CORTICOCANCELLOUS GRAFTING AND AN AO/ASIF LAG SCREW FOR NONUNION OF THE SCAPHOID

A RETROSPECTIVE ANALYSIS

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We report our experience in 42 patients, using corticocancellous bone grafts and lag screw fixation for un-united scaphoid fractures. Using a grading system, we analysed the suitability of the method for three types of nonunion.

We recommend the operation for the treatment of scaphoid nonunion, except where there is avascular necrosis of the proximal pole.

Several methods have been advocated for the surgical treatment of symptomatic nonunion of the scaphoid. The operations aim either to achieve bony union or to obtain a good functional wrist, without pain, in the absence of union. The former methods employ bone grafting, internal fixation or a combination of both (Adams and Leonard 1928; Murray 1934, 1946; Matti 1936; Geissendörfer 1943; Giesecking 1951; Russe 1960a,b; Koob 1967; McLaughlin and Parkes 1969; Koob, Goymann and Haas 1970; Segmüller 1973; Herbert and Fisher 1984; Bilić and Korzinek 1987). The latter operations include fragment excision (Meekison 1945; Sashin 1946; Wagner 1952), radial styloidectomy (Barnard and Stubbins 1948), soft-tissue arthroplasty (Bentzon and Randlov-Madsen 1945; Boeckstyns and Busch 1984; Boeckstyns et al 1985), prosthetic replacement (Swanson 1968, 1973; Swanson, De Groot Swanson and Maupin 1984), arthrodesis of adjacent joints (Helfet 1952; Haddad and Riordan 1967; Taleisnik 1984) and denervation of the wrist (Wilhelm 1966). That there are so many types of operation for the same problem suggests that there is no agreement on which is to be preferred, nor upon the indications for these procedures.

We have evaluated the results of corticocancellous bone grafting with lag screw fixation.

PATIENTS AND METHODS

Following AO/ASIF principles, 42 patients have been treated for scaphoid nonunion with corticocancellous bone grafts in combination with lag screws. All were documented at the AO centre in Berne, Switzerland and the data was used for a retrospective analysis.

There were seven females and 35 males, their ages ranging from 18 to 54 years (mean 27.8 years). In nine patients the fracture was on the left, in 33 on the right. In 31 patients the dominant hand was involved. Forced dorsiflexion caused the fracture in 29 patients, nine sustained direct trauma to the wrist, and four patients could not give a description of their injury.

Pre-operatively, all patients presented with pain, either localised to the 'anatomical snuffbox' (22) or in the wrist (20). Pain resulted from any form of movement in 29 patients, but only from heavy use in 13. The interval between fracture and operation ranged from 19 weeks to 11 years. Follow-up ranged from 12 to 120 months postoperatively.

Although 21 patients (50%) had a radiograph taken immediately after the initial injury, the scaphoid fracture was not recognised at that time and no treatment was provided, until they presented with established nonunion. Six patients did not seek any medical advice immediately after their injuries, and they were unsuccessfully treated by conservative methods after having persistent complaints for some time. Another group of six patients, who had no initial radiographic examination after injury, were treated by primary operation on presenting with a

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painful established nonunion. Nine patients had primary conservative treatment for fractures recognised at the time of injury, but nonunion resulted. In these, pre-operative immobilisation ranged from 6 to 74 weeks.

Technique. The corticocancellous graft was fashioned from the iliac crest. Through an incision over the anatomical snuffbox (Burnett 1937) it was driven between the un-united fragments from the dorsolateral aspect.

After positioning the graft, an AO/ASIF cortical lag screw was inserted from the distal to the proximal pole of the scaphoid to obtain compression and stability (Kaulsar Sukul 1987, Fig. 1). An image intensifier was used to position the screw. In four cases a single 2.0 mm or 2.7 mm cortical screw was used. In three cases two 2.7 mm cortical screws were used, and in four (9%) one 2.7 mm and one 3.5 mm screws were inserted. In 22 patients a 3.5 mm cortical screw was used alone, and nine had a 4.0 mm cancellous screw. Postoperatively, a plaster cast was applied to include the thumb, and was worn until radiographs revealed union (4 to 32 weeks, Fig. 2).

Evaluation. Sites of the fractures are listed in Table I.

The type of nonunion was defined according to the classification of Herbert and Fisher (1984) as modified by one of the present authors (Kaulsar Sukul 1987). In this classification, fractures of the scaphoid are listed as type A if they are stable, type B if unstable, and type C if they exhibit delayed union. Our 42 cases were all type D (nonunion) and their further classification is shown in Table II. Careful review of the whole group failed to reveal carpal instability (D3) in any cases.

The clinical evaluation at follow-up was based on pain, wrist mobility, grip strength and functional capacity, using the uninjured hand for comparison. Radiographic union was considered to have occurred when bony trabeculae were seen to cross the fracture line (Russe 1960b). The system of grading the clinical and radiographic results is shown in Table III.

RESULTS

Radiographic union was achieved at an average of 26.9 weeks postoperatively. Four patients (9%) failed to unite. Tables IV, V and VI show that our method was most appropriate for types D1 and D2 nonunions but that it is not suitable for the D4 type.

In two patients a permanent lesion of the sensory branch of the superficial radial nerve was found but other complications such as wound infection, haematoma or Sudeck's dystrophy did not occur.

DISCUSSION

Our union rate of 90% was achieved in an unselected group of patients in which even those cases with a small and avascular proximal fragment were included. It has been our policy to perform this operation, even when it

Fig. 1

Corticocancellous inlay bone graft with screw fixation.

Fig. 2

Time taken to achieve bony union after operation.

Table I. Sites of scaphoid fractures, number and per cent

Distal one-third	6	14
Waist	15	36
Proximal one-third	18	43
Multiple fragments	3	7

Table II. Modified Herbert and Fisher (1984) classification for scaphoid nonunions of type D

Nonunion with a distinct fracture gap, cystic degeneration, sclerosis and (possibly) dislocation

- D1 Fibrous union with no distinct fracture line or cystic changes and little or no deformity and/or mobility at the fracture site (n = 25, 59%)
- D2 Sclerotic nonunion, with a distinct fracture line, sclerotic fracture surfaces, cysts and instability at the fracture site. Radiocarpal arthritis may be present, but without carpal instability (n = 15, 36%)
- D3 as in D2, but with carpal instability (none)
- D4 as in D2, but with avascular necrosis of the proximal fragment (n = 2, 5%)

Table III. System of grading results of treatment of scaphoid nonunion

Assessment			
Grade	Subjective	Clinical	Radiographic
0	Very satisfied and asymptomatic	Normal function and unlimited use	Good union and no joint changes
1	Improved, with minimal symptoms*	Minimal functional loss, unlimited use†	Probable union with minimal joint changes
2	Unchanged, with moderate symptoms*	Moderate functional loss, mildly limited use†	Doubtful union, with obvious joint changes
3	Worse with severe symptoms*	Severe functional loss, limited use†	No union, severe joint degeneration

*1, pain on heavy work; 2, pain on movement; 3, pain at rest

†loss of flexion or extension: 1, < 15°; 2, 15° to 30°; 3, > 30°

Table IV. Subjective assessment versus type of nonunion

Type	Subjective grade			
	0	1	2	3
D1	14	9	1	1
D2	5	7	2	1
D4	-	-	-	2

Table V. Clinical assessment versus type of nonunion

Type	Clinical grade			
	0	1	2	3
D1	10	13	1	1
D2	4	8	1	2
D4	-	-	-	2

Table VI. Radiographic assessment versus type of nonunion

Type	Radiographic grade			
	0	1	2	3
D1	19	3	2	1
D2	6	4	5	-
D4	-	-	-	2

was clear that the chances of union were not high. It seems to us better to attempt to restore the anatomy of the carpus rather than resort to any of the palliative procedures mentioned earlier.

Corticocancellous grafts taken from the radial styloid process are too soft to sustain the compression of the lag screw, which is why we use a graft from the iliac crest to restore length to the shortened scaphoid bone (Hull et al 1976). A dorsolateral incision is preferred because it does not compromise the blood supply to the scaphoid (Taleisnik and Kelly 1966; Hull et al 1976; Gelberman and Menon 1980).

Despite our good experience with them, there are some serious disadvantages in the use of the AO/ASIF cortical or cancellous screws. These arise from the size constraints imposed by the small and irregular shape of the scaphoid bone. The screw head, situated outside the bone, is often intra-articular and may cause damage to

the joint. If a cortical screw is used for fixation, the threaded shank must cross the fracture or nonunion site, and this may lead to fibrous union (Fasol, Munk and Strickner 1977). Herbert's 'scaphoid bone screw' (Herbert and Fisher 1984) and the 'dynamic compression screw for the scaphoid bone' developed by one of the authors (Kaulesar Sukul 1987), are both contained within the bone and the screw thread does not cross the fracture site. However, in the present series these types of implants were not used.

Although we encountered several established non-unions of very long standing, we did not find any cases of carpal instability, as other authors have (Borgeskov et al 1966; Fisk 1970).

The aims of an operation for nonunion of the scaphoid are to obtain a good functional wrist without pain, and to prevent late arthritis (Mack et al 1984). These goals were achieved (Fig. 3) in 35 of our patients

Radiographs 13 weeks prior to operation, immediately after corticocancellous grafting and screw fixation, and one year later, when union had occurred.

Fig. 3

(83%). We now consider that the indications for this operation are as follows:

1. symptomatic nonunion after conservative treatment has failed,
2. symptomatic nonunion after neglected scaphoid fracture, and
3. symptomatic nonunion with early signs of radiocarpal arthritis.

Type D4 nonunion is not suitable for such reconstructive operations.

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