

Rehabilitation after two-part fractures of the neck of the humerus

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We undertook a prospective, controlled trial which compared two rehabilitation programmes for 86 patients who sustained two-part fractures of the proximal humerus. Patients were randomised either to receive immediate physiotherapy within one week (group A) or delayed physiotherapy after three weeks of immobilisation in a collar and cuff sling (group B).

At 16 weeks after the fracture, patients in group A had less pain ($p < 0.01$) and had greater shoulder function ($p < 0.001$) than those in group B. At 52 weeks, the differences between the groups had reduced. Although group A still had greater shoulder function and less pain, there was no statistical difference when compared with group B. By analysis of the area under the curve, an overall measure up to the 52-week period, group A experienced less pain as measured by the SF36 general health questionnaire and had improved shoulder function.

Our results show that patients with two-part fractures of the proximal humerus who begin immediate physiotherapy, experience less pain. The gains in shoulder function persist at 52 weeks which suggests that patients do not benefit from immobilisation before beginning physiotherapy.

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Fracture of the proximal humerus is a common injury and accounts for approximately 4% to 5% of all fractures.¹⁻⁴ The incidence increases with age and accelerates over the age of 50 years. Women show a greater increase than

men.^{5,6} Conservative management of two-part (minimally displaced) fractures has been advocated.⁷ A short period of immobilisation is recommended before the start of active exercise, but the recommended period before active exercise begins is variable. Bigliani⁸ has suggested seven to ten days while Adams and Hamblen⁹ stated that movement of the shoulder should be deferred for two to three weeks.

Our aim was to investigate prospectively whether, in a patient with a two-part proximal humeral fracture, rehabilitation without a period of immobilisation was safe and to determine whether this resulted in greater function of the shoulder.

Patients and Methods

Between November 1998 and April 2000, we recruited 86 patients over the age of 40 years with minimally displaced two-part fractures of the proximal humerus (Table I). We used the definition of Neer⁷ for a minimally displaced fracture. No bone segment should be displaced more than 1.0 cm or angled more than 45°. Isolated fractures to the greater tuberosity were included provided that they complied with the above definition.

Using sequentially numbered sealed envelopes we randomly allocated patients to group A, for whom physiotherapy started within one week of the fracture, or to group B, for whom physiotherapy started at three weeks. Both groups received the same rehabilitation programme under the guidance of 16 physiotherapists undertaken at two centres in the Sheffield Teaching Hospitals NHS Trust. During the first two weeks the patients were educated about their injury, taught pendular exercises, and shown how to flex their arm passively, within their pain tolerance, as part of a home exercise programme. Between weeks two and four, the patients progressed to full passive flexion and light functional exercises, with progressive functional exercises starting at week four. Only when both the physiotherapist and patients thought that independent shoulder function had been achieved were they discharged.

The primary outcome measure was the Constant shoulder score.¹⁰ Since it was impossible to allocate a preinjury score, we measured both the fractured shoulder and the unaffected arm and calculated the ratio between them. A score of 1.0 represents an equal shoulder score (Table II).

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Table I. Details of the 86 patients with two-part fractures of the humeral neck who underwent two different rehabilitation programmes

Factor	Group A	Group B	Mean difference (95% CI)	p value of difference
Number of patients	44	42	-	0.20
Gender				
M	11	5		
F	33	37		
Side				
Left	25	24	-	0.85
Right	19	18	-	
Dominant hand				
Left	5	6	-	0.93
Right	39	36	-	
Mean (\pm SD) body mass index	26.8 \pm 5.4	25.4 \pm 4.7	1.4 (-0.8 to 3.5)	0.21
Mean (\pm SD) age in years	70.7 \pm 12.5	69.6 \pm 11.6	1.1 (-4.04 to 6.31)	0.66
Mean (\pm SD) number of treatment sessions	9 \pm 6	14 \pm 9	-5 (-7.8 to 0.46)	0.002

Table II. Mean (\pm SD) Constant shoulder scores at follow-up for the 86 patients with two-part fractures of the humeral neck who underwent two different rehabilitation programmes

Group	Follow-up							
	8 weeks		16 weeks		52 weeks			
	Mean score \pm SD	Mean score \pm SD	Mean difference (95% CI)	p value of difference	Mean score \pm SD	AUC \pm SD	Mean difference (95% CI)	p value of difference
A	0.57 \pm 0.26 (n = 43)*	0.70 \pm 0.21 (n = 42)	0.16 (0.68 to 0.25)	0.001	0.82 \pm 0.23 (n = 41)	34.6 \pm 9.5	6.4 (2.5 to 10.5)	0.002
B	0.39 \pm 0.19 (n = 40)	0.54 \pm 0.20 (n = 40)			0.75 \pm 0.25 (n = 41)	28.2 \pm 8.6		

*number of patients

Secondary measures were the SF36 health survey¹¹ and the number of treatment sessions. The SF36, a measure of generic health in musculoskeletal conditions, is recommended by Gartsman et al¹² and Beaton, Hogg-Johnson and Bombardier¹³ with physical function, role limitation (physical) and pain being the most relevant dimensions.

The validity and reliability of the SF36 have been tested extensively.^{14,15} The primary follow-up was at 16 weeks with secondary assessment at eight and 52 weeks. A blinded assessor reviewed the patients either during their follow-up clinic appointment or at home.

Statistical analysis. All statistical analyses were completed on an intention-to-treat basis. We used details of the patients and clinical data to compare the two groups. The SF36 scores were assumed to be continuous data. At week 16, the mean Constant Scores and SF36 dimension scores were compared using two-independent sample *t*-tests and the mean differences calculated with 95% confidence intervals (CI). We also calculated the area-under-the-curve (AUC), in which all follow-up points were included (8,16 and 52 weeks), as suggested by Matthews et al¹⁶ for serial measurements.

For the purpose of calculation of the sample size we assumed a mean difference between the two groups of ten points in the Constant shoulder score at 16 weeks to be

important. In addition, by assuming that a standard deviation of 15 points in the Constant shoulder score would have a power of 80% of detecting a mean significant difference of 10 or more points, 36 patients were required for each group. The level of significance was set at $p < 0.05$.

Results

The baseline characteristics for each group were comparable (Table I) and indicate successful randomisation. There was one difference; the number of men was 11 in group A and 5 in group B. When included as a separate variable in linear regression analysis, gender did not influence the result when the Constant score at 16 weeks was used as the dependent variable ($p < 0.84$).

Of the 86 patients, 44 were in group A and 42 in group B. Three from group A were lost to follow-up since one had died, one had moved from the area and one was too ill to be assessed. In group B, two patients were lost to follow-up; one had moved area, but was seen at follow-up at 52 weeks, and one withdrew from the review process.

Table II shows that group A had significantly better shoulder function at 16 weeks. When compared with the uninjured (normal) shoulder, 70% of group A had normal

Table III. Mean (\pm SD) scores for the SF36 health survey at 8, 16 and 52 weeks of follow-up for both groups

Dimension	8 weeks (A n= 43) (B n = 40)	16 weeks (A = 42) (B = 39*)			52 weeks (A = 40*) (B = 40)			
			Mean difference in 16- weeks SF36 score (95% CI)	p value of difference	AUC	Mean AUC difference (95% CI)	p value of difference	
Physical functioning								
A	64.5 \pm 25.3	69.9 \pm 25.1	0.65 (-10.15 to 11.45)	0.90	65.4 \pm 31.3	3370 \pm 1271	-10 (-575 to 553)	0.97
B	59.4 \pm 23.5	69.2 \pm 23.6			68.4 \pm 30.2	3381 \pm 1229		
Social functioning								
A	82.5 \pm 25.4	83.0 \pm 26.7	0.95 (-10.12 to 12.01)	0.86	78.6 \pm 26.6	4093 \pm 1135	37 (-466 to 540)	0.88
B	78.6 \pm 28.9	82.1 \pm 23.0			80.0 \pm 27.2	4056 \pm 1095		
Role limitation (physical)								
A	48.8 \pm 43.3	61.9 \pm 43.6	22.2 (3.4 to 40.9)	0.02	60.0 \pm 44.1	2872 \pm 1874	727 (-71 to 1526)	0.07
B	25.6 \pm 33.2	39.7 \pm 40.8			54.4 \pm 44.2	2144 \pm 1655		
Role limitation (emotional)								
A	89.1 \pm 27.0	78.6 \pm 38.9	6.7 (-10.9 to 24.4)	0.45	80.8 \pm 35.3	3966 \pm 1320	579 (-62 to 1222)	0.07
B	68.3 \pm 39.2	71.8 \pm 40.9			68.3 \pm 42.7	3386 \pm 1526		
Pain								
A	65.8 \pm 19.0	72.0 \pm 20.6	12.2 (3.2 to 21.2)	<0.01	69.2 \pm 27.2	3475 \pm 949	486 (83 to 889)	0.01
B	50.5 \pm 18.6	59.9 \pm 20.0			65.6 \pm 26.6	2989 \pm 830		
Mental health								
A	72.9 \pm 19.7	74.0 \pm 17.3	2.8 (-5.7 to 11.3)	0.51	69.0 \pm 22.1	3722 \pm 904	80 (327 to 488)	0.69
B	69.1 \pm 19.9	71.2 \pm 21.1			70.7 \pm 18.7	3641 \pm 904		
Vitality								
A	54.8 \pm 22.9	54.8 \pm 23.3	-1.39 (-11.5 to 8.7)	0.78	55.4 \pm 26.9	2796 \pm 1127	-19 (-504 to 464)	0.93
B	52.7 \pm 23.0	56.1 \pm 22.4			56.2 \pm 26.0	2816 \pm 1013		
General health perception								
A	67.3 \pm 19.2	64.6 \pm 16.7	-0.94 (-9.7 to 7.8)	0.83	63.0 \pm 19.2	3377 \pm 857	-198 (-629 to 232)	0.36
B	67.1 \pm 23.3	65.5 \pm 22.7			69.3 \pm 22.0	3576 \pm 1049		

*one patient in group B at 16 weeks and one in group A at 52 weeks did not complete the SF36 questionnaire

function compared with 54% in group B. This was statistically significant ($p = 0.001$; 95% CI 25 to 68).

Table III shows the results of the analysis of the SF36 scores. At 16 weeks group A had a better health-related quality of life in two dimensions of the SF36 (role limitation physical, $p < 0.02$; pain, $p < 0.01$).

At 52 weeks the differences between the groups had reduced and, although group A had better shoulder function and less pain, there was no statistical difference when compared with group B. Analysis of the AUC showed that group A had less pain as measured by the SF36 general health questionnaire and improved shoulder function (Table III).

The only complication was in one patient in group B who developed a 'frozen shoulder' with stiffness at the 52-week follow-up. Despite this, the patient continued to be followed up and is included in the analysis of the results. No patient in either group developed a complication as a result of displacement at the site of the fracture.

Discussion

Although other studies have compared early and late physiotherapy for minimally displaced two-part fractures of the proximal humerus, none has assessed the effects of beginning physiotherapy within one week of the injury.

Clifford¹⁷ noted that the time spent in a sling was a significant factor in determining the final result. Koval et al¹⁸ reported that patients who started rehabilitation within 14 days of injury had greater shoulder function at a mean

follow-up of 41 months. Bertoft, Lundh and Ringqvist,¹⁹ however, comparing physiotherapy beginning at either one or three weeks after injury, found no differences in shoulder function. They concluded that patients could be immobilised for three weeks without affecting the long-term outcome.

We found that shoulder function, as measured by the Constant score, was greater in group A, compared with group B, both at the eight- and 16-week follow-up. There was still a difference at 52 weeks but it did not reach statistical significance. Nevertheless, this is probably important clinically. When all the follow-up results were included in the analysis, the overall Constant score was higher for group A.

In our study, the SF36 scores at 16 weeks showed that patients in group A had less pain and experienced less problems with work and other activities. They continued to experience less pain than group B when data were analysed for the entire follow-up period. Kristiansen, Angermann and Larsen²⁰ stated that patients had less pain when mobilised at one week compared with three weeks, but no difference was detected after six months. Our study is the first to report that patients who begin physiotherapy earlier experience less pain over a 52-week period. Although initial immobilisation is often advocated in order to allow the acute pain to settle,²¹ our results suggest that this delay may actually prolong pain.

Several authors have shown that healing of fractures is enhanced by the introduction of micromovement.²²⁻²⁴ Recent clinical trials on Colles' and ankle fractures have

shown a faster return to function with an accelerated rehabilitation programme, without any complications.²⁵⁻²⁷ The addition of micromovement has usually involved the application of gravity to the lower limb. The influence of gravity is probably less important in the upper limb in generating micromovement. Gardner et al²⁸ showed that muscle activity could produce a force five times greater than that produced by weight-bearing. The healing of a fracture involving the head of the humerus could conceivably be improved by the early activation of the shoulder muscles.

The association between osteoporosis and the risk of a fracture of the proximal humerus is well documented.^{29,30} In addition, patients with a humeral fracture are often in poor general health and have reduced neuromuscular function.³¹ Their chance of sustaining a fracture of the femoral neck is increased, a risk which is most evident in the first few years after sustaining a fracture of the proximal humerus.³² The frailty of these patients leaves them susceptible to further injury and it is therefore important that they are rehabilitated as quickly as possible. Immediate rehabilitation offers the best chance of regaining function in the shortest possible time. This approach also reduces the total amount of physiotherapy required. Even at 52 weeks, however, full shoulder recovery was not achieved. The mean improvement compared with the uninjured side was only 82%. Since a less satisfactory outcome is associated with initial immobilisation, we believe that early physiotherapy within one week is the treatment of choice for this common injury.

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