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Surgery for posttraumatic wrist deformity

Radial osteotomy and/or ulnar shortening in 16 Colles' fractures

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16 patients with pain and impaired function after malunited fracture of the distal radius were treated with opening wedge lengthening osteotomy of the radius with bone grafting (12 cases), shortening osteotomy of the ulna (3 cases), or a combination of these methods (1 case), with or without reattachment of the triangular fibrocartilage complex. 4 patients had to be reoperated because of redislocation, resorption of the graft, fracture of the plate, or persistent non-union. At re-examination after a median of 4 years, all patients but 2 were improved by the procedure.

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Impaired function and pain after malunion of distal radius fractures may be caused by derangements of the radiocarpal, ulnocarpal, and radioulnar joints. We report our experience in such cases with realignment of the distal radius to the ulnar head by opening wedge-lengthening osteotomy of the radius, shortening osteotomy of the ulna or a combination of these methods.

Patients and methods

Between 1980 and 1992, 16 patients were operated with corrective osteotomy of the radius and/or shortening osteotomy of the ulna because of malunion of a Colles' fracture. 5 patients were male, and the median age was 44 (28–58) years (Table 1). The median time between the fracture and the corrective osteotomy was 1 year.

The indications for osteotomy were malunion with pain, weakness, decreased forearm rotation, substantial loss of wrist flexion and cosmetic impairment.

Radiographically the dorsal angulation was 18 (0–28) degrees (Figure 1), the radial angulation 8 (-5 to +22) degrees, and the ulnar variance compared with the contralateral wrist was 5 (2–15) mm.

Surgical procedure

Osteotomy of the radius was performed in 13 patients without degenerative changes in the wrist joint. One of these (Case 3) was combined with a shortening osteotomy of the ulna.

The grafts were taken from the iliac crest in 12 patients and from the distal ulna in 1. The length of the grafts was 10 (5–20) mm (Figure 2). The surgical approach was mid-dorsal in 11 patients, volar and dorsal in Case 11 with carpal tunnel decompression, and a combination of radial and ulnar dorsal approach with graft from the distal ulna in Case 3. The radius was exposed subperiosteally, Lister's tubercle was removed to facilitate plate fixation, and the dorsal retinaculum was interposed to protect the tendons from the plate. AO T-plates were used without compression.

In 3 patients with moderate dorsal angulation of the radius (Figure 1), shortening osteotomy of the distal ulna and fixation with a 3.5 dynamic compression plate was performed. In Case 12, the triangular fibrocartilage complex (TFCC) was reattached using osteosutures through two drillholes from the neck of the ulnar head towards its fovea (Figure 3).

The median follow-up was 4 (1–12) years. All but one of the patients were re-examined—Case 1 died of an adenocarcinoma.

Results

6 months after the osteotomy, Case 6 had a Darrach's resection because of distal ulna subluxation. 2 of the patients without plaster cast immobilization had redislocations, 1 with loosening of the graft (Case 7), the other with resorption of the graft and fracture of the plate 2 months after the osteotomy (Case 13) (Figure 4). Both of these were reop-

Table 1. Summary of data

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
1	56	1	1	1	1	–	0	2	15	0	0	13	–	–	–	–	–	–	–	–	–	–	–	–	–
2	37	1	1	22	1	1	–	0	9	144	0	0	10	–	–3	–	15	–	2	70/70	70/60	45/35	25/40	90/90	85/90
3	42	1	1	11	1+3	2	6	6	8	129	0	0	36	23	8	8	23	9	5	50/60	20/50	10/30	10/30	90/95	40/110
4	44	1	1	32	1	1	7	0	6	129	0	0	17	22	–1	–5	19	10	5	60/80	60/70	35/40	25/40	70/100	65/90
5	44	1	1	20	1	1	15	0	6	85	3	0	0	20	10	18	28	4	2	85/75	70/85	35/35	30/40	70/80	110/120
6	58	1	1	5	1	1	5	0	2	76	3	3	6	27	12	7	14	5	2	50/80	35/60	20/25	40/40	90/120	95/130
7	44	1	2	6	1	1	10	0	0	69	1	1+4	11	19	1	11	21	5	2	0	0	0	0	70/90	60/85
8	45	1	1	11	1	1	–	0	3	53	0	0	0	25	0	15	11	5	3	90/90	85/90	25/30	40/40	90/95	100/105
9	40	2	2	9	1	1	10	0	0	45	0	0	0	18	–10	1	11	15	5	55/65	45/45	25/30	30/35	70/85	75/85
10	48	1	1	9	1	1	14	0	0	38	0	0	0	8	–2	5	14	3	1	85/85	80/80	30/35	50/55	95/100	120/120
11	38	1	1	27	1+2	1	14	0	0	21	4	0	11	12	–17	11	27	2	2	50/80	30/90	35/35	45/45	85/85	90/120
12	47	2	1	15	3	0	0	6	3	16	0	0	0	15	15	10	10	4	–2	70/80	45/60	15/15	35/50	75/85	90/100
13	30	2	1	9	1	1	15	0	0	15	1	2	0	28	–1	5	22	5	0	50/80	35/55	25/25	20/20	120/110	60/85
14	49	2	1	38	3	0	0	6	0	14	2	2	0	6	6	22	22	5	0	50/60	50/60	45/55	30/35	75/80	90/95
15	28	1	1	18	3	0	0	10	8	13	0	0	0	0	0	11	11	7	–3	90/90	85/90	30/30	35/40	90/100	85/95
16	39	2	2	9	1	1	20	0	9	12	0	0	0	30	–14	8	29	5	–2	45/60	50/55	15/25	20/25	70/90	75/90

A Case
B Age
C Sex
 1 female
 2 male
D Initial treatment
 1 Closed red + plast.
 2 Hoffmann ext. fix.
E Time before operation, months
F Surgical approach
 1 dorsal
 2 volar
 3 ulnar
G Graft
 0 no graft
 1 iliac
 2 ulnar

H Maximum length of graft, mm
I Ulnar shortening, mm
J Plaster cast immobilzation, weeks
K Length of follow-up, months
L Complications
 1 redislocation
 2 non-union
 3 sublux ulna
 4 pain
M Reoperation
 1 new osteosynthesis
 2 new osteo + graft
 3 Darrach's resection
 4 wrist fusion
N Removal of implant, months
O Dorsal angulation before osteotomy

P Dorsal angulation after osteotomy
Q Radial angulation before
R Radial angulation after
S Ulnar variance (ulna plus) before, mm
T Ulnar variance after, mm
Postoperative function, degrees (injured / uninjuried wrist)
U Extension
V Flexion
W Radial deviation
X Ulnar deviation
Y Pronation
Z Supination
– Missing data

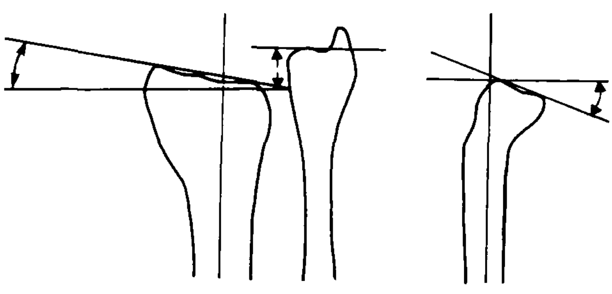


Figure 1. Dorsal angulation is defined as the angle between the articular surface and a line perpendicular to the radius' long axis on lateral radiographs (volar angle = minus).

Radial angulation is defined as the angle between a line perpendicular to the long axis of the distal third of the radius, and a line through the tip of the radial styloid and the most distal part of the radius at the radioulnar joint.

Ulnar variance is the distance between 2 parallel lines through the distal part of the radius at the radioulnar joint and the most radial point of the ulnar dome.

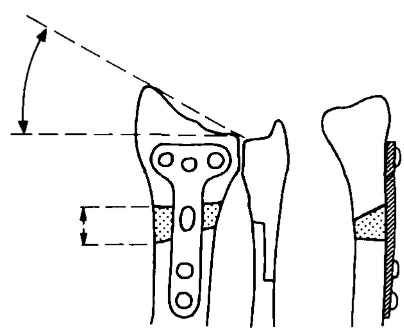


Figure 2. Lengthening osteotomy of the radius and shortening of the ulna. The radial angulation after the operation and the maximum length of the graft are indicated.

erated, Case 13 successfully with a pain-free full range of motion, whereas Case 7 developed progressive pain and had wrist fusion 20 months after the osteotomy.

Case 14, with shortening osteotomy of the ulna and no plaster cast immobilization, developed persistent non-union. He was successfully reoperated with a new osteosynthesis and bone grafting and is now

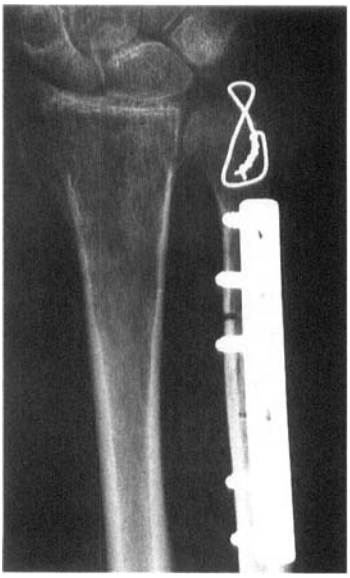


Figure 3. Case 12. Shortening osteotomy of the distal ulna and reattachment of the triangular fibrocartilage complex.

Table 2. Wrist motion, pronation and supination (degrees) at follow-up

	Operated wrist			Unoperated wrist		
	Mean	Median	Range	Mean	Median	Range
Extension	65	60	45–90	75	80	60–90
Flexion	54	50	20–85	68	60	45–90
Radial deviation	28	28	10–45	32	30	15–55
Ulnar deviation	31	30	10–50	38	40	20–55
Pronation	79	80	70–120	94	90	80–120
Supination	85	85	40–120	101	95	85–130

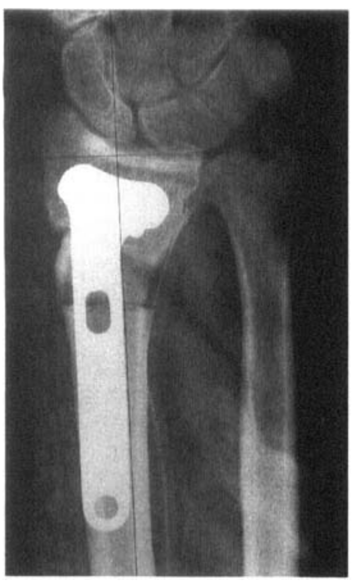
back at work as a carpenter.

Preoperative symptoms with pain from the distal radioulnar (DRU) joint, with or without limited motion, pain from the radiocarpal (RC) joint with limited motion, or disability from both joints, were improved in 14 patients with a satisfactory range of wrist motion, averaging 84 percent of the joint on the opposite side (Table 2).

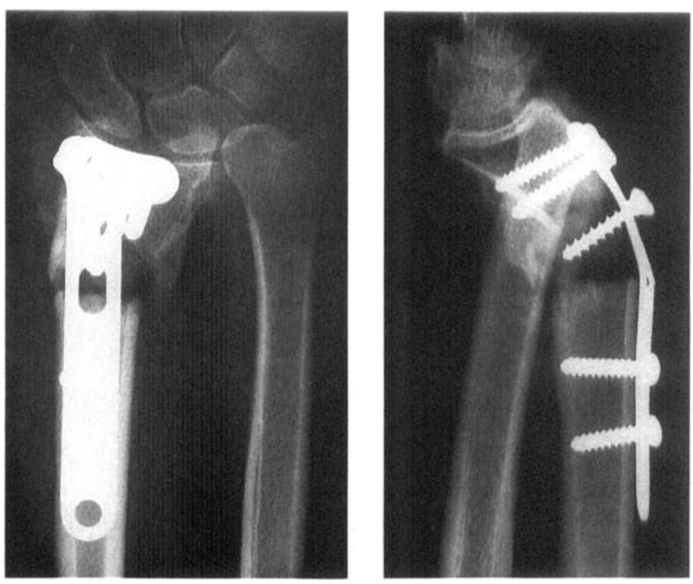
Case 3 had improved wrist motion but persistent pain after the osteotomy, and degenerative changes in the radiocarpal joint after her intraarticular fracture.

The pre-operative dorsal angulation had been reduced to –1 (–17 to +15) degrees, compared to normal –12 (–4 to –23) degrees (Solgaard 1984). The radial angulation had increased to 20 (10–29) degrees compared to normal 23 (16–35) degrees (Solgaard 1984). The ulnar variance was 0 (–3 to +5) mm compared to normal –1 (–4 to +2) mm (Schuind et al. 1992) (Table 1).

Figure 4. Case 13.



Corrective osteotomy with a graft from the iliac crest.



2 months later with resorption of the graft and fracture of the plate

Discussion

Many complications from Colles' fracture are caused by incomplete reduction, with loss of radial length or normal angulation of the distal radius (Cooney et al. 1980, Taleisnik and Watson 1984).

Short et al. (1987) found that distal radius fracture, with loss of volar angulation, leads to a load gradually increasing on the ulnocarpal and radioscaphoid articulations; the loads become concentrated along the dorsal rim of the articulation, resulting in pain and, with time, arthrosis. Corrective osteotomy is said to be indicated if the malunion angle is more than 20 degrees in the frontal or sagittal plane (Oestern and Laqué 1990).

Ekenstam et al. (1985) found that the correction of radial angulation was of particular importance and needed greater precision than correction of volar or dorsal angulation. Posner and Ambrose (1991) postulated that a decrease in radial angulation will restrict ulnar deviation of the hand, but any limitation of this motion is rarely disabling. We feel that loss of radial angulation is more likely to cause a problem at the radioulnar articulation as a consequence of shortening of the bone, a frequent event.

Distal radioulnar stability is a combined function of surface congruity and ligament stability (Palmer and Werner 1981, Ekenstam and Hagert 1985, Hagert 1987, Braun 1992). With malalignment of a distal radius fracture, both joint incongruency and ligament instability may ensue and should be meticulously corrected. If the correction does not stabilize the distal radioulnar joint, additional ligament stabilization should be performed (Ekenstam et al. 1985, Jupiter and Masem 1988, Shaw et al. 1990, Lanz 1991, Melone and Nathan 1992, Fernandez 1993).

Previously, resection of the ulnar head (Darrach 1913) was the most common operation for disabilities after distal radius fractures. Bieber et al. (1988) and Ekenstam et al. (1982) found that 50 percent of the patients did not improve significantly after this operation, and some cases even deteriorated. We agree with Darrow et al. (1985) and Fernandez (1993) that, if difficulties occur in restoring the relative length of the radius, one should be prepared to shorten the ulna at the same time, instead of resecting the ulnar head.

Fernandez (1982) recommended opening wedge osteotomies with restoration of length to the radius to correct distal radioulnar problems. However, an additional operation on the ulnar side of the wrist had to be performed in almost one half of the patients (Posner and Ambrose 1991, Fernandez 1993). Recent series have featured multi-directional correction of the distal fragment, sculptured wedge-shaped bone grafts, and rigid internal fixation with plates and screws (Jupiter and Masem 1988, Fernandez 1993).

Möllenhoff et al. (1991) and Linscheid (1993) recommend that the correction procedure should be performed within 6–12 months after the initial injury.

Our series reflects these recent changes and refinements in the surgical techniques. We now practice multi-directional correction of the distal fragment and preservation of the distal radioulnar articulation whenever possible. If the correction does not stabilize the articulation, we reattach the triangular fibrocartilage complex.

The mechanical failures of osteosyntheses are probably caused by too thin plates and lack of interfragmentary compression. As an adequate strength of fixation may be difficult to achieve with the available methods, we now recommend immobilization in a plaster cast for about 8 weeks.

Fernandez (1993) recommends radial lengthening of 10–12 mm. In our series we had several corticocancellous grafts of as much as 15–20 mm with excellent results.

We conclude that operative treatment of post-traumatic wrist deformity are procedures which require careful patient selection, correct indication, detailed preoperative planning, with calculation of the correct position in all planes, proper surgical technique, and effective postoperative stabilization. The operation has in our and other recent series proved to be effective if correct orientation of the distal radius is achieved together with congruency and stability of the distal radioulnar joint.

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