Aberdeen Colles' fracture brace as a treatment for Colles' fracture

A MULTICENTRE, PROSPECTIVE, RANDOMISED, CONTROLLED TRIAL

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We carried out a randomised, prospective, multicentre clinical trial of the treatment of Colles' fractures. A total of 339 patients was placed into two groups, those with minimally displaced fractures not requiring manipulation (151 patients) and those with displaced fractures which needed manipulation (188 patients). Treatment was by either a conventional Colles' plaster cast (a control group) or with a prefabricated functional brace (the Aberdeen Colles' fracture brace).

Similar results were obtained in both groups with regard to the reduction and to pain scores but the brace provided better grip strength in the early stages of treatment. This was statistically significant after five weeks for both manipulated and non-manipulated fractures. At the tenth day the results were statistically significant only in manipulated fractures. There was no significant difference in the functional outcome between the two treatment groups. However, younger patients and those with less initial displacement had better functional results.

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The Colles' fracture, one of the commonest fractures in orthopaedic practice, was described by Abraham Colles in

Table I. Number of patients with a Colles' fracture recruited in each of the five centres

Centre	Manipulated plaster cast	Brace	Non- manipulated plaster cast	Brace	Total
I	20	20	21	20	81
II	13	17	6	5	41
III	21	19	18	20	78
IV	20	21	20	19	80
V	20	17	11	11	59
Total	94	94	76	75	339

1814.¹ Its treatment has remained controversial. Various techniques have been used including immobilisation in a cast, functional bracing, external fixation, percutaneous wiring and open reduction and internal fixation.²⁻¹⁴ The morbidity associated with treatment, which includes stiffness and reduced strength and function of the hand and fingers, has led to an increased interest in treatment using a functional brace.^{4,5,7,13-15}

Ledingham et al¹³ reported improved anatomical and early functional results with a plaster brace compared with a Colles' cast for the treatment of displaced fractures. Moir et al¹⁴ compared the clinical results using a prefabricated Aberdeen Colles' fracture brace (Fig. 1) with those with a conventional below-elbow Colles' cast. They showed improved function for up to six months with the brace. This brace maintains reduction of the fracture by applying three-point loading as described by Charnley, while allowing movement at the wrist^{2,13-15} (Fig. 2). We have compared the outcome of the management of Colles' fractures using this brace with that obtained with a conventional plaster cast.

Patients and Methods

Five different trauma centres were involved in this trial and 339 patients with a Colles' fracture who were consecutive in each centre, were recruited (Table I). Only patients over 18 years of age with a fused radial epiphysis, a unilateral Colles' fracture and who had had no previous fractures of the forearm were included. A total of 151 patients had minimally displaced fractures which did not require manipulation and 188 had displaced fractures which needed manipulation. Fractures with a neutral degree or more of

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Fig. 1

The Aberdeen Colles' fracture brace.

Fig. 2

Drawing showing the three-point loading applied by the Aberdeen Colles' fracture brace to maintain reduction of the fracture and allow movement at the carporadial joint.

Table II. The functional scoring method of Gartland and Wersley¹⁶ used to evaluate the two treatments (plaster cast and brace) for Colles' fractures; final scores of 0 to 2 were considered to be excellent, 3 to 8 good, 9 to 14 fair and 15 or more poor

Movement/function	Range (degrees)	Score
Objective evaluation		
Dorsiflexion	<45	5
Palmar flexion	<30	1
Ulnar deviation	<15	3
Radial deviation	<15	1
Supination	<50	2
Pronation	<50	2
Cicumduction	Loss	1
Finger flexion	Not to distal crease	1 to 2
Grip	Loss of strength (<60% normal side)	1
Complications		
Median nerve compression		1 to 3
Other (eg. ulnar nerve compression)		1 to 2

Subjective evaluation

Pain	Limitation of movement	Disability	Restriction of activity	Result	Score
None	None	None	None	Excellent	0
Occasional	Slight	None	None	Good	2
Occasional	Slight	Minor	Some	Fair	4
Often	Present	Definite	Marked	Poor	6

dorsal angulation, more than 3 mm of shortening of the radius, and loss of more than 4° of the radial angle were considered to be displaced, requiring manipulation. For randomisation into treatment groups, we used a random-number-generator computer system. A total of 170 patients was treated by a conventional cast and was the control

Table III. The anatomical scoring method of Bunger et al¹⁷ used to evaluate the two treatments (plaster cast and brace) for Colles' fractures; final scores of 0 were considered to be excellent, 1 to 3 good, 4 to 6 fair and 7 to 12 poor

Dorsal angle (degrees)	Loss of radial length (mm)	Loss of radial angle (degrees)	Score
Neutral	<3	0 to 4	0
1 to 10	3 to 6	5 to 10	1
11 to 14	7 to 11	10 to 14	2
>15	12+	15+	4

group. There were 31 men and 139 women with a mean age of 60.4 years (18 to 98). In 82 patients the dominant and in 88 the non-dominant hand was injured. A total of 169 patients was treated by the Aberdeen brace. There were 37 men and 132 women with a mean age of 58.4 years (19 to 88). In 80 patients the dominant and in 89 the non-dominant hand was injured. Both groups were well matched for age, gender and hand dominance.

Treatment. The patients in the control group had conventional immobilisation in a moulded dorsoradial splint, which was converted to a full cast at seven to ten days after a routine radiological check.

The Aberdeen Colles' fracture brace (Smith & Nephew Ltd, Hull, UK) consists of two pieces of plastic, a larger dorsoradial portion with proximal and distal raised loading areas and a voloulnar portion with one loading area. These two portions are connected by two elasticated Velcro straps. The brace is applied over one layer of stockinette and plaster wool. The Velcro straps are tightened by 3 cm as shown by coloured marks. Studies using intracast pressure meas-

Table IV. The overall functional scores after treatment for a Colles' fracture

	Overall mean functional scores					
	Week 8	p value	Week 12	p value	Week 24	p value
Non-manipulated group						
Plaster cast	6.7		4.8		2.6	
Brace	5.5		3.8		2.7	
Mean difference: cast-brace (95% CI)	0.7 (-0.8 to 2.2)	0.34	0.9 (-0.5 to 2.3)	0.22	-0.2 (-1.3 to 0.9)	0.7
Manipulated group						
Plaster cast	11.4		9.2		5.4	
Brace	10.6		7.8		5.8	
Cast-brace (95% CI)	0.6 (-1.2 to 2.3)	0.52	1.0 (-0.7 to 2.6)	0.26	-0.7 (-2.1 to 0.8)	0.36

Table V. The mean grip strength as a percentage of that of the uninjured hand, after treatment for a Colles' fracture

	Mean grip strength (%)									
	Day 10	p value	Week 5	p value	Week 8	p value	Week 12	p value	Week 24	p value
Non-manipulated group										
Plaster cast	19		40		58		72		87	
Brace	22		52		68		75		82	
Mean difference: cast-brace (95% CI)	4 (-2 to 9)	0.2	11 (4 to 8)	0.003	10 (1 to 18)	0.27	3 (-5 to 11)	0.44	-4 (-12 to 4)	0.3
Manipulated group										
Plaster cast	9		21		42		55		72	
Brace	15		35		46		57		72	
Cast-brace (95% CI)	6 (3 to 9)	<0.001	14 (8 to 19)	<0.001	4 (-2 to 10)	0.23	1 (-5 to 8)	0.64	0 (-6 to 6)	1.0

urements have verified that three-point loading is maintained after reduction of the swelling of the fracture.¹⁵ Radiographs were taken at seven to ten days. If satisfactory, treatment was continued. If manipulation was required, the initial method of treatment was still followed.

Assessment. After application of either the cast or brace, clinical review was undertaken the next day and at seven to ten days. The cast or brace was removed at five to six weeks. A blind, independent, assessment was made at eight, 12 and 24 weeks after injury. Functional assessment was made using a modified Gartland and Werley scoring system¹⁶ (Table II). An anatomical assessment was made initially on the tenth day and at five weeks using the radiological displacement method described by Bunger, Solund and Rasmussen¹⁷ (Table III). Frykman's¹⁸ classification was used to grade the severity of the fracture at presentation. The grip strength of both hands was measured using an electronic dynamometer (MIE Medical Engineering Ltd, Leeds, UK) on the tenth day and at five, eight, 12 and 24 weeks. The relative grip strength of the injured hand was calculated for each patient according to the formula: mean grip strength of injured hand/mean grip strength of uninjured hand x 100. The pain scores were assessed at the same intervals and the mean pain score calculated in both manipulated and non-manipulated groups.

Statistical analysis. Statistical analysis was carried out using the SAS system (version 6.08; SAS Institute Inc, Cary, North Carolina). Data were analysed separately at each time-point for both manipulated and non-manipulated fractures. The mean difference in response between treatments was estimated with 95% confidence intervals (CI).

The method of assessment used was analysis of variance with effects for centre and treatment. In order to assess the effect of the covariates (age, gender, hand dominance and initial displacement of the fracture) the mean score for each patient was calculated as a summary measure. These means were analysed by analysis of variance with centre, treatment, and covariates included in the model.

Results

Of the 339 patients initially entered into the trial, the records for ten were misplaced and were excluded. Of the remaining 329, 166 were treated by the brace and 163 by a traditional plaster cast. Functional scores were higher for manipulated than non-manipulated patients; these scores decreased with time implying that there was an increase in the function of the hand.

At eight and 12 weeks the patients treated by the brace had lower functional scores than those treated by a plaster cast in both the manipulated and non-manipulated groups (Table IV). These differences did not reach statistical significance. At 24 weeks the functional scores were similar in both groups. Age and initial displacement of the fracture had a strong positive relationship with the functional scores in both treatment groups. Thus, young patients and those with less initial displacement of the fracture had better results. Gender and hand dominance had no relationship to the functional outcome.

Patients with manipulated fractures had a lower relative grip strength than those who had not required manipulation. In patients treated by the brace in both manipulated and

Table VI. Mean anatomical score according to Bunger et al¹⁷ after treatment for a Colles' fracture

	Mean anatomical score				
	Day 0	Day 10	p value	Week 5	p value
Non-manipulated group					
Plaster cast	0.8	1.1		1.4	
Brace	0.9	0.8		1.3	
Mean difference: cast-brace (95% CI)	-0.1 (-0.18 to 0.30)	0.3 (-0.04 to 0.64)	0.077	0.1 (-0.21 to 0.62)	0.34
Manipulated group					
Plaster cast	5.0	1.9		2.7	
Brace	4.3	1.6		2.5	
Cast-brace(95% CI)	0.7 (-0.21 to 1.30)	0.2 (-0.06 to 0.58)	0.94	0.2 (-0.24 to 0.62)	0.61

Table VII. Mean pain scores after treatment for a Colles' fracture with 0 defined as no pain, 1 occasional pain on heavy activity, 2 frequent pain on heavy activity, 3 frequent pain on normal activity and 4 frequent pain at rest

	Mean pain score									
	Day 10	p value	Week 5	p value	Week 8	p value	Week 12	p value	Week 24	p value
Non-manipulated group										
Plaster cast	2.2		1.3		1.7		1.4		1.0	
Brace	2.4	0.27	1.7	0.14	1.6	0.46	1.3	0.78	1.0	0.96
Manipulated group										
Plaster cast	1.8		1.1		1.2		0.8		0.5	
Brace	2.1	0.19	0.7	0.067	1.2	0.84	1.0	0.27	0.8	0.043

non-manipulated groups it was higher than in those treated by a cast on the tenth day and at five and eight weeks. It was statistically significant only on the tenth day and at five weeks for manipulated patients, and at five weeks for those not needing manipulation ($p < 0.05$). At 12 weeks the grip strength was the same in both treatment groups (Table V).

For manipulated fractures the mean Frykman classification score at the time of presentation was 3.8 for the group treated by a plaster cast and 4 for those treated by a brace. For non-manipulated fractures it was 2.5 for the plaster cast group and 2.7 for the brace group. The mean anatomical scores were higher in manipulated than in non-manipulated fractures. At the tenth day and at five weeks the anatomical scores for non-manipulated fractures were lower in the brace than in the cast group. Neither of these differences was statistically significant (Table VI).

The pain score was higher for manipulated patients than non-manipulated patients and decreased with time. The scores during the first five weeks for the brace group were higher than those for the plaster cast group. There was, however, no statistically significant difference between both treatments with regard to the mean pain score (Table VII).

Discussion

There has been an increased interest in the use of a functional brace to treat Colles' fractures since the reports by Sarmiento et al^{4,5} which described the maintainance of the reduction of the fracture by a three-point loading brace over the fractured radius while allowing movement at the wrist. The reported efficacy of this treatment varies. Bunger et al¹⁷ found no difference in the functional outcome after

treatment in a plaster cast, a functional brace, and external fixation at three and six months, although the anatomical results were better after external fixation. Ledingham et al¹³ reported good early functional results and a better radiological appearance with a plaster functional brace when compared with conventional treatment in a cast. Moir et al^{14,15} reported good early functional results using the Aberdeen Colles' fracture brace.

Some investigators have reported improved function with a functional brace in supination while others have found no benefit over conventional treatment.^{4,5} In these trials there was an initial period of management in a cast before using a brace. These outcomes cannot therefore be fully attributable to the brace alone. Good results have been reported with the 'Chinese' method in which a circumferential wood or plastic splint was used to maintain reduction and allow movement at the wrist.¹⁹ This procedure has not gained acceptance because of an increased incidence of swelling of the hand. The prefabricated Colles' fracture brace was developed in Aberdeen by Wardlaw and Ledingham.¹³⁻¹⁵ It applies a three-point load which aims to maintain reduction of the fracture, prevent swelling of the hand by avoiding circumferential pressure, allow movement of the wrist and be easy to apply.

In this prospective, randomised study treatment by a brace gave similar functional results to those by a conventional plaster cast. The scores for the brace group were better at the early stages of treatment but did not reach statistical significance. The grip strength in both the manipulated and non-manipulated groups was better with treatment up to 12 weeks, but significantly better only on the tenth day and at five weeks in the manipulated group and only at five weeks in those not requiring manipulation. In both treat-

ment groups, the functional and anatomical results were better in younger patients and in those with less initial displacement of the fracture ($p < 0.001$). Stewart, Innes and Burke²⁰ also reported that the functional result at three months was related to the initial displacement. De Bruijn²¹ found a correlation between the anatomical and functional results. In our study, neither functional nor anatomical results had any relationship to gender or hand dominance. Both treatments gave similar anatomical results. Thus a brace is as effective as a plaster cast in maintaining the reduction of the fracture. There was no significant difference in the pain scores between the treatment groups.

We conclude that the Aberdeen Colles' fracture brace can be used effectively in treating Colles' fractures, whether requiring manipulation or not, since it gave similar anatomical results when compared with conventional treatment in a plaster cast. It provides better grip strength during the early stages of treatment by allowing movement at the wrist. This may play a role in the early rehabilitation of elderly patients. It is easy to apply and does not require changing as in traditional treatment in a cast. It thus reduces the work load of the plaster room. A further development of the brace is under way to maintain more consistent reduction of the fracture throughout treatment.

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