

Minimally displaced proximal humeral fractures

Epidemiology and outcome in 507 cases

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ABSTRACT We analyzed 507 consecutive minimally displaced proximal humeral fractures and showed that, if the AO classification is used, there is variation in the incidence of minimally displaced fractures in the different AO sub-groups. Patients with Type A minimally displaced fractures are significantly younger than those with Type B or C fractures. 376 patients were followed for 1 year and 88% achieved excellent or good results with nonoperative management. Age was the main determinant of outcome, according to the Neer score and the time taken to return to activities of daily living. Subjectively, older patients felt that the results of treatment were better than the objective measurement of gleno-humeral function would indicate. Many patients with fair or poor results had co-morbidities that prevented a good result. The length of the physiotherapy course affected the outcome at 1 year.

Minimally displaced proximal humeral fractures were defined by Neer (1970) as those in which there was less than 1 cm of displacement and 45° of angulation between the tuberosities, humeral head and shaft. In reality most of these fractures are either undisplaced or have no more than a few mm of displacement (Figure 1). There have been very few previous studies of the epidemiology of proximal humeral fractures, but Neer suggested that up to 85% of proximal humeral fractures are minimally displaced. There is uniform agreement that minimally displaced fractures should be treated nonoperatively (Young and Wallace 1985, Kristiansen and Christensen 1987, Koval et al.

1997, Flatow 2001), but the belief that minimally displaced proximal humeral fractures are always associated with a uniformly good prognosis was challenged by Koval et al. (1997). They found that only 77% of patients had a good or excellent result after treatment although functional recovery averaged 94%. However, there is little understanding as to why some patients have a poor result after this apparently benign fracture. We present the results of a 5-year prospective study of the epidemiology and outcome of nonoperatively managed, minimally displaced proximal humeral fractures.

Patients and methods

In the 5-year period between June 1992 and May 1996, 1,027 consecutive proximal humeral fractures were prospectively studied in the Edinburgh Orthopedic Trauma Unit (Court-Brown et al. 2001). The Unit treats all of the fractures in a population of 700,000 and the epidemiological findings reflect the incidence of fractures in the whole community. All fractures were classified by the Neer (1970) and AO (Müller et al. 1990) classifications by one experienced Orthopedic Trauma surgeon (CC-B) to negate inter-observer error. Intra-observer error was not tested. 507 of the fractures were minimally displaced. These fractures were treated nonoperatively, using a standard regime supervised by two of the authors. The arm was immobilized in a sling for 2 weeks, following which a course of physiotherapy, based on Neer's regime, was started. Follow-up was undertaken at

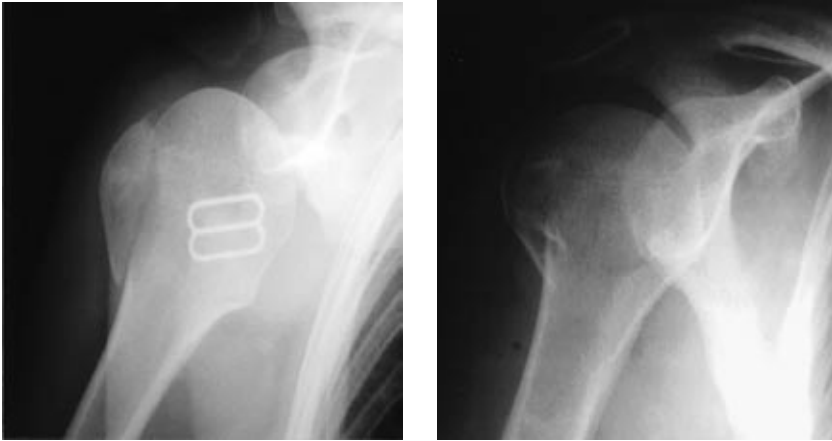


Figure 1. Anteroposterior and modified axial views of a minimally displaced A1.2 greater tuberosity fracture.

a research clinic, with the outcome being assessed by an independent research physiotherapist who was not involved in the patients' treatment.

All patients were examined at 6 weeks, 13 weeks, 26 weeks and 52 weeks, with outcome being assessed by both the Neer (1970) and Constant (1986) outcome scores. The time taken to return to employment and a number of routine daily activities was also noted. These were shopping, dressing, personal toilet and hygiene, housework and driving. Abduction and flexion power were also measured, using a spring balance technique (Moseley 1969). Since handedness does not affect shoulder function, abduction and flexion power were expressed as a percentage of the normal side (Constant 1986, Gallacher et al. 1996). Antero-posterior and modified axial radiographs (Wallace and Hellier 1983) were taken at each outpatient attendance to define the fracture type and monitor fracture union.

Of the 507 patients who presented with minimally displaced proximal humeral fractures during the period of the study, complete data were available in 376 (74%). The remaining 131 patients either died or failed to attend the follow-up. Thus the epidemiological results in 507 patients are presented together with the functional outcome in 376 patients. Associations between prognostic factors and outcomes were tested by chi-squared, Mann-Whitney or Spearman rank correlation tests, as appropriate. Multiple linear regression was used to test the significance of factors in predicting the 52-week Neer score after adjustment to one another

and the highly skewed Neer score was transformed by subtracting from 100 and taking the square root to give an approximately normal distribution for the regressions. Multiple logistic regression was used to test different factors adjusted to one another in predicting good as compared to poor outcome.

Results

The 507 fractures occurred in 506 patients, 1 patient presenting with a second contralateral fracture after being discharged following completion of treatment for the initial fracture. The average age of the 506 patients was 63 (13–87) years. There were 142 (28%) males with an average age of 53 years and 364 (72%) females with an average age of 66 years. 235 (46%) fractures were in the dominant shoulder and 435 (86%) were sustained in a simple fall. A further 21 fractures were caused by a fall down stairs or a slope, 21 followed a sports injury, 12 occurred as a result of a direct blow to the shoulder and 18 were caused by a road traffic accident. There were no multiply-injured patients (ISS > 15) in the series, although 26 (5%) patients had other musculoskeletal injuries. Of these, 15 presented with a combination of a minimally displaced proximal humeral fracture and an ipsilateral distal radial fracture.

384 (76%) fractures were AO type A. This group had an average age of 61 years. A further 114 (23%) fractures were AO type B and 9 (1.8%) were type C fractures. The average age of both

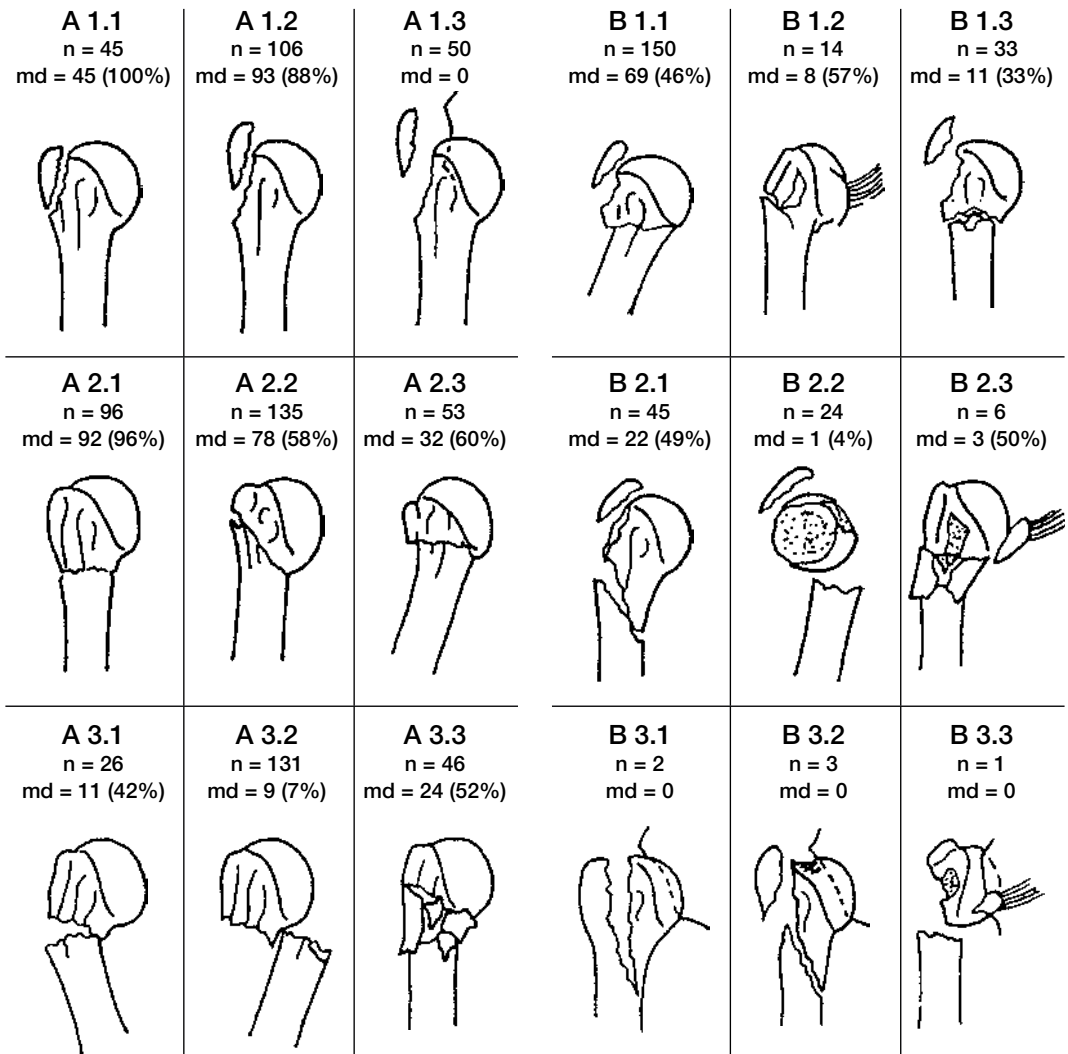
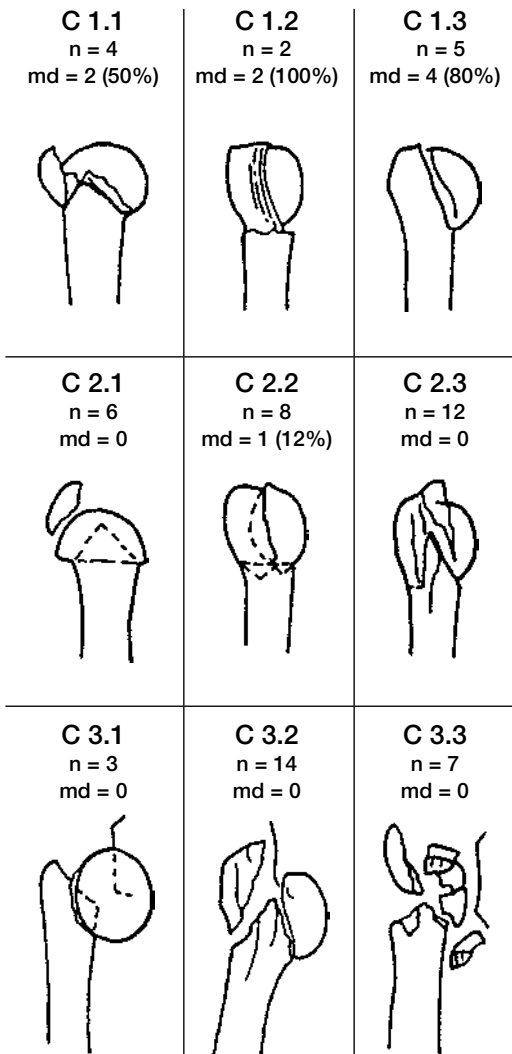


Figure 2. The epidemiology of proximal humeral fractures using the AO classification. The overall numbers of each subgroup in the 5-year study is represented by 'n' while 'md' represents the numbers and percentages of minimally displaced fractures. Figure 2 continues on the next page.

type B and C fractures was 69 years. Patients with type A fractures were younger than those with type B and C fractures ($p < 0.001$). 56% of all type A fractures were minimally displaced, as compared with 41% of type B fractures and 15% of type C fractures (Figure 2).

All of the 376 fractures with complete results united. Analysis of these patients shows that, if Neer's outcome criteria are used, 253 (67%) had excellent results, 75 (20%) had good results, 30 (8%) had fair results and the remaining 18 (5%) had poor results. Thus, 87% of the patients

with minimally displaced fractures had excellent or good results at 1 year. There was a gradual improvement in shoulder function between 6 weeks and 1 year, the average Neer score at 1 year being 90 (Table 1). The more subjective components of the Neer score, strength, reach and stability, indicate that the patients felt that they had regained about 90% of function although objective measurement of gleno-humeral movement indicates that this is probably not the case with only about 75% of abduction, internal rotation and power being regained at 1 year.



We found an association between age and outcome, and this is confirmed statistically with both Neer and Constant scores declining significantly with age ($p < 0.001$, Table 2). The component Neer scores, except strength, stability and pain also declined significantly with age, but the loss of power was not related to age. The time taken to return to dressing, personal hygiene, driving, housework, employment and shopping all correlated with age (Table 3).

Analysis of the association between outcome and the type of fracture showed no correlation once age had been taken into consideration. Patients with Type A fractures had an average Neer score of 91 at 1 year compared with 89 for Type B fractures and 81 for Type C fractures. However, statistical

Table 1. Average Neer scores, component Neer scores, except for the radiographic score, and power scores at 6, 13, 26 and 52 weeks

	6	13	26	52 weeks
Neer (100)	62	76	84	90
Pain (35)	24	29	31	33
Strength (10)	6.0	7.5	8.3	9.0
Reach (10)	6.9	8.1	8.7	9.3
Stability (10)	5.4	8.2	9.1	9.0
Flexion (6)	2.4	3.8	4.4	5.0
Extension (3)	2.1	2.4	2.7	2.8
Abduction (6)	1.2	2.7	3.5	4.3
Ext. rotation (5)	2.9	3.4	3.9	4.3
Int. rotation (5)	2.5	3.0	3.6	3.9
Abd. power (%)	12	40	61	75
Flex. power (%)	12	44	65	75

analysis indicated that the differences were related to age. The role of physiotherapy was assessed and statistical analysis showed that when the results had been adjusted for age, there was a positive correlation with outcome ($p < 0.01$). Thus, in patients of a similar age, the length of the physiotherapy course correlated with the Neer score at 1 year.

Comparative analysis of the 328 patients (average age 61 years) with excellent or good scores and the 48 patients (average age 70 years) who had fair or poor results was done to identify reasons for the poor results in apparently straightforward fractures. The age, sex, type of fracture, cause of fracture, duration of physiotherapy and prefracture functional status were all analyzed. We specifically analyzed the outcome of the A1.2 fractures (Figure 1) in view of the potential for a poor result secondary to rotator cuff damage associated with the greater tuberosity fracture. However, multiple regression analysis indicated that only age and the prefracture ability to do their own shopping determined whether a patient would have a good or poor result. However, further analysis of the patients who had fair and poor results showed that a number of them had significant co-morbidities at the time of fracture. 16 (37%) were very elderly (> 80 years), demented or institutionalized. A further 9 (21%) had prefracture shoulder dysfunction following cerebrovascular accidents, arthrodeses or impingement syndromes. The presence of a second fracture in the arm did not significantly affect outcome except for the time taken to return to dressing ($p < 0.05$).

Table 2. Relationship of age to 52-week Neer score, the component parts of the Neer score, except the radiographic score, 52-week Constant score and abduction and flexion power

Age (years)	<20	20–29	30–39	40–49	50–59	60–69	70–79	80–99	P-value
Number	12	8	21	35	54	82	105	59	
Neer (100)	100	96	93	93	92	89	90	84	<0.001
Pain (35)	35	34	32	33	33	33	34	33	ns
Strength (10)	10	9.5	8.9	9.1	8.8	8.9	9.0	8.3	ns
Reach (10)	10	10	9.7	9.7	9.4	9.3	9.1	8.7	<0.001
Stability (10)	10	9.7	9.4	9.9	9.8	9.4	9.7	9.0	ns
Flexion (6)	6	5.7	5.5	5.4	5.4	4.9	4.8	4.0	<0.001
Extension (3)	3	3.0	2.9	2.9	2.9	2.8	2.9	2.6	<0.05
Abduction (6)	6	5.5	5.5	5.1	4.7	4.2	4.0	3.1	<0.001
Ext. rotation (5)	5	5.0	4.7	4.6	4.2	4.2	4.4	3.9	<0.01
Int. rotation (5)	5	4.6	4.6	4.2	4.1	3.9	3.8	3.4	<0.001
Abd. power (%)	94	87	83	76	73	76	73	77	ns
Flex. power (%)	100	91	79	79	76	72	74	78	ns
Constant (100)	88	86	85	80	77	74	73	65	<0.001

Table 3. Relationship of age to functional outcome (expressed in weeks)

Age (years)	<20	20–29	30–39	40–49	50–59	60–69	70–79	80–99	P-value
Shopping	4.9	5.9	6.7	6.1	7.5	7.9	7.2	9.1	<0.05
Dressing	1.7	3.7	3.2	2.7	3.3	4.3	4.4	5.7	<0.001
Hygiene	1.7	4.1	3.1	2.9	3.9	4.9	5.2	6.0	<0.001
Housework	2.9	7.1	6.3	5.0	7.9	9.4	7.4	21	<0.01
Driving	0	6.9	7.4	8.8	20	35	17	11	<0.001
Employment	3.4	4.0	4.8	8.6	6.8	10.3	–	–	<0.001

Discussion

Minimally displaced proximal humeral fractures are relatively common (Neer 1970, Koval et al. 1997, Flatow 2001), but despite this there is remarkably little information about them in the literature. Until the introduction of the AO classification all minimally displaced proximal humeral fractures were combined as Neer one-part fractures, but the AO classification has permitted analysis of the different proximal humeral fracture types. Young and Wallace (1985) analyzed 34 patients with minimally displaced fractures at 6 months and showed that 97% had good or acceptable results. A good or acceptable result was defined as more than 60° abduction, no pain and satisfaction with usefulness and power. Kristiansen and Christensen (1987) showed that the results of treatment of minimally displaced fractures were better than those of displaced fractures, reporting that the average recovery was 85% one year after fracture. They based their results on the recovery

of strength, reach and shoulder stability. Koval et al. (1997) did a prospective study of 104 patients with minimally displaced fractures and found that only 77% had excellent or good results although their patients achieved 94% functional recovery. A good or excellent result was defined as no pain and recovery of at least 80% of function. They also found a positive correlation between outcome and the time of starting physiotherapy although they detected no correlation between age and outcome.

Our study confirms that the functional recovery after minimally displaced proximal humeral fractures is relatively good. We used different outcome criteria from those of Young and Wallace (1985) and Koval et al. (1997), but showed that if Neer's outcome criteria are used, 87% of patients can be expected to have excellent or good results by 1 year and that a relatively large number of the patients with fair or poor results had co-morbidities which prevented them from regaining good shoulder function no matter what treatment regime was instituted. Theoretically, the fact that

131 patients were lost to follow-up might affect the results as these patients might have had a worse final outcome than the patients who returned for follow-up. However, analysis showed no statistical difference in the distribution of AO fracture types between the patients who attended and those who did not. There was also no difference in age and we therefore believe that the results have not been significantly biased by the relatively high incidence of nonattenders in this elderly group of patients.

We believe that the most interesting association that emerges from this study is that between age and outcome. Only patients below 20 years of age had uniformly normal shoulder function at 1 year. Obviously some older patients will regain normal function, but over the age of 20 years, some patients will be left with mild residual deformity at 1 year. Patients above 60 years of age can expect an average Neer score of 85–90 at 1 year. Patients who had a limited range of shoulder mobility at 1 year considered that their subjective outcome, as measured by pain, strength, reach and stability, was better than the objective measurement of gleno-humeral function would suggest.

Lungberg et al. (1979) found no advantage of physiotherapy compared with independent exercises, but Koval et al. (1997) showed that the patients who had physiotherapy before 14 days had a better outcome. We did not start physiotherapy before 14 days, but we did allow patients to move their shoulders as much as pain permitted. However, analysis did show that in patients of a similar age increasing the duration of physiotherapy did significantly improve the results. We believe that more studies of the benefits of physiotherapy are needed as it seems likely that an independent exercise regime is useful.

Analysis of the patients with fair or poor results again indicated that age was important. However, multiple regression analysis showed that the only other determinant of outcome was the ability of the patients to undertake their own shopping. This simple criterion has been used for many years in our Unit to decide on the relative fitness of patients for proximal femoral surgery

and it appears that the simple question of asking a patient whether they can do their own shopping will also help determine outcome after minimally displaced proximal humeral fractures. Like Koval et al. (1997), we found no association between the amount of displacement of the greater tuberosity and outcome, but obviously many of the patients with poor results were frail or had preexisting shoulder pathology.

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No competing interests declared.

Constant C R. Age-related recovery of shoulder function after injury. Thesis, University College, Cork 1986.

Court-Brown C M, Garg A, McQueen M M. The epidemiology of proximal humeral fractures. *Acta Orthop Scand* 2001; 72: 365-71.

Flatow E L. Fractures of the proximal humerus. In: *Fractures in adults*. 5th Ed (eds. Bucholz R W, Heckman J D). Lippincott, Williams and Wilkins. Philadelphia 2001: 997-1040.

Gallacher M A, Zuckerman J D, Cuomo F, Ortiz J. The effect of age, speed and arm dominance on shoulder function in untrained men. *J Shoulder Elbow Surg* 1996; 5: 25-31.

Koval K J, Gallacher M A, Marsicano J G, Cuomo F, McShinaw A, Zuckerman J D. Functional outcome after minimally displaced fractures of the proximal part of the humerus. *J Bone Joint Surg (Am)* 1997; 79: 203-7.

Kristiansen B, Christensen S W. Proximal humeral fractures. Late results in relation to classification and treatment. *Acta Orthop Scand* 1987; 58: 124-7.

Lungberg B J, Svenungson-Hartwig E, Wikmark R. Independent exercises versus physiotherapy in non-displaced proximal humeral fractures. *Scand J Rehab Med* 1979; 11: 133-6.

Moseley H F. *Shoulder lesions*. 3rd Ed. Edinburgh etc: E&S Livingstone 1969

Müller M E, Nazarian S, Koch P, Schatzker J. *The comprehensive classification of fractures of long bones*. Springer-Verlag, New York 1990.

Neer C S. Displaced proximal humeral fractures. Part I. Classification and evaluation. *J Bone Joint Surg (Am)* 1970; 52: 1077-89.

Wallace W A, Hellier M. Improving radiographs of the injured shoulder. *Radiography* 1983; 49: 229-33.

Young T B, Wallace W A. Conservative treatment of fractures and fracture-dislocations of the upper end of the humerus. *J Bone Joint Surg (Br)* 1985; 67: 373-7.