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Bone cement for redislocated Colles' fracture

A prospective comparison with closed treatment

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Colles' fractures (not comminuted or intraarticular) that redislocated after two closed reductions were randomized into two groups. In one group the dorsal bone deficiency was filled with bone cement (methylmethacrylate) at operation; in the other, the fractures were rereduced and immobilized in a plaster cast. All the patients were followed for 2 years and examined with respect to anatomy of the fracture, wrist movement, strength, appearance, pain, and function. The operated on group were better with regard to all objectively measurable characteristics; all operated on fractures had healed radiographically, and the cement was surrounded by cortical bone.

One fifth of Colles' fractures redislocate (Lidström 1959, Johnsson 1983).

Redislocation is still usually treated by repeated closed reduction and plaster-cast immobilization. However, the value of this method has recently been questioned, at least in patients aged over 60 years (McQueen et al. 1986), and many advocate external fixation or pinning after closed rereduction (Dowling and Sawyer 1961, Johnson 1983).

In 1970, Charnley reported 3 cases of Colles' fracture that were reduced and the remaining dorsal deficiency filled with bone cement (methylmethacrylate). We adopted this method in 1978. Because the results of a small series (Nilsson 1979) seemed promising, a larger prospective study was initiated in 1981, and the results are reported here.

Patients and methods

A randomized study including all Colles' fractures of Frykman (1967) Types I and II that redislocated after two reductions was performed in 1981 and 1982. The second reduction had been done 8–14 days after the initial reduction. Intraarticular and comminuted fractures such as those combined with a distal ulnar fracture (apart from fracture of the styloid ulnar process) were excluded. Patients with a previous fracture of the distal radius and mentally disturbed patients were also excluded. To be included in the investigation, a dorsal angle of at least 30° and/or an axial compression of at least 5 mm were required. Patients born on even dates were operated on (Group I); patients born on uneven dates were treated by a third closed reduction with immobilization in a plaster cast, which at that time was the routine method in our department (Group II). One patient in each group had died during the 2-year observation period. Group I included 24 women with a median age of 66 (47–80) years, and Group II 23 women with a median age of 70 (55–81) years.

Malalignments before treatment. In Group I, 20 patients had dorsal angulation exceeding 30° and axial compression of more than 5 mm, and 4 showed only an unacceptable dorsal angle. The median dorsal angle was 40° and the axial compression 6 mm. In Group II, 20 exceeded the limit for both dorsal angle and axial compression, and in 3 the only feature was an unacceptable dorsal angle. The median dorsal angle was 35° and the axial compression was 6 mm.

Open reduction (Group I). The dorsal carpal ligament was divided through a longitudinal dorsal incision and the fracture exposed between the tendons of extensor pollicis longus and extensor carpi radialis, or between the tendon of extensor pollicis longus and the extensor tendons of the second digit. Reduction was

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done with a small retractor and the dorsal bone deficiency filled with bone cement (CMW 1, C.M.W Laboratories Ltd, Blackpool, U.K.). Any dorsal cortical fragments are placed on top of the cement. The cement was smoothed out in continuity with the dorsal cortex. A dorsal plaster was applied for 2 weeks.

The operations were performed 18 (14–24) days after the fracture. Twenty-three operations were performed under regional anesthesia, one was done under general anesthesia, and one under brachial plexus anesthesia.

Closed reduction (Group II). The reductions were performed 19 (15–24) days after the fracture under general anesthesia in 21 patients and regional block anesthesia in 3 patients. The fracture was immobilized in a low circular plaster cast with no dorsal or volar flexion and with slight ulnar deviation and with the arm in slight pronation.

The patients were followed for 2 years with clinical examination 2 weeks and 1, 2, 3, and 6 months after the reduction procedure and then every 6 months until the final examination at 2 years. Radiographs were taken immediately after operation, after 1 and 6 months, and again at 2 years, when both wrists were examined.

Wrist movements were measured with a goniometer and grip strength with a Martin vigorimeter (Gebrüder Martin, W. Germany); the best value of a series of three measurements was used. A wrist was regarded as painless when the patient could easily lift a saucepan or frying pan and carry a shopping bag. The cosmetic result was assessed in accordance with the patient's views. Function of the wrist was graded as proposed by Lidström (1959).

Excellent. Unimpaired function without loss of strength or subjective symptoms nor deformity. Loss of dorsiflexion or palmar flexion not exceeding 15°.

Good. Function without subjective symptoms. Deformity, moderate loss of motion up to 20°, and slight to moderate loss of strength are accepted, i.e., the dominant hand is only slightly weaker than the nondominant hand or the strength of the nondominant hand is not less than half of that of the dominant hand.

Fair. Function of the wrist is not satisfactory for activities requiring strength or extreme movements, which the patient must therefore avoid. Most preinjury activities are possible. Loss of motion, even if marked, is accepted if not associated with subjective symptoms. Moderate loss of strength is accepted, i.e., the dominant hand is definitely weaker than the other hand or the strength of the nondominant hand is less than half of that of the dominant hand.

Poor. Working capacity is diminished and the quality of life affected. Continuous pain. Considerable loss of strength, i.e., the dominant hand is considerably weaker than the nondominant hand, or the strength of the nondominant hand is considerably less than half of dominant hand.

Statistics. The Mann-Whitney test for the wrist movements and grip strength, Wilcoxon's matched-pairs signed-ranks test for the anatomic position, and the chi-square test for pain and function were used.

Results

In Group I a postoperative median nerve palsy (Case 8) required release of the carpal ligament. Recovery was uneventful.

Alignment after treatment. In Group I the dorsal angle was improved from 40° to 5° and the axial compression from 6 to 1 mm immediately after the operation, and these had not changed at the 2-year follow-up. In Group II, there was no lasting improvement in these parameters (Table 1). Radiographs at 24 months showed the cement to be surrounded by cortical bone (Figure 1) in all operated on wrists.

Wrist movements. Totally, 21 of 24 patients in Group I and 10 of 23 patients in Group II recovered full dorsiflexion (Figure 2). In all, 14 of 24 patients in Group I, but none in Group II, recovered full volar flexion. All in Group I, but only 9 of 23 patients in Group II, recovered full pronation. Maximum mobility was regained more quickly in Group I. In Group I, full supination was regained by 21 of 24 patients within 3 months and by all the patients within 6 months. None in Group II achieved full supination.

The differences between the groups were significant for all wrist movements at every examination.

Grip strength. Full strength was regained by 8 patients in Group I, but by only 1 in Group II. Group-II patients required a considerably longer time to reach maximum strength ($P < 0.001$).

Pain. In Group I, 7 patients were free from pain after 8 weeks, another 14 patients after 12 weeks, one further patient after 6 months, and the last 2 patients after 1 year. In Group II, 2 were free from pain after 6 months, 5 after 1 year, and 2 after 18 months, and 14 had persistent pain at 2 years ($P < 0.001$).

Cosmetic result. At 8 weeks all in Group I were satisfied with the appearance of the wrist in contrast to Group II in which no one was satisfied. After 1 and 2 years, 20 and 15 Group-II patients, respectively, were still dissatisfied; the remainder had accepted the malalignment.

Function. In Group I, function was excellent in 6 patients, good in 17, and fair in 1. In Group II, 2 patients were good, 12 fair, and 9 poor. ($P < 0.001$).

Table 1. Redislocated Colles' fracture treated with (Group 1) and without (Group 2) methylmethacrylate

Group 1		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Case	1	64	+	56	100	86	100	100	100	100	100	44	89	35	5	5	5	1	1	3	2	1
	2	69	+	61	100	62	100	100	100	100	100	50	75	40	5	5	3	1	1	3	2	2
	3	47	+	64	100	86	100	100	100	78	100	50	100	40	10	10	7	2	2	3	1	1
	4	63	+	41	100	38	92	72	100	72	100	22	89	35	10	10	6	2	2	2	1	2
	5	66	+	67	100	77	92	100	100	67	100	80	100	50	10	10	10	3	3	2	2	2
	6	66	+	20	87	22	100	67	100	67	100	19	63	45	5	5	4	1	1	6	2	3
	7	76	+	50	100	100	100	100	100	100	100	40	80	35	5	5	7	1	1	3	2	2
	8	77	+	54	92	75	92	78	100	78	100	30	83	45	10	10	6	1	1	3	2	2
	9	64	+	73	100	71	100	100	100	83	100	38	94	35	10	10	7	2	2	12	1	2
	10	64	+	56	100	71	93	100	100	100	100	50	86	40	5	5	6	1	1	3	1	2
	11	59	+	57	100	71	93	100	100	100	100	50	100	35	5	5	6	1	1	3	1	1
	12	65	+	64	100	67	100	100	100	100	100	22	78	45	5	5	6	1	1	3	2	2
	13	64	+	77	100	69	79	100	100	67	100	28	72	40	10	10	4	1	1	2	1	2
	14	63	+	31	100	69	92	100	100	100	100	22	72	35	10	10	7	2	2	2	2	2
	15	79	+	90	100	90	100	100	100	83	100	33	83	30	0	0	9	3	3	2	2	2
	16	74	+	88	100	100	100	100	100	100	100	33	100	35	0	0	7	2	2	2	2	1
	17	73	+	85	100	100	100	100	100	100	100	50	100	50	10	10	6	2	2	3	2	1
	18	69	+	77	100	69	92	100	100	83	100	50	80	50	10	10	3	0	0	3	1	2
	19	62	+	13	81	75	100	70	100	83	100	17	83	45	10	10	4	0	0	3	2	2
	20	65	+	83	100	100	100	100	100	100	100	50	78	35	5	5	8	1	1	3	1	2
	21	69	+	67	100	64	100	100	100	100	100	64	100	45	5	5	6	1	1	3	2	1
	22	67	+	69	100	89	76	100	100	67	100	15	100	50	5	5	3	0	0	2	1	2
	23	80	+	80	100	89	100	100	100	100	100	31	92	35	5	5	8	2	2	3	1	2
	24	73	+	86	100	57	86	100	100	100	100	60	100	45	10	5	6	2	2	12	2	1
												median		40	5	5	6	1				

Group 2		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Case	1	80	+	50	92	27	25	33	83	33	83	16	100	40	20	40	6	3	6	12	-	2
	2	76	+	33	92	23	69	44	100	44	83	13	75	30	15	20	5	3	3	-	24	3
	3	64	+	36	100	15	62	50	100	44	89	12	63	30	25	25	6	4	5	18	24	3
	4	70	+	43	86	15	62	33	100	22	67	19	63	35	10	30	7	2	7	-	-	4
	5	69	+	36	100	21	79	22	78	39	78	21	71	35	20	35	7	3	7	-	-	4
	6	55	+	44	100	17	58	44	94	33	83	11	78	45	30	40	4	3	4	6	12	3
	7	55	+	50	100	17	58	44	100	28	67	17	67	30	20	30	5	3	5	6	12	3
	8	50	+	50	75	33	58	67	100	33	72	50	50	35	20	30	8	5	7	-	-	4
	9	80	+	75	100	60	60	33	83	50	83	8	42	40	25	40	6	4	6	18	24	4
	10	67	+	67	100	46	62	78	100	44	78	20	40	30	15	25	8	4	7	-	-	4
	11	56	+	38	81	20	86	50	83	33	83	17	83	35	25	35	6	3	6	13	-	2
	12	70	+	50	100	33	50	33	83	28	78	14	71	55	30	50	3	2	3	-	24	3
	13	65	+	43	100	21	71	27	83	28	67	13	75	45	30	50	6	4	6	-	-	3
	14	72	+	22	61	40	80	39	83	33	83	17	67	35	30	35	5	4	4	12	-	3
	15	65	+	28	72	29	86	44	100	33	78	17	67	40	25	35	10	6	8	-	-	3
	16	64	+	40	73	21	79	39	89	28	67	14	71	30	25	30	7	5	7	-	12	3
	17	70	+	31	61	33	91	50	100	50	78	14	57	40	30	35	7	4	7	-	-	4
	18	75	+	41	92	22	67	44	94	44	78	16	63	43	15	30	7	2	5	12	-	4
	19	75	+	20	100	33	69	50	94	33	78	24	83	35	25	35	7	4	7	-	-	3
	20	82	+	50	92	15	67	33	100	39	78	21	67	55	30	45	4	4	4	12	24	3
	21	78	+	67	100	29	86	67	89	50	83	14	50	30	20	30	6	4	5	-	-	4
	22	61	+	43	86	40	58	39	89	22	83	13	75	35	30	35	5	4	5	-	-	3
	23	72	+	33	67	21	64	50	89	33	67	13	63	40	40	40	5	3	5	-	-	4
												median		35	25	35	6	4	6			

A Age.
B Female (+).
C Dorsiflexion at 1 month.
D Dorsiflexion at 24 months.
E Volar flexion at 1 month.
F Volar flexion at 24 months.
G Pronation at 1 month.
H Pronation at 24 months.
I Supination at 1 month.
J Supination at 24 months.
K Grip strength at 1 month.
L Grip strength at 24 months.
M Dorsal angulation (°) before operation.
N Dorsal angulation (°) after operation.
O Dorsal angulation (°) 24 months after operation.
P Axial compression (mm) before operation.
Q Axial compression (mm) after operation.
R Axial compression (mm) 24 months after operation.
S Time in months when the patient was free from pain.
T Time in months when the patient was satisfied with the appearance of the wrist.
U Function: 1 Excellent, 2 Good, 3 Fair, 4 Poor.

Values C – L are percentage of the unfractured wrist.

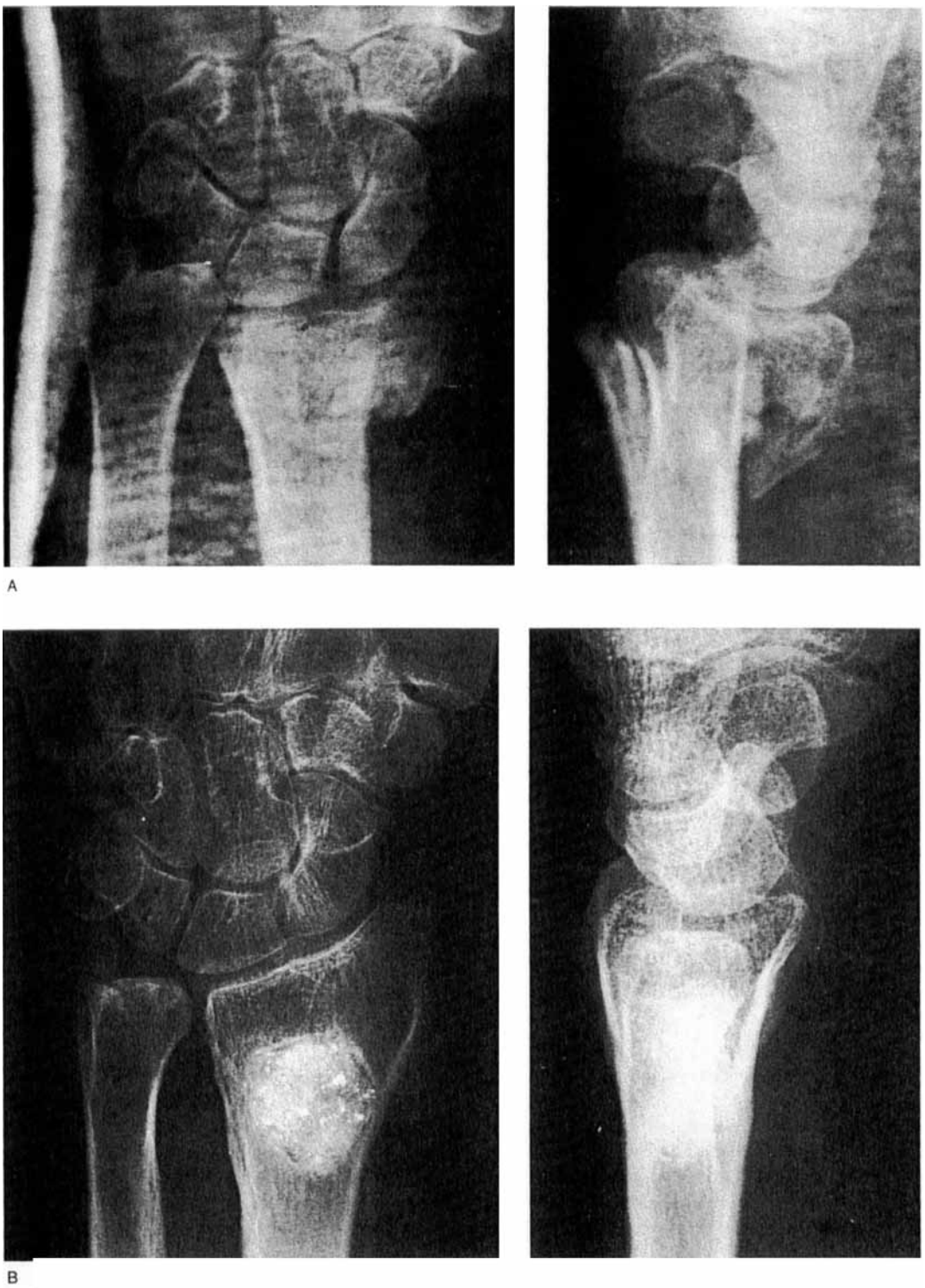

Figure 1. A 61-year-old woman (Case 20) with a Frykmann (1967) Type II fracture. Open reduction with cement, stabilization was performed after two failed attempts at closed reduction.
A. Immediately before the operation, dorsal angle 35° and axial compression 8 mm.
B. Two years after operation, the dorsal angle was 5° and the axial compression 1 mm unchanged since operation. The function was good.

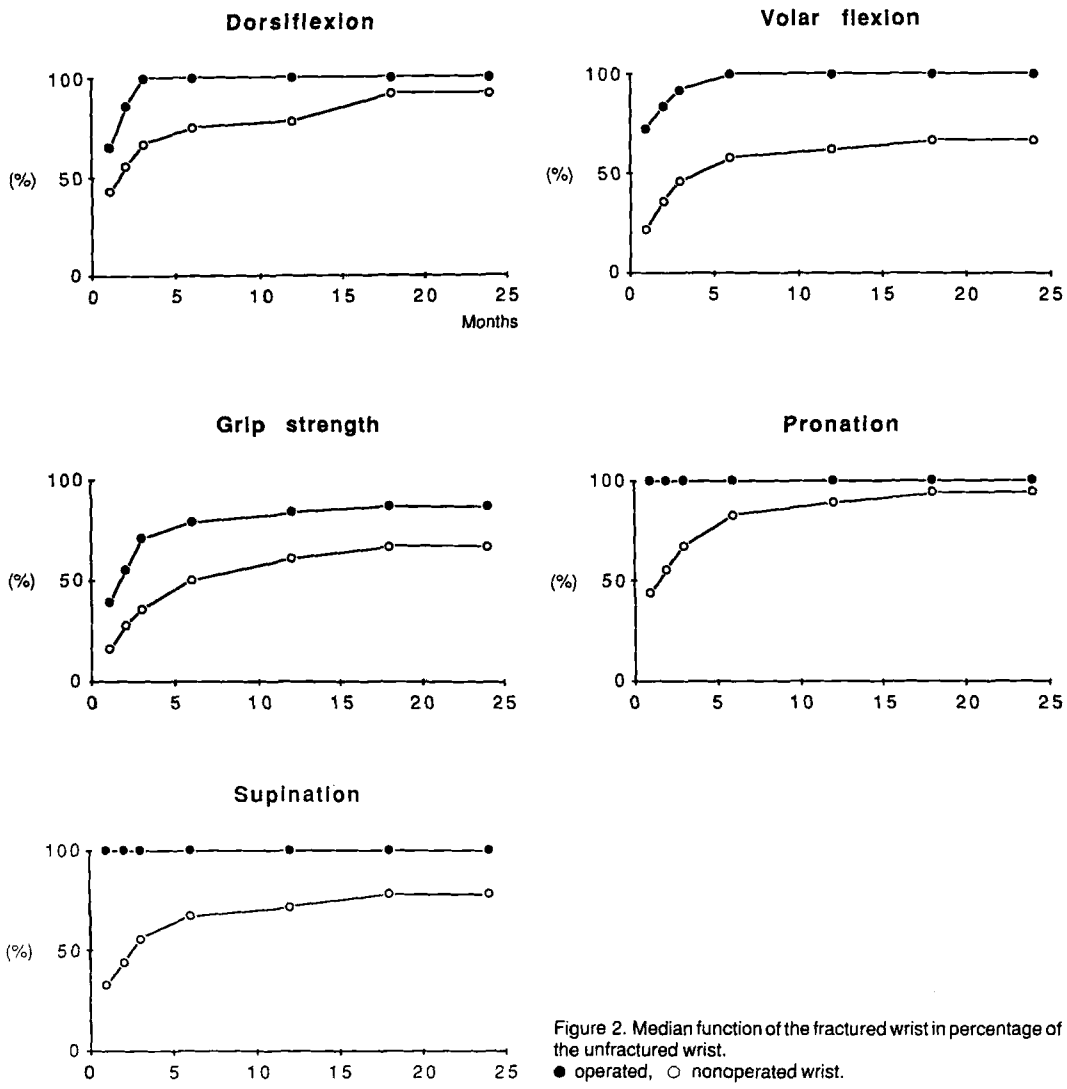

Figure 2. Median function of the fractured wrist in percentage of the unfractured wrist.
● operated, ○ nonoperated wrist.

Discussion

It has been claimed that bone cement prevents healing of fractures (Hubbard 1980). In his 3 cases, Charnley found that the cement did not become surrounded by cortical bone even though the fracture had healed clinically. In the present investigation, however, not only was the position achieved at operation maintained, but also the bone cement was surrounded by cortical bone in all the cases (Figure 1).

The operations were performed 14–24 days after the trauma. It proved more difficult to achieve reduction in the later part of the period; it is therefore preferable to operate early.

Another method is to fill the dorsal deficiency with a bone graft. This, however, is a bigger operation, which probably demands more stable fixation than a dorsal plaster cast. The patient could also have postoperative pain from the donor site.

Good results have been reported by the transfixation with Kirchner wires and plaster cast immobilization (Greene 1979). According to our experience, patients find this treatment troublesome. When the present investigation started, only a few results of external fixation had been published (Cooney et al. 1979); and at that time, another closed rereduction was usually preferred at our department. Cementation was therefore compared with this treatment.

Today, several series with good results of external fixation have been described (Johnson 1983, Vaughan et al. 1987). The method has mainly been used for comminuted and intraarticular fractures (Cooney et al. 1979, Johnsson 1983) and not on the common types of fracture as in the present study. The fixation time is long, 4-10 weeks (Jenkins 1987, Cooney et al. 1979), which is disadvantageous. External fixation is also attended by complications including infection, pin loosening, fracture of the radius through the pin site, and nerve injury (Cooney et al. 1979, Jenkins et al. 1987).

The results of operation in the present series were far better than those of closed reduction. This is perhaps not surprising, because closed reduction had failed twice. Attention should instead focus on the good function, the short rehabilitation, and the few complications.

Our experience with cement in a few comminuted and intraarticular fractures was poor, which was in contrast to Kofoed's (1983) experience with 4 cases. Such fractures should probably be transfixed, and cementing reserved for fractures that are not comminuted or intraarticular. With concomitant fracture of the distal ulna, cementing will probably not give stable fixation.

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