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On immediate functional bracing of Colles' fracture

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A prospective randomized trial was carried out in 60 consecutive patients with Colles' fractures requiring manipulation. They were treated by either a standard Colles' plaster (control group) or in a functional plaster brace applied immediately after reduction of the fracture. The brace extended from the proximal radius and ulna to the level of the radial styloid and allowed a full range of movement at the radiocarpal joint.

Both groups comprised 30 patients and were matched for age, sex and dominance of hand. There was no significant difference in initial severity of fracture or the quality of reduction. Radiological results on cast removal (35–42 days) were significantly better in the brace group compared with those treated with a below-elbow cast ($P < 0.05$). Wrist function was also significantly better in the brace treated group at 12 weeks after fracture ($P < 0.05$).

This brace has a number of advantages over standard plaster treatment, but requires a degree of skill and experience in its application. A prefabricated brace has now been developed with a similar 'built in' three-point loading which will be easier for inexperienced staff to apply.

Introduction

Techniques used in the treatment of Colles' fractures have included cast immobilization (Charnley, 1968; Soren, 1978), functional bracing (Sarmiento et al., 1975; Sarmiento et al., 1980; Stewart et al., 1984; Ferris et al., 1989), internal (Kristiansen, 1968; Lucas and Sachtjen, 1981) and external fixation (Jenkins et al., 1987; Howard et al., 1989). In the majority of hospitals, however, the standard treatment remains the application of below-elbow casts, often carried out by the more junior, inexperienced staff. Considerable morbidity may be associated with these fractures (Cooney et al., 1980), and unsatisfactory results are related to pain, stiffness and loss of function of the wrist and fingers. Residual anatomical deformity has been shown to affect the long-term function (Bacorn and Kurtzke, 1953; McQueen and Caspers, 1988) and Sarmiento et al. (1975) postulated that prolonged immobilization of the wrist during treatment would also prejudice results. In order to minimize the morbidity due to immobilization, Sarmiento et al. (1975) advocated the use of a functional brace in the treatment of Colles' fractures applied several days after fracture. Bracing the forearm in supination and allowing full palmar flexion of the wrist (while limiting dorsiflexion), they reported better early functional results in patients treated in this brace compared with standard below-elbow casts. Stewart et al. (1984), however, were unable to confirm any significant advantage of this treatment, or of bracing in pronation over conventional fracture treatment.

Cast immobilization for Colles' fracture relies on the principle of three-point loading to maintain fracture alignment. In below-elbow plasters this is applied by placing the wrist in palmar flexion and ulnar deviation while moulding the cast over the dorsoradial aspect of the wrist and antero-ulnar part of the forearm (Charnley, 1968). A plaster-of-Paris functional brace was developed which more accurately applied three-point loading to the forearm and fracture allowing free movement at the radiocarpal joint. Thus, a full range of dorsiflexion, palmar flexion, ulnar deviation, and radial deviation was possible, allowing early mobilization of the wrist.

Patients and method

A series of 60 consecutive patients attending Aberdeen Royal Infirmary with displaced or angulated Colles' fracture requiring manipulation were randomly allocated to one of two treatment groups. Each group comprised 30 patients and was evenly matched for age, sex, dominance of hand and severity of fracture (Frykman,1967). After reduction of the fracture the patient was fitted with the plaster-of-Paris functional brace (Brace) or a standard below-elbow cast (Control). Excluded from the study were patients under 18 years of age or with unfused epiphyses, those with bilateral Colles' fracture or a previous history of wrist fracture and those who were unable to follow simple instructions.

All patients had reduction of their fracture under general anaesthesia.

Control group

There were 30 patients treated with a below-elbow dorsoradial plaster backslab by a senior registrar in the accident and emergency department (CCG). The arm was then held pronated, with the wrist ulnar deviated and in slight palmar flexion, while a single layer of stockinet and undercast wool padding was applied to the forearm. A dorsoradial slab comprising 15 layers of 15 cm plaster-of-Paris bandage was then applied from immediately below the elbow to the level of the metacarpophalangeal joints. It was held in position using a 10 cm cotton bandage and moulded while hardening up to produce three-point loading. Radiographs were taken after reduction. At 7–14 days the cast was completed using a single roll of 10 cm plaster-of-Paris bandage.

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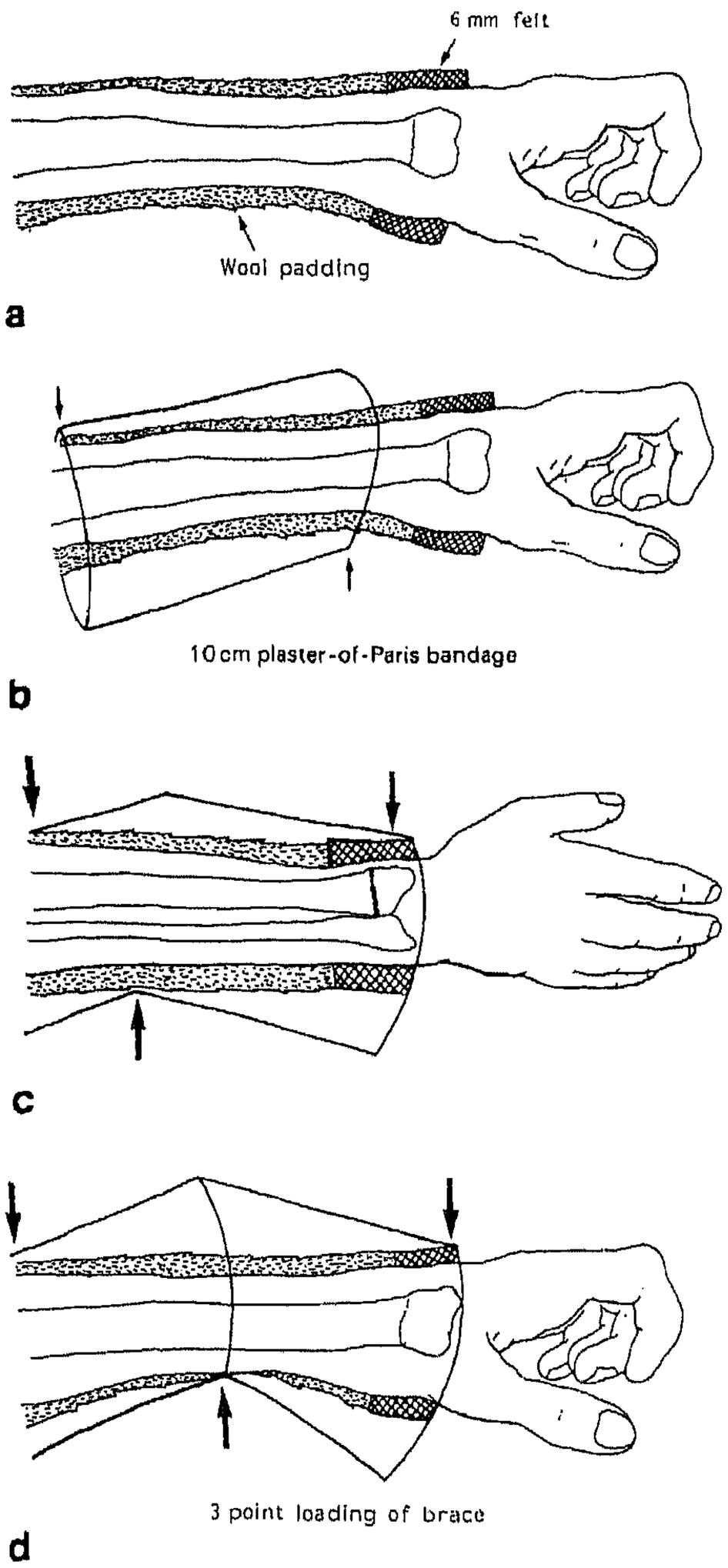

Figure 1. *a*, Lateral view of initial padding applied to forearm. *b*, Lateral view of first plaster-of-Paris cylinder applied to forearm. *c*, Anteroposterior view of three-point loading provided by completed functional brace. *d*, Lateral view of three-point loading provided by completed functional brace.

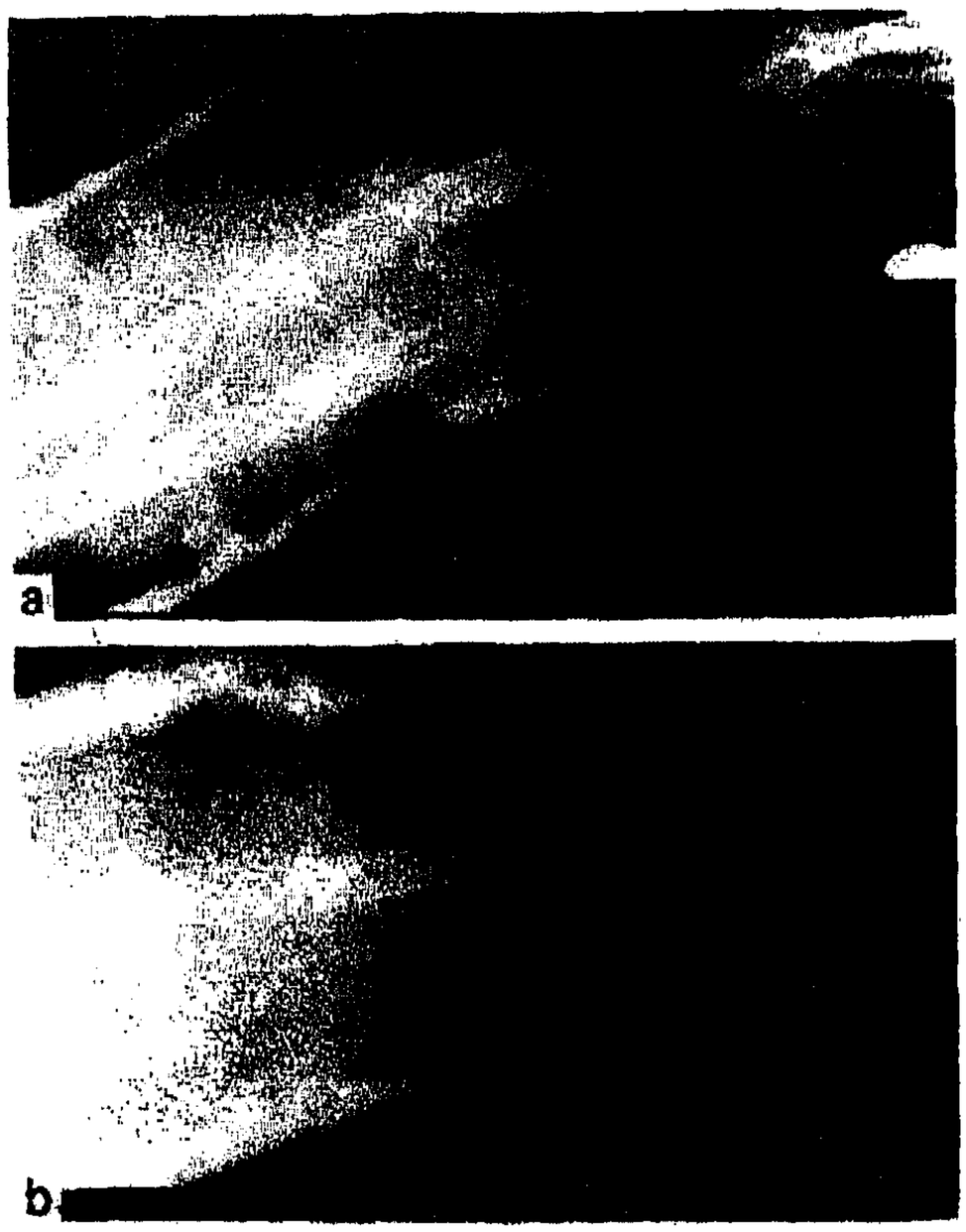

Figure 2. *a*, Anteroposterior radiograph of radius and ulna with completed functional brace. *b*, Lateral radiograph of radius and ulna with completed functional brace.

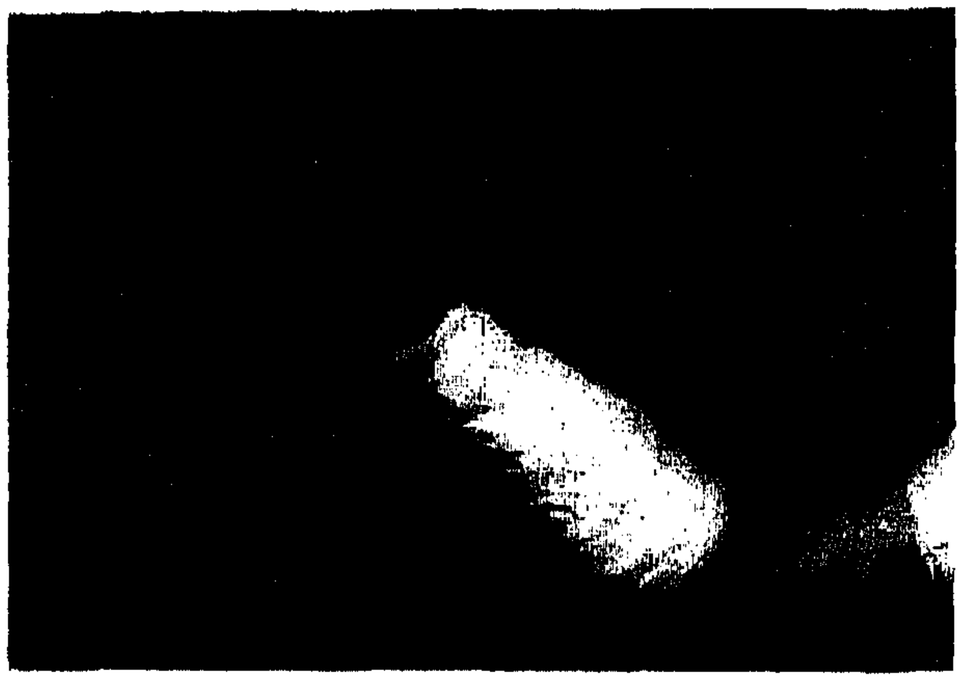

Figure 3. Photograph of completed functional brace showing range of palmar flexion and dorsiflexion possible at wrist.

Brace group

In this group, 30 patients were treated with a moulded functional plaster-of-Paris brace applied immediately after reduction of the fracture by a research registrar in orthopaedics (WML). Adhesive felt (6 mm thick) was applied to the skin at the level of the radial styloid to prevent the brace slipping distally as swelling subsided. A single layer of stockinet and undercast wool padding was applied to the forearm (*Figure 1a*). The brace was applied in three stages with the forearm in the neutral position.

Stage 1. A plaster-of-Paris (POP) cylinder was wrapped around the upper forearm using 10 cm bandage and allowed to set. By grasping this cylinder and tilting it as a unit, two points of a three-dimensional loading system could be achieved (*Figure 1b*).

Stage 2. A lower cylinder was then added using 10 cm POP bandage which overlapped the upper cylinder and extended onto the orthopaedic felt at the level of the radial styloid.

Stage 3. The cylinders were then tilted in opposing directions in both anteroposterior and mediolateral planes. This produced three-point loading on the fractured forearm (*Figure 1c, d*). The brace was completed in this position with a single 10 cm roll of POP bandage.

Radiographs were taken after reduction (*Figure 2a, b*).

The brace allowed for free wrist palmar and dorsiflexion (*Figure 3*), but restricted supination and pronation due to moulding over the distal radius and ulna.

Table I. Anatomical scoring method

Dorsal angle	*Loss of radial length*	*Loss of radial angle*	*Score*
Neutral	0–3	0–4°	0
1–10°	13–6	5–9°	1
11–14°	7–11	10–14°	2
>15°	>12	>15°	4

Grading: Combined score of dorsal angle, radial length, radial angle: Excellent 0; Good 1–3, Fair 4–6; Poor 7–12.

Table II. Functional scoring – method

a, Subjective complaints

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

b, Objective evaluation

Movement/function	*Range (degrees)*	*Score*
Dorsiflexion	<45	5
Palmar flexion	<30	1
Ulnar deviation	<35	3
Radial deviation	<15	1
Supination	<50	2
Pronation	<50	2
Circumduction	Loss	1
Finger flexion	Not to distal crease	1–2
Grip	Loss of strength	1

c, Complication	*Score*
Median nerve compression	1–3
Poor finger function	1–2
Other (e.g. ulnar or radial nerve compression)	1–2

Final grade: Excellent 0–2; Good 3–8, Fair 9–14; Poor > 15.

All patients were re-examined after 24 h, and had a check radiograph at 7–14 days after fracture. Remanipulation was carried out at this stage if considered necessary. The plaster was removed and radiographs of both injured and normal wrist taken at 35–42 days.

Assessment

Anatomical and functional assessments were made using the methods described by Stewart et al. (1984). The anatomical assessment consisted of a combined score of dorsal angle, radial angle, and radial length with the normal wrist used for comparison (Van der Linden and Ericson, 1981) (*Table I*).

Functional assessment was carried out 'blind' at 12 and 26 weeks by an independent observer (ABM), using a modified Gartland and Werley scoring system (Stewart et al., 1984; Gartland and Werley, 1951). The assessment criteria are shown in *Table II*.

Statistics

Student's *t* test was used to determine the levels of statistical significance of the experimental data.

Results

Both groups of 30 patients comprised 25 females and 5 males with a mean age of 60.2 years for the control group and 61.3 years for the brace group. The initial severity of the fractures was assessed using the Frykman (1967) grading system. There was no significant difference in severity between the brace and control groups ($P > 0.1$).

Three patients were removed from the trial before completion of treatment; one had senile dementia, one a previous wrist fracture and the third requested early withdrawal from the trial. Therefore, full radiological results were available for 57 patients of whom 49 were available for clinical assessment at 12 weeks and 50 at 26 weeks.

Two control patients required remanipulation of their fractures at 14 days due to redisplacement, but no brace patient required remanipulation.

Anatomical results

Measurement of standard anteroposterior and lateral radiographs of the wrist showed no significant difference in the

Table III. Final radiological result

	Mean score	
Brace	2 5	*P*< 0 05
Control	4 3	
Brace under 60 years	2 3	*P*> 0 05
Brace over 60 years	2 6	
Control under 60 years	4.4	*P*< 0 005
Control over 60 years	12 7	

Table IV. Final radiological grade

	Number of patients (%)			
	Excellent 0	*Good 1 3*	*Fair 4 6*	*Poor 7–12*
Brace	3 (10 7)	19 (67.8)	3 (10.7)	3 (10 7)
Control	3 (10 3)	12 (41.4)	4 (13 8)	10 (34 5)

Table V. Functional results – mean scores

	12 weeks	*26 weeks*
Brace	5 6	3 7
Control	8 3	5 3
Brace under 60 years	3 7	1 8
Brace over 60 years	6 6	4 6
Control under 60 years	5 3	3 4
Control over 60 years	10 5	6 9

quality of reduction of the fractures, with a mean score of 0.8 for the braced group and 1.17 for the control group after reduction ($P > 0.1$). However, there was a significant difference in the radiological result at the time of cast removal (*Table III*), with a mean score of 2.46 for the brace patients and 4.27 for the controls ($P < 0.05$).

Age-related differences were examined by dividing patients into two groups, those under or over 60 years of age (*Table III*). At the beginning of the study 11 braced patients were under 60 years and 19 over 60 years of age, whereas for the conventional plaster group 12 were under 60 years and 18 over 60 years of age. Overall the younger patients had better final radiological results with no significant difference between the under 60 years brace and control groups ($P > 0.05$). When the brace and control groups are examined separately, the under 60 years controls had significantly better final radiological results than the over 60 years controls ($P < 0.005$). In the brace group, however, there was no significant difference between the age groups ($P > 0.05$). This may be due to the more accurate loading of the brace, preventing collapse of the fracture during splintage.

Comparing the two groups by grading (*Table IV*), the braced group had a much larger percentage of excellent or good results (78.5 per cent) compared to controls (57.7 per cent) and only 10.7 per cent poor results compared with 34.5 per cent.

Functional results

Functional evaluation demonstrated significantly better overall functional results in the braced group at 12 weeks (*Tables V, VI*) ($P < 0.05$). By 26 weeks, however, the differences were no longer statistically significant ($0.1 < P > 0.05$).

Table VI. Functional results – statistical comparison

	12 Weeks	*26 Weeks*
Brace *vs* control	*P*< 0 05	0 05< *P*< 0 1
Brace under 60 years *vs* brace over 60 years	*P*< 0 02	*P*< 0 02
Brace under 60 years *vs* control under 60 years	*P*> 0 1	*P*> 0 1
Brace over 60 years *vs* control over 60 years	*P*< 0 01	*P*< 0 005
Control under 60 years *vs* control over 60 years	*P*< 0.01	*P*< 0 005

Table VII. Functional results – grades

		Number of patients				
		Excellent	*Good*	*Fair*	*Poor*	*Total*
12 weeks	Brace	6	14	4	0	24
	Control	4	8	11	2	25
26 weeks	Brace	8	16	0	0	24
	Control	6	15	4	1	26

Further subdividing the groups by age, younger patients (< 60 years) regained function more quickly in both brace and control groups. In three patients over 60 years the brace group showed significantly better functional results at 12 and 26 weeks than the control group ($P < 0.05$, $P < 0.005$, respectively). The difference in functional result between brace and control in patients under 60 years did not reach a level of statistical significance. This may be related to the improved results previously reported in the younger age group and the relatively small numbers analysed in this trial.

Grading of results (*Table VII*) showed 83 per cent of braced patients to have excellent or good results by 12 weeks and 100 per cent by 26 weeks compared with 48 per cent and 83 per cent, respectively in the controls.

Complications

The incidence of median nerve symptoms overall was 21 per cent at 12 weeks and 14.5 per cent at 26 weeks, with no significant difference between groups. One complication peculiar to the brace was superficial radial nerve paraesthesia experienced by 21 per cent of the braced patients. This was transient and often only elicited by specific questioning and testing. All but one case had resolved by 12 weeks and all cases by 26 weeks. This complication is explained by the *modus operandi* of the brace which concentrates higher pressures over the distal radial fragment than a conventional Colles' cast.

One control patient had a spontaneous rupture of her extensor pollicis longus tendon and no patient developed Sudeck's atrophy or shoulder–hand syndrome.

Discussion

Closed reduction and immobilization is likely to remain the mainstay of treatment in Colles' fractures, despite increasing interest in operative fixation. Fracture bracing is an attractive alternative to conventional treatment, although reports of its efficacy vary. With the plaster-of-Paris brace described in this paper, we have shown improved final radiological and early functional results compared to the standard below-elbow cast. This brace confers the benefit of full finger and hand movement facilitating the early return of the muscle

pump allowing more rapid resolution of swelling. The brace also allows early restoration of the functionally important movements of wrist dorsiflexion and ulnar deviation. Maximum useful function of the hand is obtained during the treatment period by placing the forearm in neutral rotation while limiting pronation and supination by moulding.

In this study we have demonstrated the technique of immediate fracture bracing to be a satisfactory treatment for Colles' fractures. The application of the brace requires experience in plastering technique and an understanding of the principle on which the brace operates. Therefore it is not suitable for application by inexperienced staff.

A prefabricated thermoplastic orthosis is now being developed which has the desirable loading properties 'built-in' and which can be applied by inexperienced staff after simple instruction.

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References

Bacorn R. W. and Kurtzke J. F. (1953) Colles' fracture: a study of two thousand cases from the New York State Workmen's Compensation Board. *J. Bone Joint Surg.* **35A**, 248.

Charnley J. (1968) *The Closed Treatment of Common Fractures* 3rd Ed. Edinburgh, London: E&S Livingstone, 128.

Cooney W. P., Dobyns J. H. and Linscheid R. L. (1980) Complications of Colles' fractures. *J. Bone Joint Surg.* **62A**, 613.

Ferris, B. D., Thomas N. P., Dewar M. E. et al. (1989) Brace treatment of Colles' fracture. *Acta Orthop. Scand.* **60(1)**, 63.

Frykman G. (1967) Fracture of the distal radius including sequelae-shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function: a clinical and experimental study. *Acta Orthop. Scand. Suppl.* **108**, 30.

Gartland J. J. Jr and Werley C. W. (1951) Evaluation of healed Colles fractures. *J. Bone Joint Surg.* **33A**, 895.

Howard P. W., Stewart H. D., Hind R. E. et al. (1989) External fixation or plaster for severely displaced Colles' fractures: an anatomical study. *J. Bone Joint Surg.* **71B**, 68.

Jenkins N. H., Jones D. G., Johnson H. R. et al. (1987) External fixation of Colles' fractures: an anatomical study. *J. Bone Joint Surg.* **69B**, 207.

Kristiansen A. (1968) Colles' fracture. Operative treatment, indications and results. *Acta Orthop. Scand.* **39**, 33.

Lucas G. L. and Sachtjen K. M. (1981) An analysis of hand function in patient with Colles' fracture treated by Rush rod fixation. *Clin. Orthop.* **155**, 172.

McQueen M,. and Caspers J. (1988) Colles' fracture: Does the anatomical result affect the final function? *J. Bone Joint Surg.* **70B**, 649.

Rush L. V. (1954) Closed medullary pinning of Colles' fracture. *Clin. Orthop.* **3**, 152.

Sarmiento A., Pratt G. W., Berry N. C. et al. (1975) Colles' fractures: functional bracing in supination. *J. Bone Joint Surg.* **57A**, 311.

Sarmiento A., Zagorski J. B., Sinclair W. F. (1980) Functional bracing of Colles' fractures: a prospective study of immobilisation in supination vs pronation. *Clin. Orthop.* **146**, 175.

Soren A. (1978) Reduction and immobilisation for Colles' fracture. *Ital. J. Orthop. Traum.* **4(1)**, 37.

Stewart H. D., Innes A. R. and Burke F. D. (1984) Functional cast bracing for Colles' fractures: a comparison between cast-bracing and conventional plaster casts. *J. Bone Joint Surg.* **66B**, 749.

Van der Linden W. and Ericson R. (1981) Colles' fracture: how should its displacement be measured and how should it be immobilised? *J. Bone Joint Surg.* **63A**, 1285.

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