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Treatment of nonunion of the scaphoid by a limited combined approach

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Seven patients with nonunion of the scaphoid were treated by a limited approach combining a palmar wedge graft with insertion of a dorsal (retrograde) Herbert screw through small incisions. All patients had palmar bone deficiency and a 'difficult' proximal fragment. They were followed up for a minimum of 12 months (12 to 38). Radiological union was achieved in all. In five patients correction of instability of the dorsal intercalary segment which was present before operation, was achieved. On a wrist-scoring chart, all patients had an excellent or good rating. The limited combined approach allows correction of the deformity with rigid fixation and has the advantage of preserving most of the palmar ligaments.

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A Herbert screw[1] is considered to be the best device for fixing fractures of the scaphoid.[2] At present, there is agreement about the management of a non-avascular nonunion of the scaphoid.[3,4] Treatment of an unstable[5] nonunion of the middle third is by a palmar opening-wedge graft to correct the palmar deficiency of the scaphoid and fixation by an antegrade Herbert screw. The operation can be done through a palmar (Russe type) incision. This approach is unsuitable for nonunion of the proximal pole since purchase of the screw in the proximal fragment cannot be assured. The recommended treatment is cancellous bone grafting and fixation by a retrograde Herbert screw.[1,3,4,6-8]

This report deals with a puzzling group of ununited fractures of the scaphoid which have palmar bone deficiency and a proximal fragment which is 'difficult' to engage by a screw inserted via the palmar route. As shown in Figures 1 and 2, this group includes, but is not limited to, nonunion of the middle third in which scooping-out of the proximal fragment is required at surgery (scooped-out scaphoid), and unstable nonunion of the junction of the proximal and middle thirds (junctional nonunion). Optimal treatment cannot be achieved by standard methods (Fig. 3) because if the palmar approach is used there is a high risk of poor fixation of the proximal fragment or the screw thread may cross the fracture line. A considerable amount of dissection of the palmar radiocarpal ligaments is required which may cause iatrogenic carpal instability.[9] However, if the dorsal route only is used the deficiency of the palmar aspect of the schaphoid remains uncorrected.[10]

In order to correct the deficiency of the palmar scaphoid and, at the same time, achieve rigid fixation a limited combined approach has been used. First, by a palmar route with preservation of the long radiolunate and most of the radioscaphocapitate ligaments, an interpositional bone graft from the iliac crest was inserted to correct the shortening of the palmar scaphoid. The construct was then secured by a retrograde Herbert screw inserted through a limited dorsal approach (Fig. 3). Experience of the technique is now reported in seven patients.

Patients and Methods

Between July 1996 and August 1998, seven patients were treated using the limited combined approach. All had a 'difficult' nonunion of the scaphoid with a 'scooped-out' scaphoid in four patients, junctional nonunion in two, and a previously failed antegrade Herbert screw in one. Table I gives the details of the patients. Four patients were students (cases 1 to 3 and 7), one a mechanic (case 4), one a carpenter (case 5) and one a painter (case 6). The dominant hand was affected in all the patients. Vascularity was poor in five patients (cases 1 to 4 and 6) and fair in two (cases 5 and 7).[7]

Operative technique. This is similar to the standard palmar and dorsal approaches, but the incisions and dissection are smaller (Fig. 4). Through an incision 2.5 to 3 cm long the capsule of the wrist is divided on the radial side of the tendon of flexor carpi radialis. The scaphotrapezium joint is identified with a needle and care taken not to violate it. Maximal ulnar deviation and dorsiflexion are required through this part of the procedure to bring the nonunion

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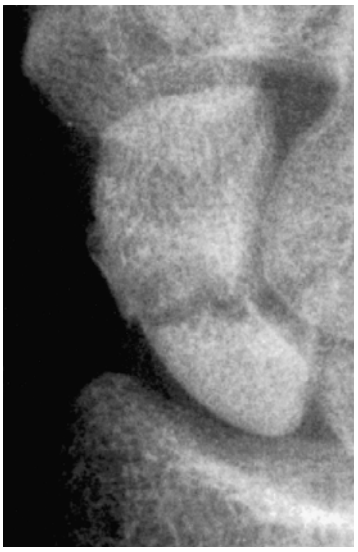

Fig. 1a

Fig. 1b

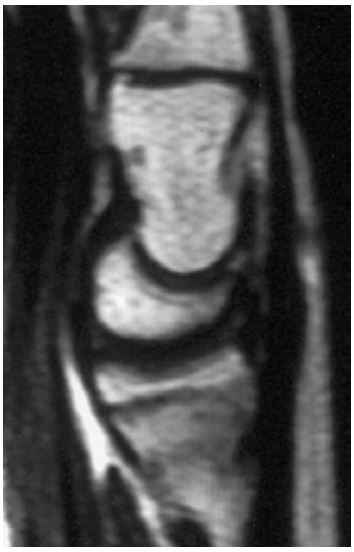

Fig. 1c

Case 1. The scooped-out scaphoid as shown by a) a plain radiograph, b) sagittal CT (scaphoid level) and c) sagittal MRI (lunate level).

Fig. 2a

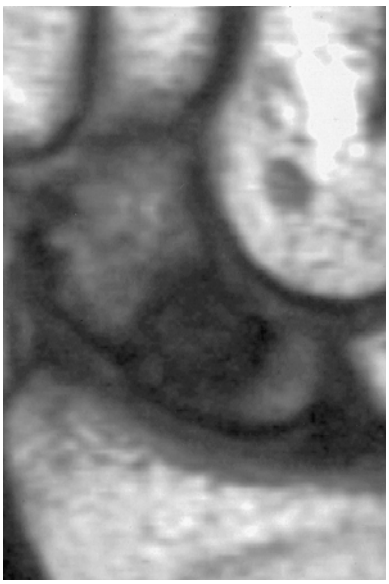

Fig. 2b

Fig. 2c

Case 3. Junctional nonunion as shown by a) a plain radiograph and b) coronal and c) sagittal MRI.

into view. Longitudinal traction on the thumb by an assistant provides additional exposure. The ligamentous tissue is probed with the tips of scissors to locate the nonunion or alternatively a small opening is made at its probable location. Only the ligamentous tissue which obstructs the view is sectioned, usually a small part of the radioscaphocapitate ligament. The nonunion is debrided without using power tools but, if the bone within the proximal fragment is considered to be sclerotic once the debridement is completed, multiple 1 mm holes are made with a power driven Kirschner wire (K-wire). This produces an even transverse distal portion and a hollowed-out proximal fragment. Iliac cancellous chips are packed into the cavity in the proximal fragment. The flexion deformity is corrected, and the largest wedge-shaped bone graft from the iliac crest that will fit is inserted. Appropriate restoration of the length of the scaphoid is checked by fluoroscopy.

To reach the proximal pole of the scaphoid a transverse incision 1.5 to 2 cm in length is centred over, but slightly distal to, Lister's tubercle. Only the most distal part of the extensor retinaculum, in line with Lister's tubercle, requires division. The tendons are retracted and, through a transverse capsular incision, the proximal pole of the scaphoid and the scapholunate ligament are identified. Throughout

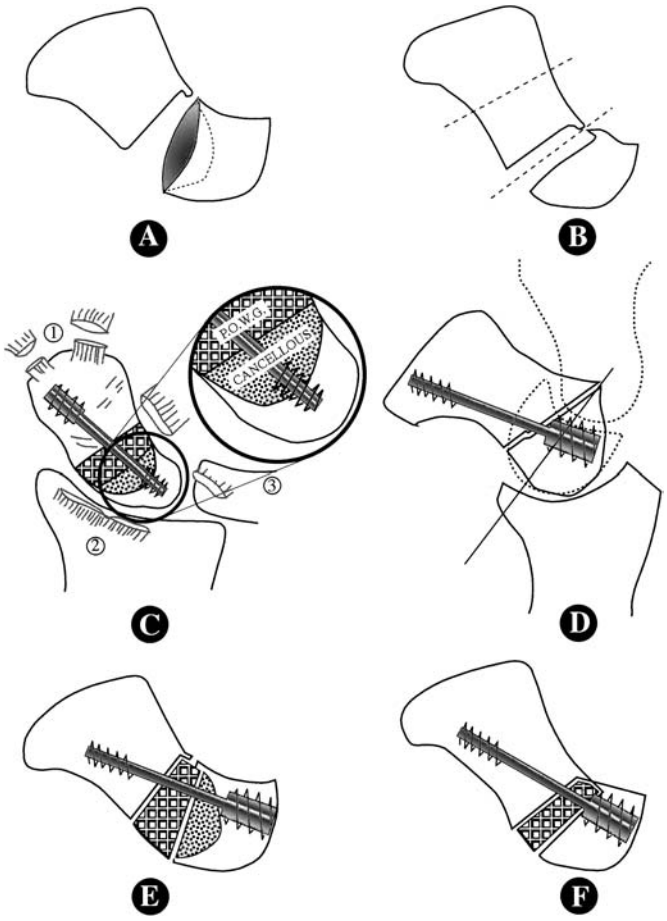

Fig. 3

Diagram showing the deformities and the theoretical results depending on the route selected for treatment. Figure 3A – Scooped-out scaphoid. Figure 3B – Junctional nonunion. Figure 3C – The palmar approach for A or B requires violation of the scaphotrapezium joint (1) and sectioning of the radioscaphocapitate and long radiolunate ligaments (2). Difficulties of purchase are highlighted (3) (POWG, palmar opening wedge graft). Figure 3D – Treatment of A or B by the dorsal route leaves a DISI deformity. Figures 3E and 3F – Correction of the deformity and rigid fixation by the limited combined approach.

this part of the procedure the wrist is flexed to bring the proximal row into view and minimise the dissection. A 1.2 mm K-wire is inserted at the apex of the proximal pole of the scaphoid, near the insertion of the scapholunate ligament, along the long axis of the bone. Fluoroscopy is used at this stage to confirm the location of the K-wire. A second K-wire is then introduced parallel to the first and its position confirmed by fluoroscopy. The first K-wire is removed and its track used to insert a Herbert screw in a standard retrograde manner. It is important when inserting the first K-wire to pass through the insertion of the scapholunate ligament into the scaphoid, as this position ensures that the proximal threads of the screw will engage the small proximal fragment. Image intensification is again used to recheck the position of the screw before final tightening until the trailing head becomes buried beneath the articular surface of the proximal pole. The second K-wire, which holds the construct while the first is retrieved and controls rotation while the screw is tightened, is then removed. The tourniquet is deflated and the skin closed with a subcuticular suture. No attempt is made to close the capsule or any other deep structure.

After surgery the arm is maintained for six weeks in an above-elbow thumb spica cast and then for another six weeks in a short scaphoid cast. Patients are then allowed to use their wrist and hands for light activities, wearing a removable palmar splint until they feel confident without it.

Results

The patients were followed up for a mean of 23 months (12 to 38) after operation. They returned to work or resumed unrestricted sporting activities at a mean of 4.5 months (3.5 to 6). Definite bony union,[11] assessed at a minimum of one year,[4] occurred in all. The radiological study also showed an improvement in carpal angles; the mean improvement in the scapholunate angle was 19.7° (15 to 22), and in the radiolunate angle 19.1° (15 to 26). In five patients (cases 1, 3, 5 to 7) there was correction of instability of the dorsal intercalary segment (DISI) (Fig. 5). No further statistical calculations were made due to the limited sample size, unavoidable bias, and potential inaccuracy.[12,13]

At the latest follow-up, the mean range of movement (ROM) was 91.8% of the normal side (80.8 to 100.9). At that time grip strength was 102.3% of the normal side (100 to 105). The function of the wrist was also assessed and graded according to the modification of the Mayo wrist-scoring chart of Jiranek et al[14] (Table I).

Complications occurred during the procedure in two

Fig. 4c

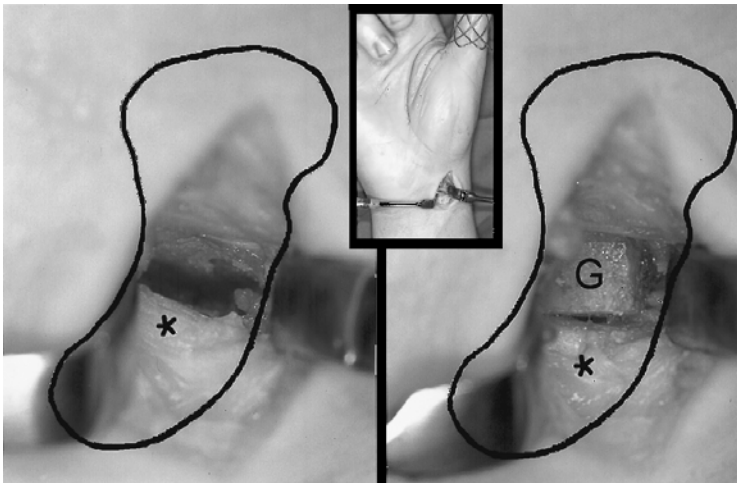

Fig. 4e

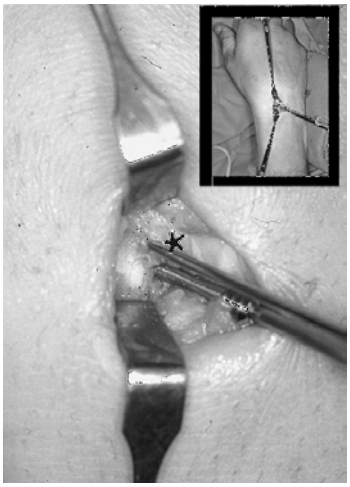

Fig. 4a Fig. 4b Fig. 4d

Figures 4a and 4b – Photographs showing an intraoperative palmar view a) before and b) after insertion of the bone graft (G). Most of the radioscaphocapitate ligament (*) is preserved. The outlines of the scaphoid have been defined. Inset: (c) the corresponding panoramic view. Figure 4d – The intraoperative dorsal view while the Herbert screw is being tightened, and with the second K-wire still in place. The entrance points of these are within the scapholunate interosseous membrane (*) Inset: (e) the corresponding panoramic view.

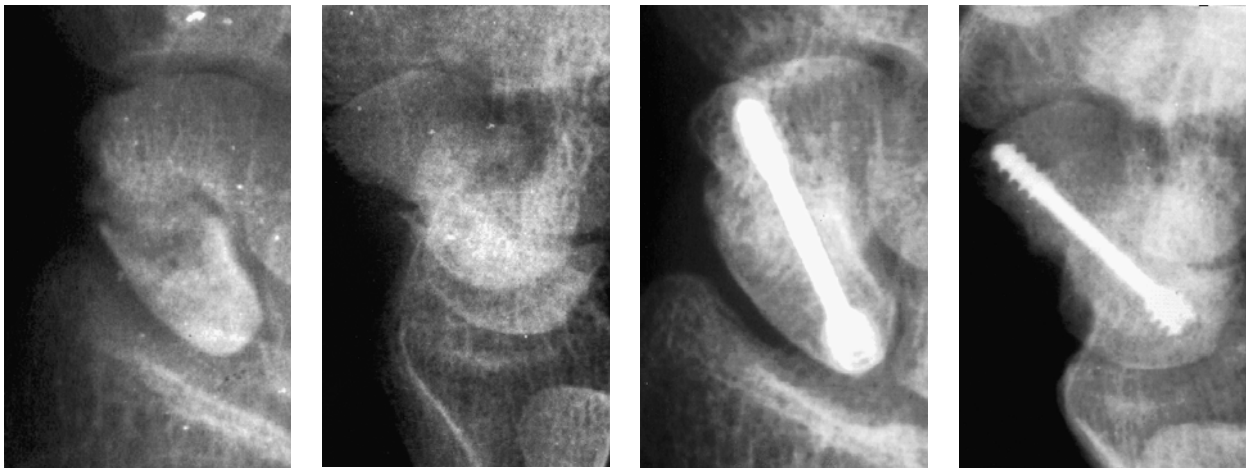

Fig. 5a Fig. 5b Fig. 5c Fig. 5d

Case 5. Scooped-out scaphoid with DISI deformity. Figures 5a and 5b – Preoperative radiographs showing cystic changes and DISI deformity. In spite of the bizarre density of the proximal pole its blood supply was considered acceptable on preoperative MRI, and intraoperatively it was graded as 'fair'. Figures 5c and 5d – Radiographs taken at one year showing bony union and correction of the DISI.

Table I. Details of the seven patients with nonunion of the scaphoid

Case	Age (yr)	Gender	Type of nonunion*	Scapholunate angle (degrees)		Radiolunate angle (degrees)		Postop (affected/normal)		Length of follow-up (mth)	Mayo modified scale‡	
				Preop	Postop	Preop	Postop	ROM (degrees)†	Grip (kg)		Objective	Subjective
1	16	M	S	62	40	22	0	218/222	42/42	38	100	100
2	17	M	S	60	45	5	+10	230/228	44/42	34	100	100
3	18	M	J	72	58	30	8	177/204	40/38	36	95	100
4	20	M	J	70	50	15	0	190/208	53/52	16	95	88
5	17	M	S	75	55	26	10	202/221	45/45	12	95	96
6	25	M	F	75	50	30	12	176/220	47/47	14	95	92
7	21	F	S	85	67	43	17	216/230	24/23	12	95	100

* S, scooped-out scaphoid; J, junctional nonunion; F, failed antegrade Herbert screw (see text)
† dorsiflexion + palmar flexion + ulnar + radial deviation
‡ Mayo wrist scoring chart modified according to Jiranek et al[14]

patients. In one (case 3), at the last examination by the image intensifier, it was found that the leading part of the screw was within the scaphocapitate joint. This was recognised and the screw repositioned. In another patient the graft was clearly too large, but on follow-up radiographs most of the redundant graft had resorbed with no adverse effects.

Discussion

This study considers the treatment of patients with nonunion of the middle and proximal thirds of the scaphoid with palmar deficiency and a 'difficult' proximal pole. The most common reason for failure after fixation with a Herbert screw is inappropriate placement of the device.[8,15-17] The combined approach allows optimal purchase of the proximal fragment because the screw can be placed in a more palmar or dorsal position, taking into account the location of the bone stock as seen by the palmar route. When the Herbert screw is inserted retrogradely, the shorter head (trailing) is located in the shorter (proximal) fragment.

The limited combined approach also has the advantage of requiring minimal dissection of the palmar ligaments of the wrist, since only a small portion of the radioscaphocapitate ligament needs to be resected for debridement of the pseudarthrosis and placement of the graft. The scaphotrapezial joint is not violated. The minimal dissection through the palmar incision, although advantageous for carpal kinematics,[9] requires reliance on the surgeon's spatial orientation and on image intensification.[18] The complications which arose with intraoperative misplacement of the screw and an oversized graft, stress that the procedure is demanding, and that image intensification can be misleading.

There is controversy about the appropriate regime of immobilisation[19,20] as it may be unnecessary, or even detrimental, for healing of the fracture. Apart from a longer time away from work, the results compared favourably with those of other authors who recommend early movement,[3,21,22] and it is presumed that the minimal surgical scarring played a major role.

The rate of union in this preliminary study should be interpreted cautiously. Our aim is to indicate a procedure which achieved correction of the deformity and rigid fixation in this difficult subgroup. It should be considered as a therapeutic alternative in non-avascular nonunion of the scaphoid with a 'difficult' proximal fragment and a palmar deficiency. The technique allows correction of the deformity and rigid fixation and no adverse effects have been found to date.

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