

External fixation or a cast for Colles' fracture

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Function and radiographic position were evaluated 2.5 years after a displaced distal radial fracture had been reduced and treated by external fixation in 40 patients as compared with immobilization in a below-the-elbow cast in 91 patients. Wrist function was better after external fixation associated with less residual displacement. The frequency of arthrosis was the same in both series. The rate of complications after external fixation was higher than after immobilization in a plaster cast, notably sensory disturbances in the thumb. This complication can probably be eliminated by modifying the surgical technique.

I have compared external fixation and cast immobilization in the treatment of displaced distal radial fracture.

Patients and methods

From September 1984 through May 1985, 45 consecutive patients with displaced distal radial fractures were treated by external fixation. Only fractures of Older's Types 2, 3, and 4 were included, excluding undisplaced fractures of Type 1 (Older et al. 1965, Solgaard 1985).

The mini-Hoffmann external fixator with three parallel, 3-mm threaded pins were inserted through stab wounds in the distal radius 4 cm proximal to the fracture, and two additional pins were inserted in the second metacarpal. All the pins were inserted in a 45° dorso-radial angle to the interosseous plane. No predrilling or soft-tissue protection was used. After reduction in Chinese finger traps, a single bar was mounted. The patients were discharged from the hospital after a median of 3 (1-14) days. The fixator was removed after 5 weeks, and was replaced by a dorsal plaster slab for 1 additional week.

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All the patients were examined at 3, 6, and 12 months, and were followed up after a median of 29 (26-32) months. At this time, 3 patients had died and 2 refused to participate, leaving 40 patients (7 men, 33 women) for follow-up. Their median age was 59 (27-82) years. The residual dorsal angulation, the length of the radial styloid distal to the ulna, and the occurrence of arthrosis (Lidström 1959) were recorded radiographically. Function was evaluated using a scoring system (Table 1).

For comparison of the radiographic and functional results, a series of patients, previously published (Solgaard 1988) was used. Ninety-one patients (18 men and 73 women) had fractures of Older's types 2, 3, and 4. Their median age was 63 (23-86) years, and the follow-up time was 42 (31-54) months. The patients had been treated by reduction under local anesthesia, followed by immobilization in a below-the-elbow cast for 4-6 weeks. No fractures had been reduced more than once.

The statistical analysis was performed using graphic models for multidimensional contingency tables (Edwards and Kreiner 1983) to describe relations between the variables of the study. The model is represented by an interaction graph (Figure 1), and is a mathematical model from which properties of the statistical and probabilistic model, important for the analysis and the interpretation of results, can be derived. The statistical tests, used in the course of the analysis, were the standard chi-square and likelihood ratio statistics, always considered when analyzing multi-dimensional tables; and when ordinal variables were

Table 1. Function score system modified after Gartland and Werley (1951)

		Points
Deformity	Prominent ulnar styloid	1
	Radial deviation	1-2
	Dinner fork deformity	1-3
	Maximum	6
Subjective evaluation	No pain, no limitation of motion	0
	Occasional pain, some limitation of motion, weakness	4
	Pain, limitation of motion, activities restricted	6
	Maximum	6
Range of motion	Limitation of motion <20 percent	0
	Limitation of motion <50 percent	2
	Limitation of motion >50 percent	6
	Stiffness of wrist	6
	Maximum	6
Grip strength	Normal (within ± 2 SD)	0
	Within 2-4 SD	2
	Within 4-6 SD	4
	Less than 6 SD	6
	Maximum	6
Complications	None or minimal	0
	Slight crepitation	1-2
	Severe crepitation	3-4
	Median nerve compression	1-3
	Pulp-palm distance < 1 cm	3
	Pulp-palm distance > 2 cm	5
	Pain in distal radioulnar joint	1-3
	Maximum	15
Total score	Excellent	0-2
	Good	3-7
	Fair	8-18
	Poor	19-39

considered, the Goodman-Kruskall gamma (marginal and partial) test was used, which is known to have much greater power against ordinal alternatives than the chi-square test (Kreiner 1986, 1987).

Results

Complications

Three patients treated by external fixation developed superficial infection around one, two, and three of the proximal pins, respectively (Table 2). In 2 cases, premature removal of the fixator was required, and 1 additional patient with osteitis in one of the pin holes in the second metacarpal was treated by curettage and with antibiotics. None of the patients had late sequelae, and the infections did not seem to influence the results.

In 12 cases, sensory disturbances from the cutaneous branch of the superficial radial nerve occurred, and 8 patients still had symptoms at follow-up. The symptoms were slight; 5 patients had not noticed any sensory disturbance.

The rate of other complications was similar in the two series. One patient, treated by cast required transection of the transverse carpal ligament; none of the patients with rupture of the extensor tendon of the thumb were treated.

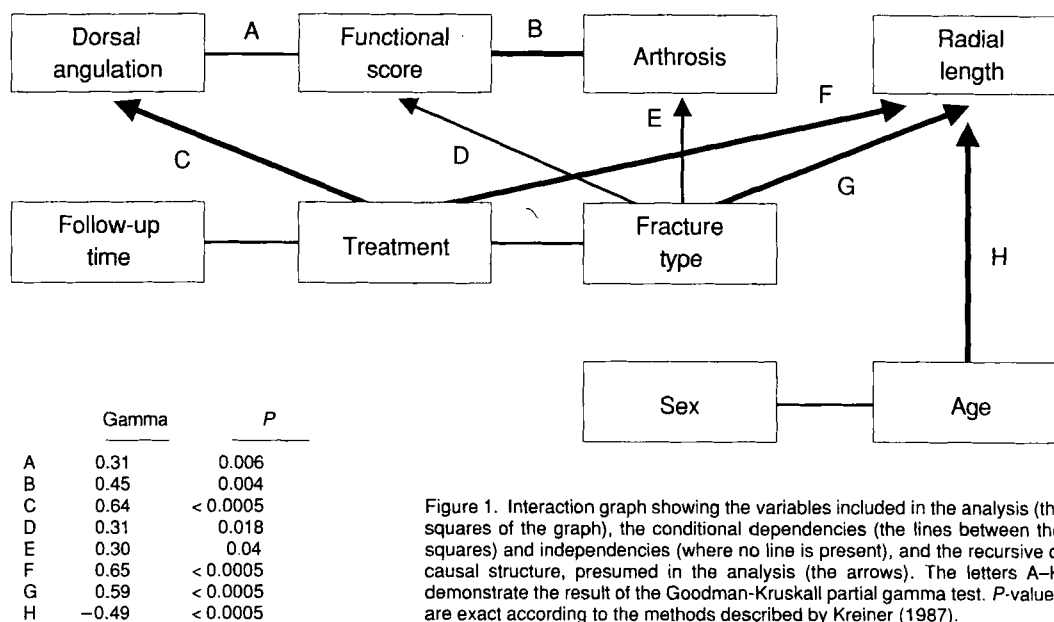


Figure 1. Interaction graph showing the variables included in the analysis (the squares of the graph), the conditional dependencies (the lines between the squares) and independencies (where no line is present), and the recursive or causal structure, presumed in the analysis (the arrows). The letters A-H demonstrate the result of the Goodman-Kruskall partial gamma test. P-values are exact according to the methods described by Kreiner (1987).

Table 2. Complications in 131 patients with displaced distal radial fractures treated by external fixation or low plaster cast

	External fixation n 40	Cast n 91
Infection	4	0
Late cutaneous radial nerve problems	8	0
Shoulder-hand syndrome	3	6
Median nerve compression	3	5
Tendon rupture	1	1
Darrach's procedure	0	1

Table 3. Function score in 40 patients treated by external fixation. Median (range)

Older Type	Months follow-up			
	3	6	12	29
2	8 (3-19)	4 (0-17)	2 (0-7)	1 (0-11)
3	7 (1-18)	4 (0-17)	1 (0-11)	3 (0-12)
4	9 (3-18)	7 (0-17)	4 (0-10)	3 (0-7)

Function and residual displacement

Function after external fixation reached a stationary level after 1 year (Table 3).

In Table 4 the results after external fixation are compared with the results after treatment with a low cast.

The radial length and the dorsal angulation at follow-up were directly related to the treatment (Figure 1). The functional score was indirectly (through the mediating effect on dorsal angulation) affected by the treatment. The fracture types and follow-up times were differently distributed in the two series, but the analysis showed that only the fracture type could have a "confounding" effect, disturbing the hypothesized effect of treatment on the functional score. The fracture type also influenced the score, both directly and indirectly through arthrosis.

No evidence against conditional independence of treatment and functional score was found (chi-square = 27.16, $P = 0.13$; partial gamma 0.016, $P = 0.49$).

External fixation gave a better radiographic result than cast immobilization, and function was also improved after external fixation by eliminating residual dorsal angulation (Table 4). Function was, however, also influenced by the initial displacement of the fracture, i.e., the fracture type, and the occurrence of arthrosis (Table 5).

Table 4. Radiographic and functional evaluation of 40 patients treated by external fixation (E) and 91 patients treated with a cast (C). Dorsal angulation given in degrees, radial length in mm. Median (range)

		Type 2	Type 3	Type 4
Fracture type	EF	8	15	17
	C	50	22	19
Dorsal angulation	initially	E 29 (0-40)	30 (12-45)	30 (0-55)
		C 16 (7-45)	20 (7-60)	28 (0-45)
	after	E -13 (-19-0)	0 (-15-20)	0 (-11-6)
	reduction	C 0 (-10-35)	4 (-12-22)	3 (-18-21)
	follow-up	E -5 (-8-17)	-7 (-12-32)	0 (-15-25)
		C 10 (-13-40)	10 (-10-35)	14 (-8-40)
Radial length	initially	E 8 (6-10)	4 (0-11)	-1 (-15-0)
		C 7 (4-12)	3 (2-9)	-2 (-12-3)
	after	E 13 (10-15)	11 (8-17)	11 (5-16)
	reduction	C 10 (6-18)	9 (2-13)	8 (3-14)
	follow-up	E 11 (5-22)	10 (6-12)	8 (3-15)
		C 7 (1-14)	3 (-5-13)	4 (-4-11)
Arthrosis	E	3/8	5/15	6/17
	C	10/50	6/22	9/19
Function score	E	1 (0-11)	3 (0-12)	3 (0-7)
	C	2 (0-12)	3 (0-10)	5 (1-18)

Discussion

When evaluating the result of treatment of distal radial fractures, it is necessary to classify the fractures in order to obtain comparable conclusions (Lidström 1959, Frykman 1967, de Bruijn 1987, Kongsholm 1987, Solgaard 1988); and in the present two series, all the fractures were classified. The different distributions of the various fracture types and follow-up times were eliminated by the statistical method. The graphic models used in the present analysis constituted a subset of the well-known class of log-linear models for contingency tables (Bishop et al. 1975), but the method can eliminate the confounding effect of the different variables, and is thus more valid. The analysis demonstrated a direct relationship between the radiographic results and the choice of treatment, but only the dorsal angulation influenced function directly. Van der Linden and Ericson (1981) and Rubinovich and Rennie (1983) also stressed the importance of the residual dorsal angulation. The long-time function in the present series, however, was not only influenced by the radiographic result. The importance of the initial displacement, i.e., the fracture type, was also confirmed (de Bruijn 1987).

As demonstrated by Villar et al. (1987), the length of the radial styloid had no direct effect on function, but had an indirect influence through the close correlation with the dorsal angulation (Solgaard 1985, 1988). The

Table 5. Observations in 131 cases of Colles' fracture

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	2	49	2	28	EF	2	0	2	0	0	0	27	-10	-7	6	12	12	O	67	2	65	2	47	C	6	2	2	0	2	0	10	10	11	11	11	13	O
2	3	62	2	29	EF	8	0	2	0	4	2	30	-4	7	4	14	10	L	68	2	75	2	38	C	1	1	0	0	0	0	17	17	23	7	7	5	O
3	3	66	2	29	EF	4	0	2	0	2	0	12	-4	-6	4	8	7	O	69	2	56	2	40	C	0	0	0	0	0	0	45	3	0	9	14	10	M
4	4	82	2	28	EF	5	1	2	0	2	0	55	0	25	0	5	8	L	70	2	50	2	48	C	2	0	2	0	0	0	13	-7	5	11	12	11	O
5	4	51	2	32	EF	2	1	0	0	0	1	47	6	20	0	12	4	O	71	2	56	2	50	C	0	0	0	0	0	0	10	10	10	12	12	10	O
6	4	76	2	29	EF	5	1	2	0	0	2	24	0	5	0	11	10	L	72	2	67	2	45	C	1	1	0	0	0	0	20	9	22	10	18	6	O
7	3	55	1	29	EF	10	3	4	0	2	1	33	5	32	6	11	10	L	73	2	52	2	49	C	1	1	0	0	0	0	8	-5	7	12	13	9	O
8	3	47	2	28	EF	3	0	2	0	0	1	30	4	-7	6	12	12	L	74	2	41	1	41	C	4	1	2	0	0	1	18	0	-2	12	16	13	O
9	2	44	2	29	EF	2	0	2	0	0	0	31	-19	0	7	14	11	L	75	2	60	2	39	C	0	0	0	0	0	0	16	16	16	8	8	12	L
10	3	42	2	28	EF	3	0	2	0	0	1	25	-8	-7	3	9	8	O	76	2	60	1	50	C	3	1	2	0	0	0	18	-6	23	8	9	6	L
11	2	71	2	32	EF	1	1	0	0	0	0	35	3	-8	10	13	12	O	77	2	52	2	44	C	0	0	0	0	0	0	11	-9	-6	8	8	10	O
12	3	66	2	28	EF	0	0	0	0	0	0	27	-10	-10	3	17	13	O	78	2	53	2	49	C	4	2	2	0	0	0	20	4	0	8	10	8	L
13	2	48	1	31	EF	0	0	0	0	0	0	40	0	5	9	15	12	O	79	2	79	1	51	C	5	2	0	2	0	1	30	6	35	12	16	11	O
14	2	49	2	30	EF	12	0	4	2	2	4	40	0	2	0	15	6	O	80	2	78	1	43	C	1	1	0	0	0	0	16	-3	12	8	11	8	L
15	3	79	2	29	EF	3	0	2	0	0	1	30	0	-10	1	9	10	L	81	2	68	2	38	C	10	3	2	2	0	3	15	15	23	6	7	5	L
16	4	57	2	29	EF	0	0	0	0	0	0	30	-4	-10	2	11	11	O	82	2	31	2	38	C	4	1	2	0	0	1	10	10	13	5	5	4	O
17	4	79	2	29	EF	3	1	2	0	0	0	30	-6	8	0	7	5	O	83	2	40	2	42	C	4	1	2	0	0	1	20	8	20	8	11	5	O
18	3	67	2	29	EF	0	0	0	0	0	0	22	-15	-10	4	11	10	O	84	2	51	1	39	C	12	1	4	2	4	1	17	7	-13	5	7	6	O
19	4	55	2	29	EF	0	0	0	0	0	0	40	-11	-10	-2	11	10	O	85	2	41	2	40	C	1	0	0	0	0	1	8	8	12	12	12	11	O
20	4	45	2	28	EF	1	1	0	0	0	0	55	6	-6	-5	9	8	O	86	2	62	2	48	C	1	1	0	0	0	0	20	-18	10	7	10	6	O
21	3	57	1	28	EF	11	3	2	2	0	2	40	20	16	4	11	6	L	87	2	77	2	35	C	1	0	0	0	0	0	12	18	7	7	5	O	
22	3	27	1	29	EF	2	1	0	0	2	0	30	5	4	4	8	9	O	88	2	45	2	42	C	10	2	4	2	2	0	35	10	40	7	10	7	L
23	4	63	2	29	EF	4	1	2	0	0	1	30	-5	4	-6	8	4	M	89	2	58	1	54	C	4	2	2	0	0	0	25	6	-13	7	12	1	O
24	3	79	2	31	EF	1	0	0	0	0	1	40	-6	-9	7	12	12	L	90	2	63	2	44	C	12	4	4	0	4	0	32	10	30	10	9	9	O
25	4	57	2	31	EF	3	1	2	0	0	0	30	0	5	0	16	15	O	91	3	85	2	35	C	1	1	0	0	0	0	30	10	0	4	8	4	O
26	4	57	2	32	EF	0	0	0	0	0	0	40	-9	6	10	12	2	L	92	3	41	2	39	C	7	1	4	0	2	0	40	15	20	3	12	8	O
27	3	68	2	30	EF	2	0	2	0	0	0	27	-10	-12	3	17	10	O	93	3	43	1	42	C	9	2	4	0	2	1	25	4	3	9	11	7	O
28	2	55	2	30	EF	1	1	0	0	0	0	0	-16	17	7	13	5	O	94	3	72	2	46	C	3	2	0	0	0	1	7	-9	-10	2	10	-5	O
29	4	64	2	29	EF	0	0	0	0	0	0	0	-17	-14	0	13	10	O	95	3	40	1	38	C	0	0	0	0	0	0	28	-3	-6	2	13	7	O
30	3	45	1	30	EF	0	0	0	0	0	0	40	8	-12	5	14	12	O	96	3	65	2	47	C	2	2	0	0	0	0	60	8	26	5	4	-2	O
31	4	53	1	30	EF	5	1	2	0	0	2	30	0	14	0	13	9	M	97	3	59	2	47	C	10	3	4	2	0	1	15	10	20	4	7	0	L
32	4	80	2	28	EF	5	1	0	0	0	2	14	0	-15	-3	11	10	L	98	3	68	2	48	C	9	4	2	2	0	1	35	7	35	5	9	3	O
33	2	60	2	30	EF	6	2	4	0	0	0	0	-16	2	7	13	10	O	99	3	66	2	48	C	4	2	2	0	0	0	13	-6	-3	4	10	-5	O
34	4	45	1	30	EF	7	3	4	0	0	0	30	0	4	-5	9	3	O	100	3	68	2	43	C	4	2	2	0	0	0	34	1	0	2	5	3	O
35	2	82	2	29	EF	1	1	0	0	0	0	17	-13	-6	7	14	9	L	101	3	61	2	38	C	2	0	2	0	0	0	13	4	5	4	8	1	O
36	3	59	2	31	EF	0	0	0	0	0	0	40	3	-2	4	8	10	O	102	3	71	2	41	C	1	0	0	0	0	0	30	12	10	4	7	0	O
37	4	43	2	26	EF	7	1	4	0	0	2	37	-7	-13	0	9	6	O	103	3	64	2	48	C	7	2	2	0	2	1	15	15	15	2	2	4	O
38	2	68	2	30	EF	11	3	4	0	2	2	30	-15	-5	10	13	22	M	104	3	69	2	44	C	3	1	1	0	0	1	10	-12	0	5	14	7	O
39	4	77	2	30	EF	3	3	0	0	0	0	0	0	-15	10	4	O	105	3	60	2	48	C	6	3	2	0	0	1	20	4	5	3	5	4	O	
40	4	57	2	31	EF	3	1	2	0	0	0	54	-11	-9	-5	11	6	O	106	3	68	2	48	C	1	0	0	0	0	0	20	3	7	2	15	13	L
41	2	66	2	34	C	3	0	2	0	0	1	9	-3	11	6	7	7	O	107	3	58	2	44	C	1	1	0	0	0	0	10	3	14	3	5	3	O
42	2	34	2	42	C	2	1	0	0	0	1	35	-6	25	7	13	8	O	108	3	64	1	47	C	5	2	0	0	2	1	12	22	23	6	6	3	O
43	2	48	1	41	C	2	0	0	0	0	2	20	10	15	9	8	8	O	109	3	56	2	36	C	0	0	0	0	0	0	30	3	11	3	4	1	M
44	2	49	2	39	C	3	0	1	0	2	0	12	0	0	12	14	11	O	110	3	71	2	42	C	8	1	4	0	2	1	30	12	22	4	11	4	O
45	2	66	1	36	C	8	1	4	0	0	0	35	10	13	7	7	7	L	111	3	74	2	44	C	3	1	2	0	0	0	16	0	25	3	9	3	O
46	2	47	1	36	C	3	1	1	0	0	1	20	-7	0	11	13	8	O	112	3	50	1	43	C	5	2	2	0	0	1	35	7	28	3	10	2	L
47	2	63	2	41	C	2	0	2	0	0	0	10	6	10	10	6	8	O	113	4	85	2	43	C	6	1	2	0	0	0	3	30	4	-10	4	0	O
48	2	78	2	38	C	2	1	1	0	0	0	23	0	6	7	12	8	O	114	4	69	2	36	C	1	1	0	0	0	0	35	7	14	0	8	6	O
49	2	48	2	39	C	1	0	1	0	0	0	12	-10	0	6	7	7	O	115	4	56	2	40	C	4	3	0	0	0	1	25	7	18	-2	9	3	O
50	2	75	2	38	C	0	0	0	0	0	0	15	10	8	6	6	5	O	116	4	42	2	44	C													

choice of treatment had no direct effect on the function, but external fixation eliminated the negative effect of residual dorsal angulation (Figure 1).

Theoretically, a better radiographic result should prevent the occurrence of arthrosis, but this could not be demonstrated in this study. Arthrosis was closely correlated with the fracture type; and contrary to what has been found by Lidström (1959), arthrosis influenced the function of the wrist.

External fixation is costly because of the necessity of hospitalization, and also more complications occur. Infection occurred in a similar number of cases as reported by Forgon and Mammel (1981), Cooney (1983), Vaughan et al. (1985), and Kongsholm (1987). Another complication specific for external fixation was the damage to the cutaneous branch of the superfi-

cial radial nerve, which occurred in one fourth of the patients; at follow-up, one fifth of the patients still had decreased 2-point discrimination on the dorsal aspect of the thumb and index fingers. Five patients had not noticed this, which perhaps could account for the lower rate of this complication in other studies (Vaughan et al. 1985, Foster and Kopta 1986, Kongsholm 1987). This complication can probably be avoided by using blunt dissection and soft-tissue protection when inserting the pins in the distal radius. Kongsholm (1987) has advocated a more proximal position of the pins in the radius and surgical exposure of the bone in order to avoid nerve damage.

We conclude that external fixation of distal radial fractures is justified in severely displaced fractures of Older's Types 3 and 4.

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