FUNCTIONAL CAST-BRACING FOR COLLES' FRACTURES

A COMPARISON BETWEEN CAST-BRACING AND CONVENTIONAL PLASTER CASTS

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The use of Orthoplast cast-bracing to allow early hand function in the treatment of displaced Colles' fractures was investigated in 243 patients. They were randomly allocated into three groups: in the first a conventional Colles' type plaster was used; in the second an above-elbow cast-brace with the forearm in supination; and in the third a below-elbow cast-brace. Radiographic measurements were made at each stage of treatment, and the final anatomical result was scored using Sarmiento's (1975) criteria. Function was assessed at three months and at six months.

The anatomical result was not influenced by the method of immobilisation but was related to the efficacy of reduction. Loss of position in the braces was no greater than in plaster. The functional result at three months also was uninfluenced by the method of immobilisation; it was, however, related to the severity of the initial displacement, and (to a lesser degree) to the anatomical result, an effect which was lost at six months.

Early hand function and the supinated position advocated by Sarmiento were found to confer no anatomical or functional advantage; we could see no reason to change from the use of conventional plaster casts in the treatment of uncomplicated Colles' fractures.

The long-term functional results of the treatment of Colles' fractures are agreed to be satisfactory, but the short-term results are less so (Cassebaum 1950; Mason 1953; Charnley 1961; Smaill 1965; Sarmiento, Zagorski and Sinclair 1980). Poor short-term results are more common after fractures with comminution of the distal articular surface (Gartland and Werley 1951; Spira and Weigl 1969).

Functional cast-bracing of tibial and femoral fractures permitting active joint movement during healing has been shown to reduce stiffness and osteoporosis after union (Sarmiento 1970, 1972). An analogous method of treatment for Colles' fractures has been developed by Sarmiento *et al.* (1975), who reported improved early results after displaced fractures. His supinated brace was developed on the theoretical ground that the brachioradialis muscle is a major deforming force and is relaxed in supination (Sarmiento 1965). In a review of 93 displaced fractures, Sarmiento *et al.* (1980) reported that better anatomical end-results were obtained by treatment in supination than in pronation; however, they reported

no difference in early functional results between the two treatments.

The present study was designed with two main aims. First, to investigate the effect of cast-bracing on early functional results and, secondly, to investigate Sarmiento's claim that supination improves the anatomical result and hence the functional outcome.

MATERIALS AND METHODS

The study included 243 patients with displaced Colles' fractures who presented consecutively at the Derbyshire Royal Infirmary between September 1981 and October 1982. There were 36 men and 207 women; their ages ranged from 18 to 86 years, with a mean of 60.2 years.

Initial treatment was in the Accident and Emergency Department, where 193 of the 243 fractures required reduction, 179 under intravenous regional analgesia (Bier's block), 10 with sedation and four under general anaesthesia. Every fracture was then splinted in a below-elbow radiodorsal plaster slab, with the wrist in slight flexion and ulnar deviation. Eleven fractures which displaced were remanipulated early, before allocation to a treatment group. Early movement of the shoulder and fingers was encouraged.

Within one week of injury the patients were allocated to one of the three treatment groups on the basis of their month of birth. *Group I* consisted of patients with birthdays from January to April; these were managed in standard below-elbow plaster casts. *Group II* consisted of those with birthdays from May to August; these had above-elbow cast-bracing in supination. *Group III* con-

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Fig. 1

Fig. 2

Fig. 3

Orthoplast cast-braces. Note the freedom of movement of the hand and the fingers. Figure 1—The supinated above-elbow cast-brace (Group II). Figure 2—The below-elbow cast-brace (Group III). Figure 3—The distal hood of both cast-braces, preventing extension at the wrist.

sisted of patients with birthdays from September to December; these were managed in below-elbow cast-bracing.

The three groups were shown to be indistinguishable statistically for mean age, sex incidence, wrist dominance, intra-articular involvement, and severity of fracture. Eight patients were lost to follow-up before treatment was completed, leaving 235 at that stage; 215 patients were available for review at three months and 209 at six months.

Splintage. The two designs of "custom-made" Orthoplast cast-brace are illustrated in Figures 1, 2 and 3. The possible extent of wrist flexion is demonstrated, as is the distal dorsal hood which prevents extension of the wrist.

The above-elbow extension used in Group II patients holds the forearm in supination, but allows elbow flexion.

The average interval between fracture and the application of the cast-brace was 9.7 days for the above-elbow supinated brace, and 9.4 days for the below-elbow brace. Despite the lack of special precautions to prevent displacement of the fracture, check radiographs showed that this did not occur during transfer from plaster slab to cast-brace. All splintage was removed at six weeks. Physiotherapy was requested only if finger or wrist stiffness was excessive two weeks after release.

Table I. Assessment of anatomical result (modified from Sarmiento *et al.* 1980)

Final dorsal angle (degrees)	*Loss of radial length (mm)	*Loss of radial angle (degrees)	Score for each measurement
Neutral	Under 3	0-4	0
1-10	3-6	5-9	1
11-14	7-11	10-14	2
≥ 15	≥ 12	≥ 15	4

Anatomical grade obtained by addition of the three scores for each result: excellent 0; good 1-3; fair 4-6; and poor 7-12

* Difference between control and final radiographs; if the control side had suffered previous fracture, an average value was used

Table II. Assessment of functional result

A. Subjective complaints

Pain	Limitation of movement	Disability	Restriction of activity	Result and score
None	None	None	None	Excellent 0
Occasional	Slight	None	None	Good 2
Occasional	Slight	None if careful	Present	Fair 4
Often	Present	Present	Marked	Poor 6

B. Objective evaluation

Movement	Range	Score
Dorsiflexion	Less than 45°	5
Palmar flexion	Less than 30°	1
Ulnar deviation	Less than 25°	3
Radial deviation	Less than 15°	1
Supination	Less than 50°	2
Pronation	Less than 50°	2
Circumduction	Loss	1
Finger flexion	Not to distal crease	1-2
Grip	Loss of strength	1

C. Median nerve compression: mild 1; moderate 2; severe 3

Functional grade from totals of A, B and C: excellent 0-2; good 3-8; fair 9-14; poor ≥ 15

Fig. 4

Fig. 5

Radiographs showing the measurements used for assessing the anatomical result. Figure 4—Anteroposterior radiograph of normal (control) wrist. Figure 5—Lateral view showing normal volar tilt. When this angle is reversed after a Colles' fracture it has been described in the text and tables as the "dorsal angle".

Anatomical assessment. This was based on a radiograph of the normal wrist (the control film) and serial radiographs of the injured wrist taken at four stages of management: at fracture; after reduction; after transfer from plaster slab to definitive splint; and after removal of splintage at six weeks (the final film). Values for the dorsal angle, the radial length and the radial angle were obtained using the lines shown in Figures 4 and 5. Table I shows the scoring system used to grade the anatomical result, which is based on the modification by Sarmiento *et al.* (1980) of the scheme devised by Lidström (1959).

Functional assessment. Clinical interview and examination were performed at three months, and again at six months after fracture, by a consultant hand surgeon (FDB) who had no knowledge of which method of treatment had been used. Subjective and objective criteria were scored on a points system based on the adaptation by Sarmiento *et al.* (1975) of the system of Gartland and Werley (1951). The criteria used to grade the functional result are shown in Table II.

RESULTS

The anatomical scores at six weeks ranged from 0 to 10; the mean scores and grades are shown in Table III. There was no statistically significant difference between the scores of the three treatment groups, nor between the

incidence of excellent and good grades and of fair and poor grades in each of these groups.

The severity of fracture, the type of fracture, and the age of the patient were found to have no influence on the anatomical result. The efficacy of reduction did have an effect. Sixty-seven fractures were well-reduced to a position which, without change, would score an excellent anatomical result. The mean anatomical score of these (2.35), was significantly better than that for all other fractures (3.74), ($P < 0.001$). Measurements for collapse of the fracture between reduction and final radiograph are shown in Table IV, and reveal no significant difference between the groups.

Table IV. Mean loss of measured anatomical position between reduction and removal of splintage

Group	Number	Dorsal angle (degrees)	Radial length (mm)	Radial angle (degrees)
I (Plaster)	93	9.9	1.8	1.7
II (Supinated brace)	70	7.2	2.1	2.3
III (Short brace)	72	6.7	1.5	2.2

The mean functional scores for the three groups are shown in Table V. There was no significant difference between the mean scores of each of the groups at either three months or at six months, nor between the scores of fractures with or without intra-articular involvement.

Table III. Results of anatomical assessment, by score and grade (see Table I)

Group	Number	*Mean score	Number of fractures			
			Excellent	Good	Fair	Poor
I (Plaster)	93 <i>31</i>	3.58 <i>3.64</i>	8 <i>2</i>	37 <i>13</i>	40 <i>13</i>	8 <i>3</i>
II (Supinated brace)	70 <i>26</i>	3.22 <i>3.50</i>	9 <i>2</i>	34 <i>14</i>	23 <i>6</i>	4 <i>2</i>
III (Short brace)	72 <i>16</i>	3.19 <i>2.93</i>	4 <i>0</i>	39 <i>11</i>	22 <i>5</i>	7 <i>0</i>

Figures in *italics* refer to fractures which involved the joint

*The differences in mean scores between Group I and Group III were NOT significant ($P > 0.1$; *t* test) in either column

Taking each objective functional test separately, there was no statistically significant correlation between loss of movement and any one treatment group. In particular, early finger function was no better in either of the groups with cast-bracing than it was in the group treated in plaster. Seventeen of 84 patients who had plaster showed poor finger flexion at three months compared with 13 of 64 patients who had the supinated above-elbow brace, and 6 of 67 patients who had the short below-elbow brace. The differences in these results were not statistically significant ($P > 0.05$).

Table V. Functional results recorded as mean scores at 3 months and at 6 months after fracture

Group	At three months		At six months	
	Number	*Mean score	Number	Mean score
I (Plaster)	84	10.0	83	6.3
II (Supinated brace)	64	9.5	59	6.7
III (Short brace)	67	10.7	67	6.9
All groups	215	10.1	209	6.6

*The difference in mean functional scores between Group II and Group III at three months is not significant ($P > 0.1$)

Fig. 6

The percentage of patients obtaining an excellent or good functional result at three months (open column) and at six months (hatched column) for each of four anatomical grades.

The relation between anatomical and functional results is shown in Figure 6. At three months a better anatomical result correlated with a better functional result, but this trend was only significant when excellent anatomical results were compared with poor ones ($0.05 > P > 0.02$). At six months even this trend had vanished.

Patients with excellent reduction of their fractures did not achieve a significantly better mean functional score at three months (9.77), than all other patients (10.17), ($P > 0.5$). However, the mean functional score at

three months of 49 patients who had initially sustained severe fractures was significantly worse (11.36) than that of the remaining 166 patients with less severe fractures (9.67), ($P > 0.01$); this difference occurred despite the fact that the anatomical results for severe fractures were statistically indistinguishable from those with less severe fractures.

Complications. The incidence of symptoms of carpal tunnel compression was 17% at three months and 12% at six months; there was no statistically significant difference in incidence between the three groups. Eleven patients from the braced groups had symptoms of irritation of the terminal branches of the radial nerve at three months. All but one of these settled by six months. No patient in the plaster group had such symptoms. No patient developed Sudeck's osteodystrophy or shoulder stiffness, but one patient ruptured the tendon of extensor pollicis longus at six months.

Three patients underwent Baldwin's operation, one for pain at the ulnar styloid, and one, who had been treated in a conventional plaster cast, for total loss of supination. The third patient had pain and prominence of the ulnar styloid and had been treated in a below-elbow cast-brace.

The preference of patients for a particular method of management was not specially assessed, but it was noted that younger women did not like the appearance of the supinated brace. Only three patients out of 93 returned with problems arising from plaster casts, compared with 38 visits for problems with the 142 cast-braces. The majority of brace problems were due to pressure over the distal radial border and the head of the ulna, and could be minimised by careful moulding and padding. Two patients had serious sweat rashes necessitating removal of their braces.

DISCUSSION

The conclusion that, with Colles' fractures, the type of definitive splintage used is irrelevant to the final anatomical result is shared by Pool (1973) and by Van der Linden and Ericson (1981), but not by Sarmiento *et al.* (1975, 1980). However, neither of Sarmiento's studies included any patients treated in conventional plaster casts.

Cast-bracing provides less support than a plaster cast; despite this, the anatomical result is no different. Whether even less support would suffice is not known. The only factor found to benefit the anatomical result was complete reduction, and this accords with many previous studies (Green and Gay 1956; Lidström 1959; Pool 1973; Van Der Linden and Ericson 1981). We believe that a good cosmetic result is important and therefore advocate anatomical reduction.

The lack of better early function in patients treated by cast-brace rather than by plaster cast is both surprising and disappointing. This contradicts the views of Sarmiento *et al.* (1975, 1980) and those of Gibson and

Bannister (1983), though neither of Sarmiento's studies involved conventionally treated patients as controls. Furthermore, in Sarmiento's 1980 study the marginal superiority in function, 15 weeks after fracture, of patients treated in supination over patients treated in pronation is not statistically significant. Gibson and Bannister (1983) found that a supinated cast-brace gave better functional results than either a pronated or a supinated plaster cast at nine weeks, but not at 20 weeks; they concluded that the difference was an effect of early movement. Our study does not support this, though the timings of assessment are slightly different.

The finding of some correlation between anatomical and functional results at three months is agreed by other authors (Cassebaum 1950; Lidström 1959; Sarmiento *et al.* 1975, 1980). Our finding that this trend is lost by six months is agreed only by Lidström (1959), who also states that the maximal period of disability after fracture is 3 to 3½ months. Others report that long-term disability is greater in patients with more residual deformity (Bacorn

and Kurtzke 1953; Frykman 1967). The correlation we found between excellent anatomical and functional results was due more to the large number of fractures with excellent positions obtained after minimal initial displacement than to good reductions of badly displaced fractures. It has not previously been shown that the functional result is related more to the severity of displacement of the fracture than to the anatomical result or to the method of immobilisation.

In our view there are four indications for the use of a below-elbow cast brace in the treatment of a displaced Colles' fracture. These are: a request by the patient for complete freedom of movement of the fingers and thumb; pre-existing finger stiffness or painful arthritis of the carpometacarpal joint of the thumb; the possibility that the patient may develop Sudeck's osteodystrophy; and to allow direct access to the hand for dressings in patients with soft-tissue injuries. In other cases there is no indication to change from the use of the traditional plaster cast.

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