg (40% of the opposite wrist) to 30 kg (77% of the opposite wrist). Clinical results were excellent in 6 patients and good in 3 patients based on a modified Mayo wrist-scoring chart. Radiographically neither additional degeneration nor progress of degenerative changes was noted after surgery in 8 patients. Newly developed degenerative arthritis occurred at the proximal scapholunate capitate articulation in the remaining patient who has a type II lunate, which had a facet (medial facet) articulation with the hamate.

Conclusions: The results of this study showed that distal scaphoid resection produces a satisfactory clinical outcome, requires only a short period of immobilization, and should be considered one of the surgical options for long-standing scaphoid nonunion with either radioscaphoid or intercarpal degenerative arthritis. Nevertheless care must be taken in performing this procedure on patients whose preoperative radiograph show a type II lunate. (J Hand Surg 2003;28A:591–596. Copyright © 2003 by the American Society for Surgery of the Hand.)

Key words: Scaphoid nonunion, distal scaphoid resection, carpal arthritis, carpal instability.

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The treatment of scaphoid nonunion poses a clinical problem that is particularly challenging in cases of associated dorsal intercalated segmental instability collapse (DISI), radiocarpal and intercarpal degenerative changes, and poor scaphoid bone quality. Treatment options include (1) scaphoid excision and intercarpal arthrodesis,[1] (2) proximal-row carpectomy,[2] and (3) wrist arthrodesis.[3] Distal scaphoid resection has been proposed by Malerich et al[4] as a further surgical option for the treatment of long-standing scaphoid nonunion; they reported that wrist range of motion and grip strength improved by 85% and 134%, respectively, after this procedure within a follow-up period of 49 months. Ruch et al[5] also reported satisfactory clinical results achieved by using the arthroscopic technique of distal scaphoid resection. Although both of these studies showed satisfactory results we were particularly interested in the clinical outcome of this procedure especially for patients with pre-existing arthritis. The purpose of this study was to report our clinical experience in performing a distal scaphord resection for symptomatic scaphoid nonunion in patients with either radioscaphoid or intercarpal arthritis who had undergone multiple operations.

Patients and Methods

Since 1997 our facilities have treated 11 patients with symptomatic scaphoid nonunion associated either radioscaphoid or intercarpal degenerative changes and carpal malalignment with resection of the distal pole of the scaphoid. Of these 11 patients 9 (8 men and 1 woman) who were monitored for more than 1 year were included in the present study. One of the excluded 2 patients was within 1 year from surgery and 1 failed to continue the follow-up evaluation. The average age of our subjects was 45.2 years (range, 23–68 y). Seven of the 9 patients had undergone a previous surgery such as osteosynthesis with or without iliac bone grafts (mean, 2.1 times; range, 1–4 times) before distal scaphoid resection. The average period from the initial injury to this surgery was 94.3 months (range, 5–372 mo). All patients had distal pole radioscaphoid arthritis and 6 patients also showed capitolunate arthritis on preoperative radiographs. The average follow-up period was 28.6 months (range, 12–52 mo).

The palmar (Russe) approach was used to resect the distal scaphoid fragment. A needle was inserted into the nonunion site to verify its location under fluoroscopy. The distal fragment was removed *en bloc* or in a piece-by-piece fashion. No specific attempt was made to perform an interpositional arthroplasty other than capsular closure. The radioscaphocapitate ligament was repaired with 5-0 monofilament nylon. A short-arm thumb spica splint was applied for only 1 or 2 weeks. After splint removal the patient was instructed on wrist range of motion and muscle strengthening exercises for a few weeks.

Wrist pain, the ability to return to work, grip strength, and wrist range of motion were assessed both before and after surgery. A modified Mayo clinical scoring chart[6] (Table 1) was used to determine clinical status. For radiographic assessment joint space narrowing, sclerotic change, and cystic change were identified as arthritic changes. These findings were further compared on the preoperative and final follow-up radiographs by other than the operator in the blind fashion. The radiolunate angle and carpal height ratio; used as an index of DISI and carpal collapse, also were measured before and after surgery. As an index of first metacarpal subsidence the ratio of the height of the resection space divided by the length of the first metacarpal (B/A) was applied on the postoperative radiograph at rest, at 0 kg, and 2 kg key pinch (Fig. 1). The data for each parameter are expressed as mean ± SD. All data were subjected to statistical analysis using the paired *t*-test. A p value of less than .05 was considered significant.

Results

The patients' clinical assessments are summarized in Table 2. Seven patients reported pain with daily use and the remaining 2 patients reported mild pain with light work before surgery whereas after surgery 4 of the 9 patients had no wrist pain and the remaining 5 patients had only mild pain with strenuous activity. All patients returned to their preoperative jobs. The wrist range of motion improved in the flexion-extension arch from 70° ± 32° before surgery to 140° ± 21° after surgery (from 51% to 94% on the opposite side) with statistical significance ($p = .0001$). Grip strength improved from 18 ± 11 kg before surgery to 30 ± 10 kg after surgery (from 40% to 77% in the opposite wrist) with statistical significance ($p < .0001$). Furthermore a modified Mayo clinical score improved from 32 ± 16 points before surgery (fair in 2 patients and poor in 7 patients) to 90 ± 7 points after surgery (excellent in 6 patients and good in 3 patients), with statistical significance ($p < .0001$). No patient had complications after the procedure.

The radiographic assessment of all patients is summarized in Table 3. The radiolunate angle increased from −26 ± 12° to −27° ± 12° and the carpal

Table 1. Modified Mayo Clinical Scoring Chart

Pain (25 points)	25	No pain	
	20	Mild occasional	
	15	Moderate, tolerable	
	0	Severe to intolerable	
Functional status (25 points)	25	Returned to regular employment	
	20	Restricted employment	
	10	Change of occupation because of pain	
	0	Unable to work because of pain	
Range of motion (25 points)		Flexion-extension arch	Percentage of normal
	25	≥120°	≥90%
	20	90° to 119°	75% to 89%
	15	60° to 89°	50% to 74%
	10	30° to 59°	25% to 49%
	0	≤29°	0% to 24%
Grip strength (25 points)		Percentage of normal	
	25	≥ 90%	
	20	75% to 89%	
	15	50% to 74%	
	5	25% to 49%	
	0	0% to 24%	
Overall grade (total points)			
	Excellent	90–100	
	Good	75–85	
	Fair	50–70	
	Poor	≤45	

height ratio decreased from 0.51 ± 0.02 to 0.50 ± 0.02; neither ratio showed statistical significance. The ratio of the height of the resection space divided by the length of the first metacarpal after distal scaphoid resection was maintained during the follow-up period, from 0.23 ± 0.05 to 0.22 ± 0.06. Furthermore this space was preserved even with 2 kg key pinch (0.21 ± 0.06) in the final follow-up radiograph. All preoperative radiographs showed degenerative arthritis between the radial styloid and distal scaphoid, and 6 of the 9 patients had additional degenerative changes between the lunate and the

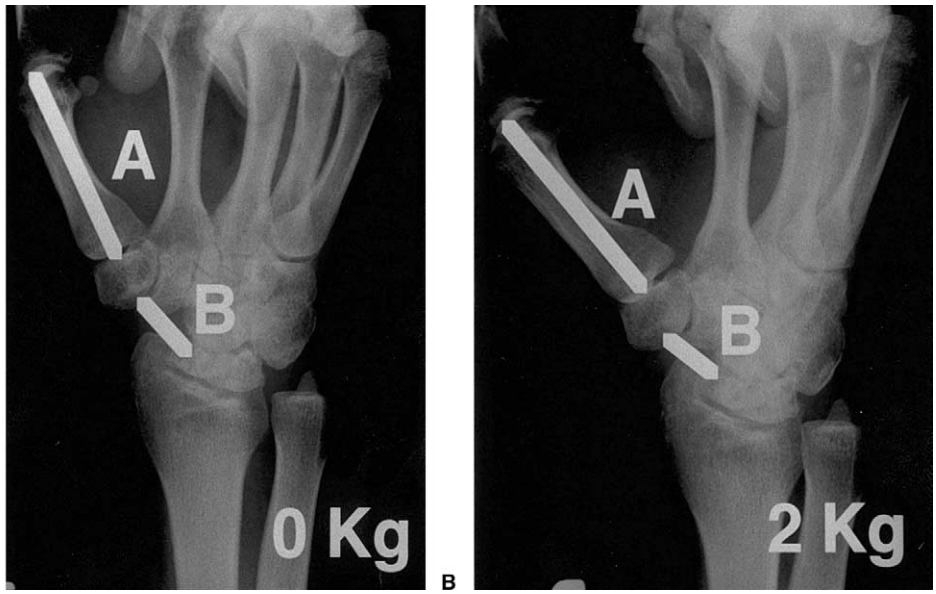

Figure 1. As an index of first metacarpal subsidence, the ratio of the height of the resection space divided by the length of the first metacarpal (B/A) was applied on the postoperative radiograph at rest, at 0 kg, and 2 kg key pinch.

Table 2. Individual Patient Data

Patient No.	Age (y)	Gender	Occupation	Follow-Up Period (mo)	Pain* Before/ After Surgery	Chronicity (mo)	Grip†	ROM‡	Degenerative Joint Disease in Addition to Styloscaphoid		Clinical Score§
									Before Surgery	After Surgery	
1	39	M	Yakitori house manager	52	++/−	55	20/100	105/140	Lunate-capitate	Unchanged	50/100
2	50	M	Taxi driver	49	++/±	35	57/67	80/150	Lunate-capitate	Unchanged	35/90
3	29	M	Bartender	47	++/−	156	58/82	40/155	None	None	40/95
4	55	F	Laundry worker	39	++/−	11	27/79	40/130	Lunate-capitate	Unchanged	10/90
5	51	M	Machine worker	17	++/±	?	16/82	20/95	None	Proximal scaphoid/ lunate-capitate	35/80
6	51	M	Truck driver	12	++/−	12	48/76	75/145	Lunate-capitate	Unchanged	15/95
7	41	M	Painter	15	+/±	372	85/85	110/125	Lunate-capitate	Unchanged	55/90
8	68	M	Unemployed	14	++/±	5	14/71	60/160	None	None	15/80
9	23	M	Wiring worker	12	+/±	108	32/50	100/160	Lunate-capitate	Unchanged	35/80

*Pain: −, painless; ±, mild pain with strenuous activity; +, mild pain with light work; ++, pain with daily use.
†As a percentage of the opposite wrist before/after surgery.
‡Total wrist motion before/after surgery.
§Modified Mayo wrist score before/after surgery.
ROM, range of motion.

capitate (Table 2). Nevertheless no further degenerative changes were noted on the final follow-up radiographs. Newly developed degenerative arthritis occurred at the proximal scapholunate-capitate articulation in one patient (patient 5) who had a type II lunate that has a facet (medial facet) articulation with the hamate (Fig. 2). This patient had only mild pain with strenuous activity at 17 months after surgery. On the other hand only one patient (patient 3) of the remaining 8 patients had a type II lunate, the other 7 patients had a type I lunate, which has no medial (hamate) facet.

Table 3. Radiographic Assessment

	Before Surgery	After Surgery	p Value
RLA (°)	−25.8 ± 12.1	−26.7 ± 12.5	NS
CHR	0.51 ± 0.02	0.50 ± 0.02	NS
B/A*	0.23 ± 0.05	0.22 ± 0.06	NS
	(0 Kg pinch)	0.21 ± 0.06	NS
	(2 Kg pinch)	0.21 ± 0.06	

The data are expressed as mean ± SD.
*B/A is the ratio of the height of the resection space divided by the length of the first metacarpal on the postoperative radiograph.
RLA, radiolunate angle; CHR, carpal height ratio.

Discussion

Conventional bone grafting such as the Matti-Russe inlay graft technique has been described as the most common treatment of established scaphoid nonunion, with successful healing in 70% to 90% of cases.[7–9] Scaphoid nonunion persisting after a failed previous bone graft or other procedure, however, still is clinically challenging. Several methods have been used to treat recalcitrant nonunions (those that do not improve after an initial surgical procedure), including repeat bone grafting,[10] vascularized bone grafting,[11] scaphoid excision and intercarpal arthrodesis,[1] and proximal-row carpectomy.[2] Most recently Merrell et al[12] conducted a systematic review of the literature regarding the treatment of scaphoid nonunion. For avascular necrosis of the proximal fragment they showed a superior union rate in patients treated with a vascularized graft compared with the rate in those who underwent screw and wedge fixation, and thus they suggested that vascularized bone grafting might be preferable for patients with avascular necrosis of the proximal fragment or with a previously failed surgery. Steinmann et al[13] have reported an unsatisfactory outcome in vascularized

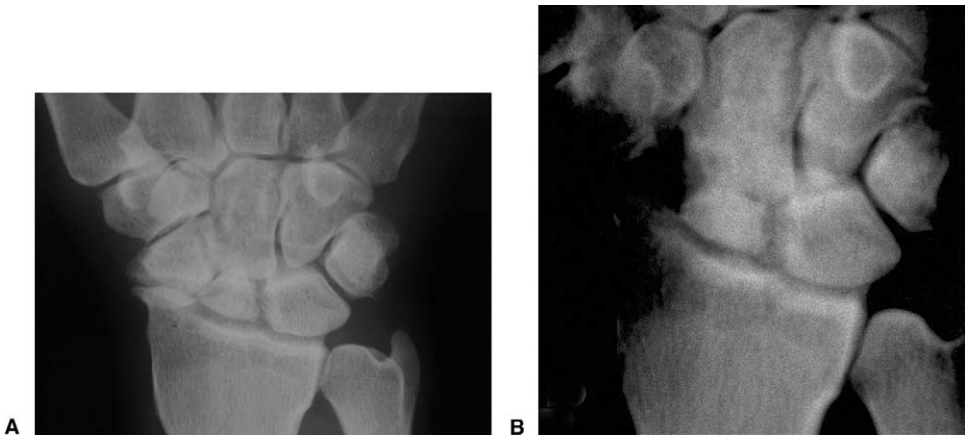

Figure 2. (A) Preoperative and (B) postoperative radiographs of patient 5. (B) Newly developed degenerative arthritis was observed at the proximal scapholunate capitate articulation on the postoperative radiograph. Note that the lunate shows a facet (medial facet) articulation with the hamate.

bone grafting in a patient with evidence of preoperative arthritis owing to its progression. In addition this procedure still is demanding technically, may require long-term postoperative immobilization, and can result in significant loss of wrist function.

Both Malerich et al[4] and Ruch et al[5] also have reported satisfactory clinical results for distal scaphoid resection for symptomatic scaphoid nonunion with radioscaphoid arthritis compared with the results reported for proximal-row carpectomy or intercarpal arthrodesis. They stated that the advantages of this procedure are its simplicity, its improvement of wrist function with no early degenerative changes, and the fact that it requires minimal immobilization. Although Malerich et al[4] do not recommend distal scaphoid resection for patients with capitolunate arthritis owing to the progression of degenerative arthritis, in the present study we also showed excellent results for all patients, including those with capitolunate arthritis (patients 1, 2, 4, 6, 7, 9). Furthermore the final follow-up radiographs showed no progress of degenerative changes.

Newly developed degenerative arthritis at the proximal scapholunate-capitate articulation was observed in one patient (patient 5) who had a medial (hamate) facet on the lunate. Viegas et al[14] have identified 2 types of lunate radiographically: type I, in which there is no medial (hamate) facet on the lunate, and type II, in which there is such a medial facet. In a recent study by Nakamura et al[15] radiographs and magnetic resonance imaging showed that the kinematics of type I and type II lunates differed during radial-ulnar deviation of the lunate. They reported that the total range of radial-ulnar translation of type II lunates is greater than that of type I lunates during radial-ulnar deviation, and that the curvature of the proximal head of the capitate in type II lunates had a smaller radius than in type I lunates. A type II lunate therefore might be subjected to more chronic cumulative trauma owing to its greater range of motion. These data suggest the possibility that distal scaphoid resection may increase share loads at the proximal scapholunate-capitate articulation, which may result in degenerative arthritis.

Distal scaphoid resection is particularly rewarding in patients with long-standing nonunion because it allows early return of function with high satisfaction and no early degenerative changes. Furthermore, if this procedure is not successful, subsequent surgical options such as proximal-row carpectomy and intercarpal arthrodesis still are available. This technique using a distal scaphoid resection showed a satisfactory clinical outcome and it required only a short period of immobilization. Thus it can be considered as an initial surgical option for long-standing scaphoid nonunion associated with either distal pole radioscaphoid or capitolunate arthritis. Care must be taken, however, when performing this procedure in patients whose preoperative radiographs show a type II lunate. Although this series was small and the follow-up data were limited, the early results are promising.

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