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Early mobilization in the treatment of Colles' fracture: a 3 year prospective study

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Ninety consecutive women with unilateral Colles' fractures were randomized into two different treatment groups. The control group was treated for 5 weeks in conventional short-arm, below the elbow plaster of Paris casts. The other group (N=45) was treated similarly in plaster casts for 3 weeks and then had flexible casting applied for the remaining 2 weeks which allowed for early joint mobilization. Functional recovery was assessed by measuring grip strength and joint mobility at intervals over the 3 years. Radiographic and overall assessments were also made during 3 year course of study. Virtually all patients reported greater comfort after switching to the flexible casting. Mean grip scores and joint mobilities were higher at all time points with early mobilization, reaching levels of statistical significance at 6 months for grip score and at 3 months for joint mobility. By 3 years most differences between treatment groups had resolved. We found no evidence that early mobilization was detrimental to recovery. We conclude that early mobilization is a satisfactory treatment option for Colles' fracture, and may, in fact, hasten functional recovery.

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Introduction

Since the fracture of the distal radius was first described by the Dublin physician Abraham Colles in 1814, there has been no clear consensus as to the best means of treatment¹. Gartland and Werley were among the first to discuss the poor results seen after this relatively common fracture². Since then, there have been many proposed methods of treatment, including immobilization in plaster with the forearm and wrist in various positions, functional bracing, percutaneous pinning, and open reduction with internal fixation³⁻¹².

One of the conclusions that Bacorn and Kurtzke made in a study of 2000 Colles' fractures was that early and persistent active motion was a key factor in decreasing long-term disability¹³. More recent studies have also advocated the use of early mobilization after fracture, either through functional bracing or flexible bandaging, as a means to improve clinical recovery^{5,6,11}.

As the functional outcome is the most important clinical parameter, our study was undertaken to investigate whether early mobilization of the fractured wrist could influence the recovery and improve the functional outcome after Colles' fracture.

Patients and methods

Patients

Ninety consecutive adult women patients with unilateral Colles' fracture were randomized into two different treatment groups. Criteria for inclusion in the study were no previous history of forearm or hand injury, normal forearm and hand function before injury, essentially normal contralateral forearm and hand (as this would be used for comparison), absence of generalized rheumatic disease, and the ability to return for follow up. Informed consent and ethical permission were obtained prior to the commencement of the study.

One group (N=45) was treated non-operatively for 5 weeks with immobilization in ulnar deviation and supination in short arm below the elbow plaster of Paris casts; the other group (N=45) was treated similarly in plaster casts for 3 weeks followed by 2 weeks in a flexible Viscopaste® cast (Smith and Nephew). Displaced fractures in both groups were manipulated under regional or general anaesthesia. Four patients treated by plaster only and one patient treated with early mobilization required re-manipulation for failure to maintain initial reduction.

Both groups were serially assessed both clinically and radiographically before and after reduction, at 1, 3, and 5 weeks, 3 months, 6 months and 3 years. All patients were given identical rehabilitation instructions and were encouraged to use the limb as often as possible, as much as the casting allowed, and through a range of motion that was comfortable. No patient received formal physiotherapy.

Standard anteroposterior and lateral radiographs were taken before and after reduction and subsequently. The distal radius fractures were classified from the initial radiographs according to the criteria of Frykman¹⁴ (Table I). The contralateral forearm was used for reference.

Table I. Frykman classification scheme

I	Extra-articular fracture
II	As I, with fracture of the ulnar styloid
III	Fracture involving the radiocarpal joint
IV	As III, with fracture of the ulnar styloid
V	Fracture involving the radioulnar joint
VI	As V, with fracture of the ulnar styloid
VII	Fracture involving the radiocarpal and radioulnar joints
VIII	As VII, with fracture of the ulnar styloid

In all cases, radiographs were assessed independently and blindly.

Functional assessment

A pneumatic grip test with a bulb dynamometer was used to measure grip strength quantitatively in kiloPascals (kPa) beginning at 1 week. The test was performed bilaterally without casting using a standardized protocol. The mean of three attempts was recorded, and a grip score was calculated as the ratio of the grip strength in the injured arm over that in the uninjured arm. The change in grip score for each patient was calculated by subtracting the calculated grip score at each time point (5 weeks, 3 months, 6 months, and 3 years) from the baseline attained at 3 weeks.

Active, painless ranges of motion for flexion, extension, pronation, and supination were measured without casting about the wrist beginning at 5 weeks. To assess range of motion for both the radiocarpal and radioulnar joints, joint mobility was calculated as the sum of flexion, extension, pronation, and supination¹⁵. Abduction and adduction were also measured and compared at 3 years.

Overall assessment

At the 3 year follow up, overall objective and subjective functional assessments were made by the senior surgeon (N.R.). Each patient was questioned about pain and disability. Swelling was assessed by direct comparison with the uninjured wrist. Residual deformity, complication rate and overall acceptability were also recorded.

Statistical methods

Student's *t*-tests were used to compare means between groups, χ^2 tests were used to compare categorical data between groups, and multiple regression analysis was used to compare grip scores and joint mobility between groups, adjusting for age, fracture severity (Frykman classification), and dominant hand. Statistical analysis was performed using SPSS software (SPSS for Windows, Version 6.0, SPSS (UK) Inc., London, 1993).

Results

Patient demographics

Patients in both groups were similar in age, with a mean (SD) of 61 (14.5) years (range 22–88) for the conventional plaster group and 60 (14.5) years (range 23–84) for the early mobilization group ($P = 0.68$). Seventeen women did not complete the 3 year trial; five patients from each treatment group died during the study, and the remainder either moved away or were otherwise lost to follow-up.

Table II. Frykman classification of fractures for patients treated with either conventional plaster or early mobilization

Frykman class	Conventional plaster	Early mobilization
I	9	8
II	7	16
III	3	1
IV	2	0
V	7	4
VI	5	4
VII	7	5
VIII	5	7

Fracture classification

The Frykman classifications are summarised in *Table II*. Seventeen patients (38 per cent) in the conventional plaster group and 25 patients (56 per cent) in the early mobilization group injured their dominant arm. There were no statistical differences between group means in either the severity of fracture ($P = 0.51$) or the incidence of injury to dominant hand ($P = 0.14$, $\chi^2 = 2.2$).

Subjective assessment

All patients in the early mobilization reported greater comfort after switching at 3 weeks from the plaster of Paris short-arm cast to the flexible casting. Moreover there was no increase in discomfort or pain at any time with early mobilization.

Functional assessment

At 3 weeks, mean grip score was essentially the same between groups. Patients treated with early mobilization regained functional grip strength more rapidly than those treated conventionally with plaster (*Figure 1*). Beginning at 5 weeks, patients in the flexible casting group had mean grip scores which were higher than those of patients in the plaster only group (*Table III*), although the difference only reached a level of statistical significance at 6 months ($P = 0.04$). Early mobilization led to an earlier return of

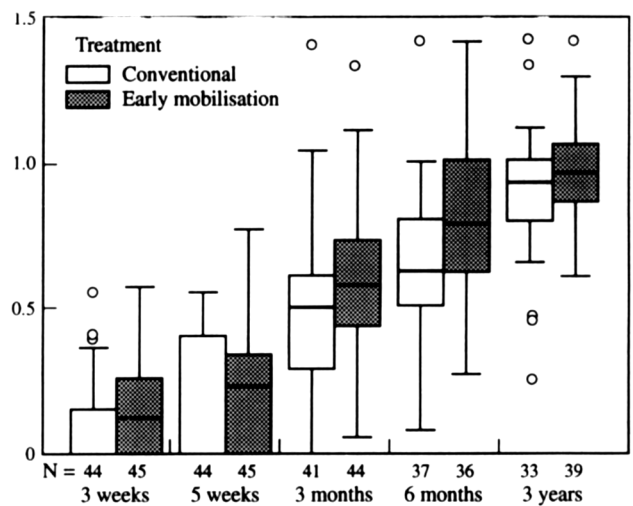


Figure 1. Grip score over 3 years for patients treated either by conventional plaster or early mobilization (grip score was calculated as the ratio of the injured wrist to the uninjured). Rectangles represent the middle 50 per cent of data; bars represent the range and median values. Open circles represent outliers.

Table III. Mean (SD) grip score calculated as the ratio of injured grip strength over non-injured

	Conventional plaster	Early mobilization
3 weeks	0.145 (0.415)	0.155 (0.160)
5 weeks	0.194 (0.444)	0.237 (0.209)
3 months	0.477 (0.278)	0.603 (0.266) *
6 months	0.638 (0.246)	0.811 (0.260)
3 years	0.941 (0.388)	0.963 (0.181)

* $P < 0.05$.

hand strength. Patients who injured their dominant hand had higher grip scores than patients who injured their non-dominant hand; this was unaffected by treatment. Age and severity of fracture did not influence recovery of grip strength at any time point.

Patients treated with the flexible casting also regained wrist movement more quickly than those treated conventionally. The mean ranges of joint mobility (sum of flexion, extension, supination and pronation) were greater at all time points and for all motions in the group treated with early mobilization (Table IV). At 3 months the difference reached a level of statistical significance ($P=0.04$) (Figure 3). However the most significant variable affecting

Table IV. Mean range of motion calculated as the sum of active, painless flexion, extension, pronation, and supination at the wrist joint

	Conventional plaster	Early mobilization
5 weeks	143.4 (69.6)	169.6 (80.6)
3 months	252.1 (72.1)	280.1 (59.7)*
6 months	290.6 (55.8)	303.6 (54.3)
3 years	304.7 (49.7)	317.7 (21.8)

* $P < 0.05$.

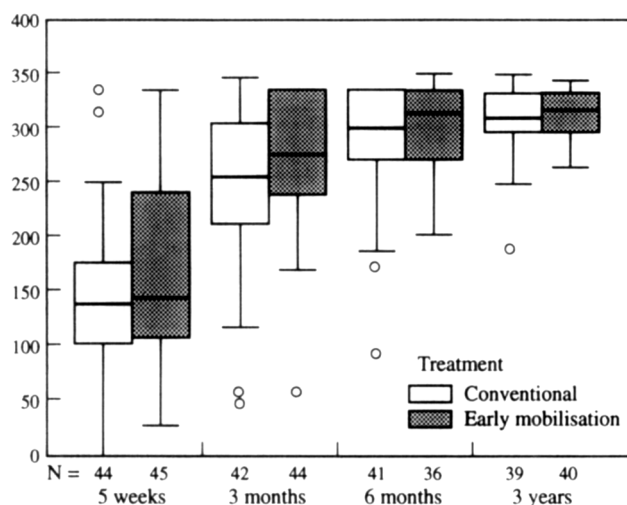


Figure 2. Joint mobility at the injured wrist (calculated as the sum of flexion, extension, pronation and supination) over 3 years for patients treated either by conventional plaster or early mobilization. Rectangles represent middle 50 per cent of data; bars represent the range and median values. Open circles represent outliers.

Table V. Radiographic results: mean (SD)

	Conventional plaster	Early mobilization
Dorsal tilt of radius (degrees)	6.2 (9.3)	4.6 (10.0)
Radial tilt of radius (degrees)	0.6 (1.6)	2.5 (4.6)*
Radial shortening (mm)	3.4 (2.8)	2.8 (2.4)
Radioulnar joint space (mm)	2.3 (0.7)	2.0 (0.3)*
Radiocarpal joint space (mm)	2.1 (0.2)	2.0 (0)
Impaction of distal radius (incidence)	30 (67%)	30 (67%)
Osteoarthritis (incidence)	7 (16%)	5 (11%)

* $P < 0.05$.

early joint mobility (i.e. less than 6 months) was the severity of the initial fracture ($P < 0.01$); at 3 years, total joint mobility was also influenced by age ($P = 0.05$).

At 3 years, the mean (SD) values for abduction were 21.5° (9.9°) and 20.3° (9.3°) for the early mobilization group and the conventionally treated group respectively. The difference was not statistically significant. Mean adduction measurements were essentially the same at 31.3° in both groups.

Radiographic assessment

The significant differences between the two groups at 3 years were in the radial tilt of the radius and the radioulnar joint space. In the early mobilization group there were on average approximately 2° more radial tilt than were seen in the plaster only group ($P = 0.02$). At 3 years, the early mobilization group had a mean radioulnar joint space that was 0.3 mm less than the mean of the group treated conventionally ($P = 0.04$). There were no statistical differences in dorsal tilt of the radius, the amount of radial shortening, the radiocarpal joint space, the impaction of the distal radius, the incidence of prominent ulnar styloids, or the incidence of osteoarthritis (Table V).

Overall assessment

At the 3 year follow-up, one-third of patients in both groups reported pain in the injured wrist. This was most often localized over the radioulnar joint. Six patients (13 per cent) in the early mobilization group and two (4 per cent) in the plaster only group had swelling over the injured wrist. The incidence of residual deformity was higher in the plaster of Paris group (36 per cent) than in the early mobilization group (27 per cent).

Disability, defined as interference with the activities of daily living, was present in about 10 per cent of patients in both groups at 3 years. It was however classified as mild in all cases. There was no difference in overall clinical acceptability between groups; the complication rate was slightly higher in the plaster of Paris group (33 per cent) than in the early mobilization group (22 per cent). None of these variables (pain, swelling, deformity, disability, acceptability, or complications) reached a level of statistical significance.

Discussion

The treatment of Colles' fractures remains a topic of great debate. The results from this 3 year randomized prospective clinical trial support early mobilization as a potential means to improve short-term functional recovery after this relatively common wrist fracture.

Sarmiento et al. in a prospective study of 156 Colles'

fractures concluded that early mobility via bracing leads to an earlier recovery of range of motion and a more rapid rehabilitation⁵. While they advocated bracing in supination, they also noted a high proportion of satisfactory results for those braced in pronation with early mobilization. Dias et al. treated patients in either a flexible bandage (nondisplaced fractures) or a modified cast (displaced fractures) to promote early mobilization and concluded that the major determinant of functional outcome was the extent of soft-tissue damage at the time of injury¹¹. As mobilization has been shown previously to prevent joint stiffness and to hasten the resolution of swelling¹⁶, it may also improve soft tissue healing and as such contribute to the functional recovery. Moreover studies have shown that dynamic axial loading enhances fracture healing^{17,18}. Early mobilization may increase micromovement at the fracture line and subsequently accelerate bone remodelling and promote bony union. We conclude, as have others, that early motion of the fingers, wrist and elbow is consistent with obtaining a satisfactory outcome and may actually hasten recovery.

Patients in our series who were treated with the flexible casting recovered grip strength and joint mobility at least as quickly and perhaps more rapidly than those treated conventionally. Stewart et al. proposed that early recovery (the first 6 months) following Colles' fracture was an extremely important consideration⁸. In their study, as in ours, any benefits of early mobilization had resolved by 3 years. McQueen and Caspers postulated that any residual grip weakness at 3 years was most likely due to pain and/or bony shortening which put the flexor tendons at a mechanical disadvantage¹⁹.

While anatomy is related to functional and gross deformities are certainly reflected in poor recovery, it is well demonstrated that excellent function can accompany poor anatomical position and poor function can accompany good position^{2,4,8,9,19,20}. We were concerned that early mobilization might increase the incidence of redisplacement, bony deformity, or pain. We found no evidence to suggest any of these. By 3 years, radial shortening (a significant early predictor for final outcome) was similar in both groups demonstrating in this series that the fracture can be maintained by the flexible casting without collapse^{2,8,21}. We found a mean radioulnar joint space that was 0.3 mm less in the early mobilization group; this was a cause for concern as several authors have reported that radioulnar dysfunction is a common complication after Colles' fracture and may lead to poor results in the longterm²²⁻²⁴. In our study however, we found no difference in the incidence of joint osteoarthritis or residual wrist pain between the two treatments.

Despite a satisfactory clinical recovery, approximately one-third of patients in both groups had residual deformity at 3 years. This is an important outcome, as the cosmetic result should not be ignored. It was interesting that the incidence of residual deformity was actually slightly lower in the early mobilization group.

Perhaps most striking was the subjective assessment made by the patients after switching from the plaster cast to the flexible casting. In virtually all cases, they noted greater comfort and enjoyed the greater mobility afforded by the flexible casting. While it is conceivable that the improvement can simply have been attributed to changing the cast, we believe that improved patient satisfaction was most probably due to the specific properties of the flexible cast.

There is little doubt that Colles' fractures will remain a problem for clinical medicine. We believe that early mobilization after Colles' fracture has the potential to improve not only short-term functional recovery but also patient satisfaction. We found no evidence to suggest that early mobilization was detrimental, and it may in fact slightly enhance return of grip strength and joint mobility after fracture of the distal radius.

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Note added in proof

Since this study was undertaken, the formulation of Viscopaste has been changed. The new formulation Viscopaste PB7 is designed to remain more flexible and has a tacky surface. It is therefore not suitable for application without a further layer of protective bandage.

An appropriate material is under development by Smith and Nephew.