INTERNAL FIXATION OF SCAPHOID FRACTURES WITH AN AO MINI-FRAGMENT LAG SCREW, USING TEMPORARY INTEROPERATIVE AO MINI EXTERNAL FIXATION

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We present the results of our technique for bone grafting and internal fixation of scaphoid fractures using 2.0 mm or 1.5 mm AO mini fragment screws and temporary intraoperative AO mini external fixation. Union was achieved in 14 out of 16 fractures.

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Internal fixation of the scaphoid is recommended for fractures that are unstable and those with delayed healing or established nonunion. The best method of surgical management is still controversial with respect to surgical approach, technique, type of internal fixation and the need of bone grafting. Herbert and Fisher (1984) described the Herbert screw method of fixation and proposed a classification of scaphoid fractures. Fernandez (1984) described a method of anterior wedge grafting of ununited scaphoid fractures using a K-wire for fixation and later reported his results for the same problem using the 2.7 mm AO lag screw (Fernandez, 1990). We report the early results of 16 scaphoid fractures treated by internal fixation with 2.0 or 1.5 mm AO mini fragment lag screws. In all these cases we used the AO mini external fixator to provide temporary intraoperative stabilization of the fractures.

PATIENTS AND METHOD

Between 1994 and 1997, 16 patients with 17 scaphoid fractures (one bilateral), underwent open reduction and internal fixation with AO 2.0 or 1.5 mm mini fragment lag screws. One patient was lost to follow up in the early postoperative period. All operations were done by the senior author (SC). There were 15 men and one woman. The mean age of the patients was 26 years (range, 16–35 years) and the dominant wrist was involved in eight. The average period between the injury and diagnosis was 27 days (range, 0–13 months) and primary conservative treatment was reported in seven patients using scaphoid plaster or splint with a mean immobilization of 9 weeks. Scaphoid radiographs were taken preoperatively and the injuries were graded using the modified Herbert classification (Filan and Herbert, 1996). Three cases were classified as B4 (fracture dislocation <6 weeks), seven type D2 (pseudarthrosis >6 weeks old) and seven type D3 (sclerotic pseudarthrosis >6 weeks old).

Surgical technique for ununited scaphoid fracture

We have used either the anterior or dorsal approaches, depending on the site of the fracture and its configuration. If the proximal segment is avascular, a dorsal approach is used to incorporate a vascularized bone graft from the distal radius. During the surgical exposure, the capsule and extrinsic carpal ligaments (particularly the radioscaphocapitate ligament in the anterior approach) are defined and tagged for later reconstruction. The fracture is then defined and joint adhesions are excised before a temporary AO mini external fixator is applied. A 1.6 mm K-wire is inserted vertically into each scaphoid fragment, parallel to the fracture, carefully avoiding the planned path for the AO screw. A clamp is then applied to each K-wire and joined with a connecting rod. The scaphoid anatomy is restored by distraction of the fracture (using the K-wires as joysticks) to restore the length and alignment of the bone. The clamps are tightened and fibrous tissue and sclerotic bone are removed from the nonunion site until normal vascular bone is exposed (Fig 1). In the majority of the cases, the nonunion gap is a trapezoid shape and a matching corticocancellous bone graft is harvested from the iliac crest or the dorsal distal radius. The scaphoid is internally fixed, under fluoroscan guidance, using a 2.0 or 1.5 mm mini fragment AO screw (Fig 2). In the anterior approach, the screw is lagged and inserted from the distal pole after the distal screw path is countersunk. In the dorsal approach, the screw is placed from proximal to distal with the screw head being countersunk flush with the articular surface. The screw path is planned to pass dorsal to the pivot axis of the scaphoid so that its compression will aid the tension band effect with normal wrist motion. The external fixation and K-wires are removed and the screw is tightened further. Postoperatively, the wrist is immobilized in a splint for 3 weeks and then physiotherapy is started.

RESULTS

All patients had clinical and radiographic postoperative follow up (Table 1). The mean period between diagnosis and operation was 6 months (range, 2 weeks–4 years). Bone graft was added in 11 out of 14 cases of nonunions (10 from the dorsum of the distal radius and one from the ipsilateral iliac crest). The dorsal approach was used in 16 cases mainly for fractures of the proximal pole.

Fig 1 Temporary application of AO mini fragment fixator and resection of sclerotic bone from nonunion site.

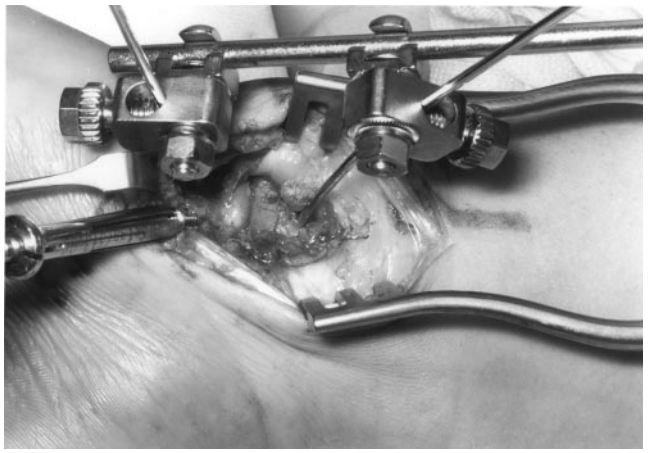

Fig 2 Corticocancellous bone graft insertion and AO minifragment screw fixation.

The mean period of follow-up was 7 months (range, 2–15 months). We considered radiographic union to be present when there was evidence of bony trabeculae crossing the fracture gap and the fracture line was not visible on any of the four standard scaphoid views (Filan and Herbert, 1996). Union was achieved in all three cases with type B4 scaphoid fractures at a mean of 4 months. The scaphoid nonunions united in 11 out of the 13 cases at a mean time from the operation of 7 months.

Postoperative complications

The two failures to obtain union both occurred after using the dorsal technique for proximal pole nonunions. Another patient complained of reduced sensation over the dorsum of the third web space. In one patient with an united fracture of the proximal pole, the screw was removed 7 months postoperatively because of impingement at the radiocarpal joint.

Table 1—Radiographic results

	Fracture type			
	B4	*D2*	*D3*	*Total*
Union	3	6	5	14
Nonunion	–	–	2	2
Lost to follow up	–	1	–	1
				17

DISCUSSION

We favour the 2.0 mm AO screw for waist and proximal third fractures and the 1.5 mm screw for small fractures of proximal pole of the scaphoid. Using temporary external fixation to reduce and stabilize the scaphoid, the resection of fibrous tissue and sclerotic bone, the insertion of the proper size of corticocancellous bone graft and final internal fixation with the AO mini fragment screw can be done easily.

Internal fixation with AO 2.0 or 1.5 mm mini fragment screw has several advantages. It is applied as a true lag screw and the screw can be inserted in a tension band fashion. During wrist motion the scaphoid is eccentrically loaded. The tensile forces are on the dorsal surface and the compressive forces on the anterior surface. The radioscaphocapitate ligament (RSC) crosses the narrow waist of the bone and acts as a pivot point for the fracture. Bending moments in relation to the RSC ligament produce a force couple that induces the scaphoid to angulate dorsally. The final result will be humpback deformity with dorsal intercalated segment instability (Cooney et al., 1988). If the screw is placed in the dorsal third of the scaphoid bone, it will function as a tension band that allows early

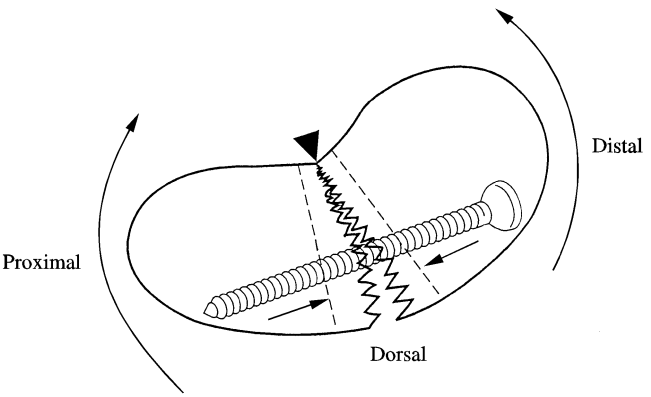

Fig 3 AO minifragment screw tension band fixation and insertion of the screw dorsal to the pivot axis of the scaphoid.

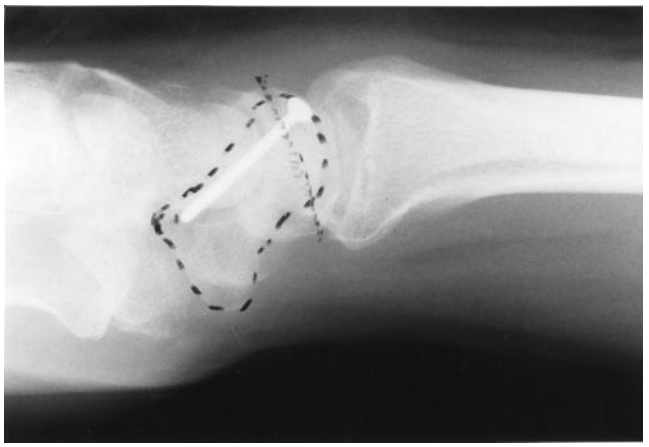

Fig 4 Lateral X-ray demonstrates the correct position of AO minifragment screw.

mobilization (Fig 3). This early mobilization will increase the compression at the fracture site and hence improve the chances of union (Fig 4). Another advantage of the AO mini fragment screw is its small size (2.0 or 1.5 mm) which helps in correct positioning of the screw relative to the long axis of the scaphoid and the fracture line. This is particularly useful in small fractures of the proximal pole of the scaphoid in which screws with a larger diameter do not allow an optimal biomechanical placement or the opportunity for a second attempt. Finally, the cost of the AO mini fragment screw is less than that of some other screws.

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