

Technical note

Intramedullary cancellous screw fixation for nonunion of midshaft clavicular fractures

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Submitted 02-01-21. Accepted 02-10-19

ABSTRACT 6 patients with symptomatic nonunion of midshaft clavicular fractures were treated by internal fixation with an intramedullary cancellous screw and autologous cancellous bone grafting.

At follow-up after median 21 (12–72) months, all nonunions had healed. The Constant score was median 98 (57–100) points. 1 patient, with shortening of the clavicle, had poor function.

Surgical treatment of symptomatic nonunion of a fracture of the clavicle is commonly treated by plate osteosynthesis and the plate is usually removed later because of loosening, discomfort or cosmesis (Jupiter and Leffert 1987, Bradbury et al. 1996).

Intramedullary fixation has also been done with Kirschner wires (Kona et al. 1990), a modified Haige pin (Boehme et al. 1991), Steinmann (Capicotto et al. 1994) and Rush pins (Enneking et al. 1999). However, loosening and a protruding lateral part have caused tenderness and discomfort. Therefore most of them have had to be removed after the fracture healed. Intramedullary devices also involve risks—e.g., of migrating, damage and serious complications (Norell and Liewellyn 1965, Lyons and Rockwood 1990, Liu et al. 1993, Lepilähti and Jalovaara 1999).

Therefore, we have used a new technique with a 4.5 mm AO cancellous screw having built-up threads. We report on the healing and functional outcome in 6 patients treated with this type of

intramedullary fixation and autologous cancellous bone grafting for nonunion of the clavicle.

Patients

6 patients (median age 41 (25–53) years, 5 men) with nonunion of a midshaft clavicular fracture (Table) were treated with intramedullary fixation using a 4.5 mm AO-cancellous screw having built-up threads. Autologous cancellous bone grafts from the ipsilateral iliac crest were placed at the site of the nonunion.

In 2 patients, the clavicular fracture was sustained in a bicycle accident, in 1 by a car accident, in 1 by a fall from a horse, and in 2 after a direct trauma during sports (Table). All fractures were closed. The dominant side was injured in 2 patients. None had a history of shoulder injuries or disabilities.

Radiographically, 3 nonunions were considered atrophic, 2 hypertrophic, and 1 resembled a pseudarthrosis, which was confirmed at surgery. The median displacement of the fracture was 21 (12–25) mm.

Surgery was performed median 2 (1–26) years after fracture. The indications for surgery were one or more of the following symptoms: pain and crepitus at the site of the nonunion during motion, ptosis of the shoulder, restricted range of motion, inability to return to work, and reduced strength of the shoulder (Table). In 5 patients, the fracture was initially treated by an arm sling or a figure-of-eight

Data on the 6 cases with clavicular nonunion treated with AO intramedullary fixation and autologous cancellous bone graft

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	M	49	C	R/R	P	20	312	S	72	1.03	99	99	20	C, L, P
2	M	40	S	L/R	A	21	87	S	40	1.00	100	100	0	C, P, T
3	F	42	H	L/R	H	20	28	S	26	1.00	88	90	10	I, P
4	M	53	B	L/R	H	22	20	S	16	0.94	57	97	10	L, P, W
5	M	25	S	R/R	A	12	23	S	16	1.00	100	100	5	I, P
6	M	32	B	L/R	A	25	12	S	12	1.00	96	96	0	I, P
A Case no.									G Displacement of nonunion (mm)					
B Gender									H Months from injury to operation					
M male									I Operation					
F female									S AO-screw					
C Age at operation (years)									J Follow-up (months)					
D Accident									K Follow-up, clavicular length ratio					
B Bicycle									L Constant score, injured arm (points)					
C Car									M Constant score, uninjured arm (points)					
H Horse									N VAS value (mm)					
S Sport									O Preoperative symptoms					
E Injury/dominant side									C Crepitus					
L left									I Instability					
R right									L Limited mobility					
F Nonunion									P Pain					
H Hypertrophic									T Ptosis					
A Atrophic									W Weakness					
P Pseudarthrosis														

bandage for 2–5 weeks. In 1 patient (case 1), the fracture was primarily treated elsewhere with a Rush pin.

Surgery

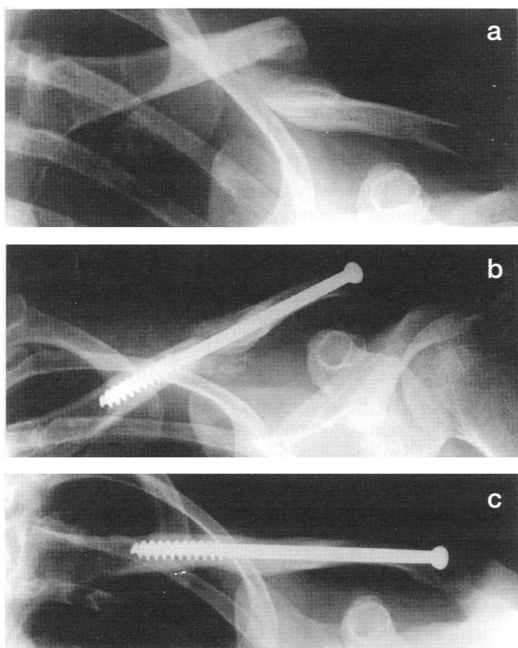
The patient was placed in a beach-chair position on the operating table with a folded towel under the affected shoulder. Open reduction and internal fixation were performed through a horizontal skin incision along the inferior border of the clavicle. The ununited ends of the clavicle were exposed, interposed fibrous tissue excised, and the ununited fragments debrided until bleeding of the bone could be seen on each side. The intramedullary canal of the medial fragment was drilled without penetrating the anterior cortex of the anterior bow of the fragment. The intramedullary canal of the lateral fragment was then drilled, and the posterior cortex of the lateral clavicle, posterior to the acromioclavicular joint was penetrated. An AO cancellous screw having built-up threads of adequate length—to avoid penetrating the anterior cortex of the medial fragment—was inserted through a separate skin incision into the intramedullary canal of the lateral fragment through the predrilled hole

of the lateral posterior cortex. The fracture was reduced and the screw inserted into the intramedullary canal of the medial fragment, to ensure secure fixation in the medial fragment (Figure). The screw was tightened until sufficient compression was obtained, but without leaving any protruding part of the screw on the posterolateral aspect of the clavicle. In all patients, autologous cancellous bone grafts were harvested from the ipsilateral iliac crest and packed in the defects and around the site of the nonunion.

Postoperatively, the shoulder was immobilized in a sling for 2–3 weeks. The next 3–4 weeks daily training was initiated without raising of the arm over 90°.

Follow-up

The median follow-up was 21 (12–72) months. Both shoulders were evaluated. The results were graded using the Constant score (Constant and Murley 1987) concerning pain (15 points), activities of daily living (20 points), active range of motion (40 points), and power (25 points). For additional evaluation of pain, we used the visual analog pain score (VAS scale). The patient



Case 6. Radiographs showing the left clavicle with atrophic nonunion of a midshaft fracture (a). The nonunion was treated with an AO screw and bone grafting (b). Satisfactory healing of the fracture at follow-up 12 months after surgery (c).

assessed the severest degree of pain experienced during activities of normal daily living on a 100-mm linear scale. Anteroposterior full-width view radiographs were taken of both clavicles.

Results

In all patients, the nonunion was clinically and radiographically healed at follow-up (Figure). The Constant score was median 98 (57–100) points in the affected shoulder and median 98 (90–100) points in the contralateral (Table). They all returned to their preinjury activity level. None of them had symptoms at the donor site of the bone graft. No screws loosened and no patient had any discomfort from the head of the screw.

In one of the patients (case 2), the screw was too long, and caused a minor intraoperative penetration of the anterior cortex of the medial fragment of the clavicle. The screw had to be removed 17 months later because of local tenderness and discomfort.

Case 1 complained of mild shoulder pain during heavy work. Case 4 had a subacromial inflamma-

tion in the affected shoulder, which resulted in tiredness, weakness, and mild shoulder pain during work. He was the only patient with shortening of the clavicle. The other patients had no complaints from the affected shoulder.

Discussion

The clavicle is subjected to considerable tension and bending, rotating about 40°, most of which occurs after the arm passes the horizontal level (Moseley 1968). Therefore, to reduce the rotating forces over the nonunion of the clavicle, we restricted elevation of the arm over 90° the first 6–7 weeks after the operation.

Boehme et al. (1991) described intramedullary fixation with a modified Haige pin. However, a tender bursa developed at the distal end of the pin, and it had to be removed from 17 of the 21 patients after union. Previously, we performed intramedullary fixation with a threaded Hoffmann pin, which caused discomfort from the protruding lateral end in many cases.

The AO screw, however, has no protruding lateral end, only a smooth head. It provides the desired compression over the nonunion, and a secure anchorage of the medial fragment. In our opinion, it does not have to be removed later. Since the intramedullary screw serves as a load-sharing device (Boehme et al. 1991), osteoporosis is less severe, and the likelihood of refracture through osteoporotic bone after hardware removal is reduced.

Some authors believe that healing of a displaced clavicular fracture with malformation and shortening may cause persistent disability (Eskola et al. 1986). However, Nordqvist et al. (1997), in a 5-year follow-up, found normal and pain-free function of the shoulder in most cases despite shortening. In our series, the only patient (case 4) with shortening of the affected clavicle at follow-up was the patient with the lowest Constant scores in the injured arm (Table). The score differed markedly from that of the contralateral shoulder. This was primarily due to a limited range of motion and less strength of the affected arm, which has also been reported by Eskola et al. (1986).

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