Ununited proximal pole scaphoid fractures

Treatment with a Herbert screw in 16 cases followed for 0.5–8 years

Goro Inoue[1], Kaori Shionoya[1] and Yoshio Kuwahata[2]

We treated 16 cases of delayed union and nonunion of proximal one-third scaphoid fractures with cancellous bone grafting and retrograde insertion of a Herbert screw through a dorsal approach. Definite radiographic union was obtained in 13 of 16 patients after a median of 2 (0.5–8) years of follow-up. Using Cooney's clinical scoring system, 5 cases were excellent, 5 good, 5 fair and 1 poor. The treatment of ununited proximal pole scaphoid fractures with retrograde insertion of the Herbert screw offers the advantages of a short period of immobilization and a good function.

[1]Department of Orthopaedic Surgery, Division of Hand Surgery, Nagoya University School of Medicine, 65 Tsurumaicho, Showa-ku, Nagoya 466, Japan. Tel + 81 52-741 2111. Fax -744 2260; [2]Kuwahata Orthopaedic Clinic, Hamaoka, Shijuoka 437-16, Japan
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The treatment of delayed unions and nonunions of the proximal third of the scaphoid remains controversial. Some authors recommended bone grafting with or without internal fixation (Cooney et al. 1980, Green 1985, Steichen and Schreiber 1986, Stark et al. 1988), pulsed electromagnetic fields and casting (Frykman et al. 1986), vascularized bone grafting (Zaidemberg et al. 1991), excision of the proximal fragment with replacement by a prosthesis (Zemel et al. 1984) or allograft (Carter et al. 1989), and salvage procedures, such as resection arthroplasty (Neviaser 1983) or partial or total arthrodesis of the wrist (Gordon and King 1961, Haddad and Riordan 1967). In 1984, Herbert introduced a new headless compression screw to achieve stable fixation of the fracture and advocated its use for proximal pole nonunions of the scaphoid, with insertion in a proximal-to-distal direction through a dorsal approach (Herbert and Fisher 1984).

We report the use of this technique in 16 ununited fractures of the proximal third of the scaphoid.

Patients and methods

Since 1984, we have treated 16 delayed unions and nonunions of the proximal third of the scaphoid, using a bone graft and a Herbert screw internal fixation inserted proximally to distally through a dorsal approach (Table). There were 14 men aged between 17 and 43 years. The right hand was involved in 6 patients and the left hand in 10, the dominant hand was involved in 9 patients. The average time from initial injury to surgery was 2 (0.3–8) years. All patients complained of wrist pain. The proximal fragment was less than one-third the size of the scaphoid in all patients and less than one-quarter in 8 patients. Preoperative radiographs showed a sclerotic fracture margin, with or without cystic changes in the proximal pole. An increased bone density of the proximal fragment was observed in 8 cases. In 4 wrists, a dorsal intercalated segment instability (DISI) deformity was demonstrated. MRI was performed in 8 recent cases: 6 of them had decreased signal intensity in the proximal fragment on both T1- and T2-weighted images.

The operation

A 5-cm transverse incision was centered over Lister's tubercle. The extensor retinaculum was split, exposing the third and fourth compartments. After the wrist capsule had been transversely incised and the wrist was palmarflexed, both parts of the scaphoid were seen. Both fragments were cleared of fibrous tissue and sclerotic bone with a small curette. After realignment and reduction of the fracture, cancellous bone chips from the distal radius or the iliac crest were packed into the defect. With the wrist maximally flexed, a 1.2-mm Kirschner (K)-wire was inserted at the apex of the proximal pole near the junction of the scapholunate ligament along the long axis of the scaphoid. After confirming the correct position of the K-wire and measuring the length of screw needed by visualization on an image intensifier, we removed the K-wire. After preparation of the drill hole, a Herbert screw was inserted, using a free-hand technique. It was tightened until the head became deeply buried beneath the proximal articular surface. This provides

Data on 16 patients with nonunited proximal pole fractures of the scaphoid, treated by retrograde Herbert screw insertion

Preoperative data								Postoperative data							
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	33	–	100	80	1/4	No	–	8	11	No	++	110	90	70	F
2	26	24	83	78	<1/3	No	–	6	24	Yes	+	78	91	70	F
3	28	72	115	87	<1/3	Yes	–	6	6	Yes	–	99	78	75	F
4	22	5	120	79	<1/3	No	–	4	32	Yes	–	110	100	90	E
5	25	96	110	100	<1/3	No	–	4	12	Yes	+	110	100	85	G
6	20	12	100	80	<1/4	Yes	–	8	18	Yes	–	100	90	80	G
7	24	24	125	100	<1/4	Yes	–	6	98	Yes	–	140	94	90	E
8	17	3	125	100	<1/3	Yes	–	4	24	Yes	–	140	100	100	E
9	22	3	65	49	1/4	Yes	L/I	10	12	Yes	–	95	70	75	F
10	29	3	110	78	<1/3	No	SL/I	6	10	Yes	–	110	90	80	G
11	22	5	70	71	<1/4	No	L/L	6	18	No	++	100	82	70	F
12	26	60	100	83	1/4	Yes	SL/SL	9	37	No	++	102	61	60	P
13	43	36	135	73	<1/3	Yes	SL/SL	5	18	Yes	–	125	93	80	G
14	17	16	135	86	1/4	No	L/L	8	24	Yes	–	140	100	90	E
15	23	13	97	78	<1/4	Yes	L/SL	8	19	Yes	+	105	100	85	G
16	19	3	138	100	1/4	No	SL/SL	6	18	Yes	–	145	100	90	E

A Patient number
B Age, yr
C Time from injury to surgery, mo
D Flex/ext arc of motion, degree
E Grip strength (% of uninjured side)
F Size of proximal fragment
G Avascular changes
H MRI scans (T1- /T2-weighted)
I iso intensity
SL slightly low intensity
L low intensity
I Immobilization in cast, wk
J Follow-up, mo
K Bony union
L Pain
– none
+ mild
++ moderate
M Flex/ext arc of motion, degree
N Grip strength (% of uninjured side)
O Cooney's clinical score
P Clinical results
E excellent
G good
F fair
P poor

stable fixation of the fracture through the self-compression effect of the screw. The position of the screw was confirmed using an image intensifier before closure. The wrist was immobilized for an average of 7 (4–10) weeks in a short arm cast. On removal of the cast, patients were allowed to use the wrist and hand for light activities, regardless of radiographic union of the fracture. Full-weight exercises were allowed after radiographically confirmed bony union. The period of immobilization was based on the surgeon's assessment of the rigidity of fixation and the size of the proximal fragment. Patients with smaller proximal fragments required longer periods of immobilization.

Follow-up

The follow-up examination was performed after 24 (6–98) months. Wrist mobility was measured with a goniometer and compared with the uninvolved side on a percentage basis. Grip strength was measured with a standard dynamometer as percentage of the uninvolved side. Overall clinical evaluations employed the scoring system described by Cooney et al. (1987), which includes categories of pain, ability to function at work, range of motion and grip strength as percentage of that on the uninvolved side. In this system, a full score is 100 points. In our study, a score of 90–100 was considered excellent, 80–89 was good, 65–79 fair, and less than 65 poor.

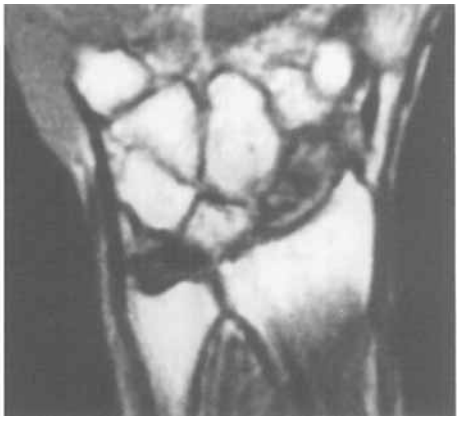
Results

Definite union was obtained in 13 of 16 patients. The average wrist flexion-extension range of motion was 83% of that in the uninvolved wrist. The average grip strength was 90% of the uninvolved wrist. In the 13 patients with successful bone union, grip strength was 92% of that in the uninvolved wrist. 10 patients had no pain, 3 had mild pain with strenuous use of the wrist, and the 3 patients who failed to achieve union complained of moderate pain. All, except 1 patient, who returned to light work, were able to resume their previous occupation. The overall function was excellent in 5 patients, good in 5, fair in 5, and poor in 1.

There were 3 instances of misplaced screws: 2 of these patients failed to achieve bony union, with fair and poor results, respectively. The third patient achieved bony union but developed scapho-capitate arthritis due to prominence of the screw, with a fair functional result. A persistent DISI deformity was observed in 2 of the 3 patients with poor results. Of the 6 cases who had a decreased signal intensity of the proximal fragment on T1- and T2-weighted images, 2 cases failed to unite. Distinct avascular changes were seen in 2 patients with persistent nonunions (Table).

Case 15. Nonunion of the proximal pole of the scaphoid 1 year after injury in a 23-year-old patient.

Increased radiodensity of the proximal fragment and proximal two-thirds of the distal fragment.



T1-weighted image shows low signal intensity in the proximal fragment and proximal half of the distal fragment.

T2-weighted image shows slightly low signal intensity in the proximal fragment.

19 months after surgery, solid union.

Discussion

Treatment of delayed unions and nonunions of the proximal third of the scaphoid depends on the size and vascularity of the fragment. Although the screw is more easily placed in a distal-to-proximal direction, we feel that the proximal pole fracture should be treated with the retrograde insertion technique. Mild or moderate ischemic changes (increased bone radiodensity) of the proximal fragment, which were present in half of our cases, can be treated with this procedure, but severe ischemic changes with sclerosis, fragmentation or deformation of the proximal fragment is a contraindication.

Although a recent report has shown that MRI of the scaphoid allows a more accurate determination of the state of the bone vascularity (Trumble 1990, Perlik and Guilford 1991, Sakuma et al. 1995), the clinical significance of this examination in predicting the outcome of the operation is questionable. Healing was achieved in 4 of our 6 cases in which MRI demonstrated decreased signal intensity of the proximal fragment on T1- and T2-weighted images (Figure). These results refute the view that decreased signal intensity on both images is associated with an increased incidence of delayed union or persistent nonunion (Sakuma et al. 1995). Several authors (Fernandez and Eggli 1995, Robbins et al. 1995) have agreed with Green's opinion (1985) that visualization of punctate bleeding during surgery is the most accurate method of determining vascularity of the proximal pole. We have not analyzed this finding with respect to the outcome in our series.

Misplacement of the screw may lead to union failure. In our cases, we used a 1.2-mm K-wire to drill a pilot hole before using the 1.9-mm drill. Because of the flexibility of the K-wire, the wrist can be placed in a neutral position during drilling, allowing good visualization of the K-wire position on the image intensifier. The K-wire can be easily repositioned when necessary.

Various authors have reported the results of Russe bone grafting for treatment of proximal pole nonunion of the scaphoid, with a success rate of 64%–97% (Cooney et al. 1980, Steichen and Schreiber 1986, Stark et al. 1988). Steichen and Schreiber (1986) and Stark et al. (1988) have reported on Russe bone grafting with K-wire fixation for such nonunions, with a high rate of success. However, this procedure requires immobilization of the wrist in plaster for up to 6 months after surgery, which frequently leads to stiffness of the wrist. We used a cast for an average of 7 weeks and achieved healing in 13/16 patients. The average range of motion of the wrist did not significantly improve after surgery, but the average grip strength increased 11% in patients with successful unions.

References

Carter P R, Malinin T T, Abbey P A, Sommerkamp T G. The scaphoid allograft: a new operation for treatment of the very proximal scaphoid nonunion or for the necrotic, fragmented scaphoid proximal pole. J Hand Surg 1989; 14A: 1-12.

Cooney W P, Dobyns J H, Linscheid R L. Nonunion of the scaphoid: Analysis of the results from bone grafting. J Hand Surg 1980; 5: 343-54.

Cooney W P, Bassey R, Dobyns J H, Linscheid R L. Difficult wrist fractures: perilunate fracture-dislocation of the wrist. Clin Orthop 1987; 214: 136-47.

Fernandez D L, Eggli S. Non-union of the scaphoid: Revascularization of the proximal pole with implantation of a vascular bundle and bone-grafting. J Bone Joint Surg (Am) 1995; 77: 883-93.

Frykman G K, Taleisnik J, Peters G, Kaufman R, Helal B, Wood V E, Unsell R S. Treatment of nonunited scaphoid fractures by pulsed electromagnetic field and cast. J Hand Surg 1986; 11A: 344-9.

Gordon L H, King D. Partial wrist arthrodesis for old ununited fractures of the carpal navicular. Am J Surg 1961; 102: 460-4.

Green D P. The effect of avascular necrosis on Russe bone grafting for scaphoid nonunion. J Hand Surg 1985; 10A: 597-605.

Haddad R Jr, Riordan D. Arthrodesis of the wrist. J Bone Joint Surg (Am) 1967; 49: 950-4

Herbert T J, Fisher W E. Management of the fractured scaphoid using a new bone screw. J Bone Joint Surg (Br) 1984; 66: 114-23.

Neviaser R. Proximal row carpectomy for posttraumatic disorders of the carpus. J Hand Surg 1983; 8: 301-5.

Perlik P C, Guilford W B. Magnetic resonance imaging to assess vascularity of scaphoid nonunions. J Hand Surg 1991; 16A: 479-84.

Robbins R R, Ridge O, Carter P R. Iliac crest bone grafting and Herbert screw fixation of nonunions of the scaphoid with avascular proximal poles. J Hand Surg 1995; 20A: 818-31.

Sakuma M, Nakamura R, Imaeda T. Analysis of proximal fragment sclerosis and surgical outcome of scaphoid nonunion by magnetic resonance imaging. J Hand Surg 1995; 20B: 201-5.

Stark H H, Rickard T A, Zemel N P, Ashworth C R. Treatment of ununited fractures of the scaphoid by iliac bone grafts and Kirschner-wire fixation. J Bone Joint Surg (Am) 1988; 70: 982-91.

Steichen J B, Schreiber D R. Radial bone graft with prolonged immobilization for scaphoid nonunions. Contemp Orthop 1986; 12: 19-24.

Trumble T E. Avascular necrosis after scaphoid fracture: a correlation of magnetic resonance imaging and histology. J Hand Surg 1990; 15A: 557-64.

Zaidemberg C, Siebert J W, Angrigiani C. A new vascularized bone graft for scaphoid nonunion. J Hand Surg 1991; 16A: 474-8.

Zemel N P, Stark H H, Ashworth C R, Rickard T A, Anderson D R. Treatment of selected patients with an ununited fracture of the proximal part of the scaphoid by excision of the fragment and insertion of a carved silicone-rubber spacer. J Bone Joint Surg (Am) 1984; 66: 510-7.