The impacted varus (A2.2) proximal humeral fracture

Prediction of outcome and results of nonoperative treatment in 99 patients

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Background and patients **The outcome of the impacted varus proximal humeral fracture has not been described. We present the results of a prospective analysis of 99 such fractures.**

Results **This fracture was relatively common in the elderly population and non-operative treatment sometimes resulted in increased varus angulation. Decreased shoulder function was associated with increasing age but not with increasing varus angulation. After nonoperative management the outcome was good, regardless of the degree of varus, 1 year after fracture. Age was the main predictor of outcome. Physiotherapy did not improve outcome.**

A recent prospective analysis of the epidemiology of 1 027 consecutive proximal humeral fractures showed that the impacted varus (AO-11A2.2) (Müller et al. 1990) fracture accounted for 13% of all proximal humeral fractures (Court-Brown et al. 2001a) (Figure 1). Thus, along with the A3.2 displaced surgical neck fracture, it is the second commonest proximal humeral fracture variant after the B1.1 impacted valgus fracture (Court-Brown et al. 2002). Despite its frequency, there has been no previous study of the impacted varus fracture. There are understandable concerns among surgeons, however, that the varus deformity associated with this fracture may predispose to an increased incidence of impingement syndrome, and therefore

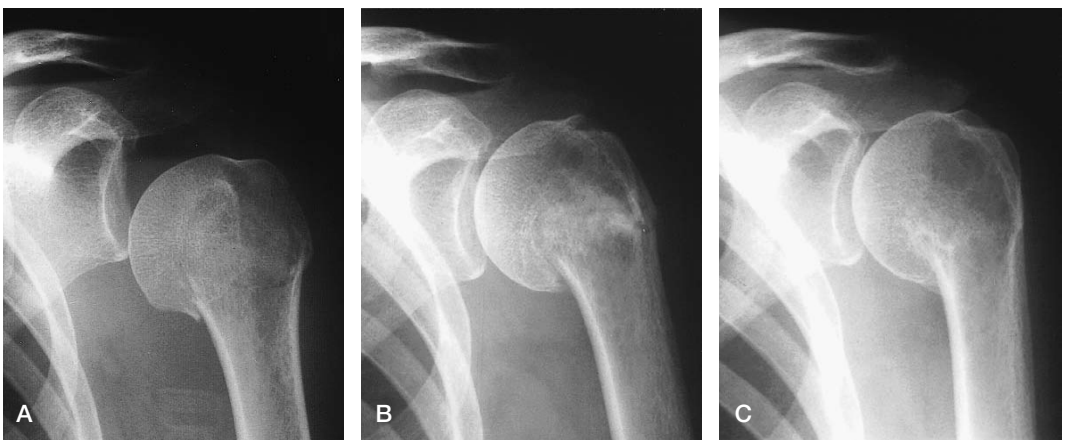

Figure 1. The antero-posterior radiographs of a 54-year-old woman who presented with an A2.2 impacted varus fracture (A). This was treated non-operatively but at 6 weeks there was evidence of increasing angulation (B) which was unchanged at 1 year (C). The final Neer score was 94.

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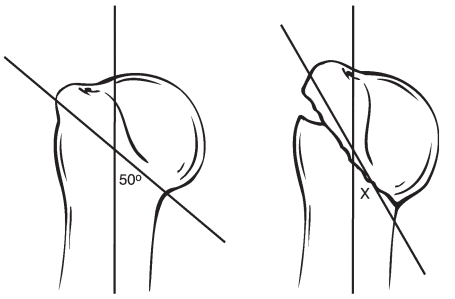

Figure 2. The method of calculating increased varus angulation. The angle in the normal population is 50° (A). The angle x is calculated from post-fracture radiographs and subtracted from 50° to give the amount of increased varus angulation (B).

shoulder pain. It is also possible that impingement of the greater tuberosity on the acromion might lead to restriction of movement, although Flatow (2001) has suggested that almost any degree of angulation can be tolerated in older patients. We have undertaken a prospective study of impacted varus fractures to examine the outcome of nonoperative management and to determine which factors affect outcome.

Patients and methods

The Edinburgh Orthopaedic Trauma Unit treats all fractures in a population of about 650 000 people. Fractures in patients from outwith the catchment area were not included in this analysis. Between June 1992 and May 1996, we treated 1 027 consecutive patients with proximal humeral fractures. 135 (13%) of the patients had impacted varus (A2.2) fractures. 2 adolescent patients had physeal fractures with varus angulation and were excluded from further analysis. The average age of the remaining 133 patients was 68 (23–94) years. There was a unimodal age distribution with 89% of the patients being over 50 years of age. 15 patients (11%) were less than 50 years of age, 16 (12%) were between 50 and 59 years, 28 (21%) were between 60 and 69 years, 40 (30%) were between 70 and 79 years and 34 (26%) were over 79 years of age. A simple fall was the cause of injury in 121 patients (91%) and only 1 patient had been involved in a road traffic accident. 16 (12%) presented with other musculoskeletal injuries. All fractures were treated by experienced orthopedic trauma surgeons and only 2 were treated surgically. The remaining 131 were treated nonoperatively with the arm being immobilized in a sling for two weeks, after which a course of physiotherapy was organized if this was felt to be appropriate. The physiotherapy regime was based on that of Neer (1970) and the duration of the physiotherapy programme was determined by the treating physiotherapist. Follow-up was undertaken by the two authors in a research clinic and the outcome was assessed by an independent research physiotherapist who was not involved in treatment of the patients.

All patients were examined at 6, 13, 26 and 52 weeks with outcome being assessed using the outcome score of Neer (1970). The time taken to return to a number of routine activities appropriate for an elderly population, such as housework, shopping, independent personal toilet and independent dressing was also assessed. The power of abduction and flexion of the injured shoulder was measured using a spring balance technique at each outpatient assessment. Since handedness does not affect shoulder function (Gallagher et al. 1996), the measurements were expressed as a percentage of the normal side. Standardized anteroposterior and modified axial radiographs (Wallace and Hellier 1983) were taken at the initial presentation and at each follow-up assessment. Varus deformity was measured by drawing a line between the tip of the greater tuberosity and the inferior articular edge and a second line parallel to the humeral cortices. The angle of intersection represents the degree of varus (Figure 2). Assessment of normal shoulders in Edinburgh showed that the normal angle was 50° and the figures for increased varus angulation that are presented in this article have been computed by subtracting the radiographic varus angle from 50°. It is accepted that standardized radiographs of the shoulder are very difficult to achieve and therefore the results have been expressed in 10° ranges to minimize the problem of radiological standardization. Of the 131 patients who were treated nonoperatively during the study period, 32 (24%) either died or were lost to follow-up. We present the outcome for the remaining 99 patients.

Statistical analysis was done using multiple regression analysis and Pearson correlations.

Table 1. Neer scores at 6, 13, 26 and 52 weeks

	6	13	26	52 weeks
Neer (100)	58	74	82	87
Pain (35)	25.1	30	32	34
Strength (10)	5.8	7.3	8.2	8.9
Reach (10)	6.9	8.2	8.7	9.2
Stability (10)	5.0	7.5	8.9	9.2
Flexion (6)	1.8	3.4	3.8	4.2
Extension (3)	2.2	2.6	2.7	2.8
Abduction (6)	0.8	2.0	2.7	3.3
Extern. rotation (5)	2.7	3.3	3.7	4.1
Intern. rotation (5)	2.6	3.2	3.7	4.0
Flexion power (%)	11	38	62	70
Abduct. power (%)	7.9	37	62	69

Results

All of the fractures united. There was a gradual improvement in the Neer score between 6 weeks and 1 year, with a mean final score of 87. Using the Neer outcome criteria, 79% of the patients had good or excellent results at 1 year. All the scores gradually improved throughout the year, but the more subjective scores of strength, reach and stability showed greater improvement than the objective scores of glenohumeral movement and power (Table 1). By 1 year, patients considered that their stability, reach and strength were about 90% of normal, although of all the glenohumeral movements only extension showed a 90% return. Flexion measured about 70% of normal and abduction only 53% 1 year after fracture. Flexion and abduction power were about 70% of normal at the end of the first year.

We found a correlation between age and outcome, with patients under 40 years of age having a virtually normal shoulder after 1 year. This contrasts with the 80–99 year-old group who showed significantly reduced glenohumeral movement and power (Table 2). Again the subjective impression of the patients was better than the objective assessment of glenohumeral movement and power would suggest. Even in the 80–99 year-old group the patients assessed strength, reach and stability at 90% of normal level whereas the results of glenohumeral movement and power were much less. In addition to the overall Neer score increasing age correlated with decreasing reach, flexion, abduction and internal rotation. There was, however, no statistical correlation between age and pain.

41% of the patients presented with less than 10° of increased varus angulation after fracture. A further 28% had 10–19° increased varus and 25% presented with 20–29° increased varus. The remaining 6% had more than 29° of increased varus at presentation. There was no statistical correlation between age and the degree of increased varus at initial presentation, although there was correlation between the final varus angle at one year and age ($p < 0.01$), suggesting that increasing osteoporosis is associated with increasing varus angulation (Figure 3).

The relationship between the increased varus angle at 1 year and outcome is shown in Table 3. There is an apparent correlation between increas-

Table 2. Mean Neer scores at one year for the different age groups, with 95% confidence limits for mean change per decade

	< 40 years	40–49	50–59	60–69	70–79	80–99	P-value	95% CL
Neer (100)	95	90	89	86	87	82	0.02	–4.20; –0.44
Pain (35)	33	35	33	34	35	33	0.7	–0.33; +0.51
Strength (10)	9.0	9.0	8.6	8.8	9.2	8.8	0.9	–0.26; +0.31
Reach (10)	10	10	9.6	9.2	9.0	8.9	0.04	–0.51; –0.01
Stability (10)	10	10	9.5	9.2	9.1	8.9	0.07	–0.61; +0.02
Flexion (6)	6.0	5.5	4.5	4.4	4.1	3.5	0.007	–0.78; –0.13
Extension (3)	3.0	3.0	2.7	2.9	2.8	2.7	0.4	–0.15; +0.06
Abduction (6)	6.0	5.5	3.7	3.2	3.1	2.6	0.002	–0.95; –0.23
Extern. rotation (5)	5.0	4.0	4.6	4.1	3.9	3.9	0.07	–0.45; +0.02
Intern. rotation (5)	5.0	4.0	4.3	4.1	3.8	3.8	0.02	–0.39; –0.05
Flexion power (%)	95	65	70	76	68	60	0.2	–11; +2.7
Abduct. power (%)	97	69	69	74	69	57	0.2	–12; +2.1

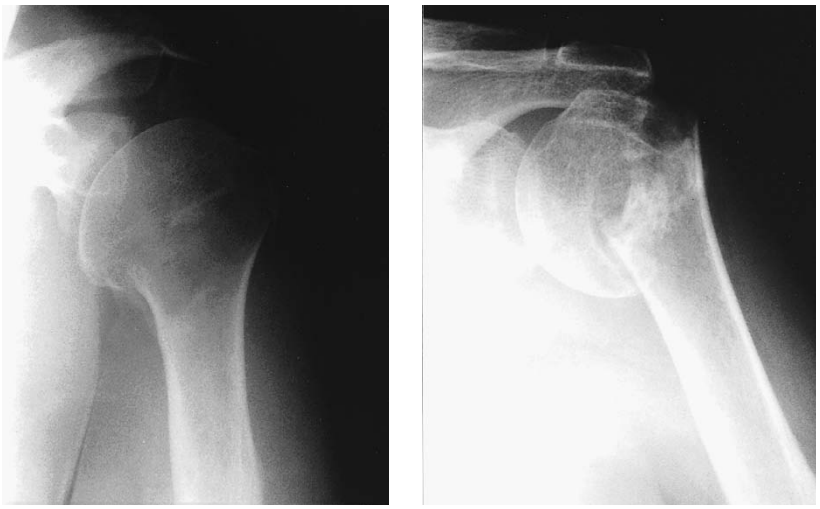

Figure 3. Antero-posterior radiographs of a 73-year-old woman who initially showed very little evidence of varus (A). However 6 weeks later there was a considerable increase in varus angulation (B).

ing varus angulation and outcome at 1 year in some parameters, but multiple regression analysis showed that decreasing function was related only to increasing age and not to increasing varus angulation (Table 3). It is also interesting to note that the Neer score at 1 year for the 40–49° group was 84, suggesting that most patients achieved a good or excellent result regardless of the degree of varus at final follow-up.

Table 3. Age and average Neer scores for different ranges of increased varus angulation at 1 year

Varus angulation	0–9°	10–19°	20–29°	30–39°	40–49°
Average age	62	58	69	69	73
Neer (100)	86	94	89	88	84
Pain (35)	32	35	35	34	32
Strength (10)	8.0	10	9.2	8.9	8.6
Reach (10)	8.7	9.6	9.4	9.3	8.9
Stability (10)	10	10	9.4	9.2	8.3
Flexion (6)	5.0	5.1	4.5	4.4	4.0
Extension (3)	3.0	2.9	2.8	2.8	2.9
Abduction (6)	4.0	5.0	4.3	3.3	2.6
Extern. rotation (5)	3.7	4.6	3.9	4.5	4.1
Intern. rotation (5)	4.0	4.3	4.3	4.1	4.0
Flexion power (%)	72	85	60	71	55
Abduct. power (%)	66	68	70	75	63

We also analyzed the role of physiotherapy. 17 patients (17%) with an average age of 77 years did not have physiotherapy, but the remaining 72 did. These patients had an average age of 66 years. The 1-year Neer score for the patients treated with physiotherapy was 88, with 74 being recorded for the patients who did not have physiotherapy. This appears to indicate that physiotherapy was useful but multivariate analysis suggested that the difference in outcome was due to the age of the patients rather than the use of physiotherapy. Analysis of the duration of physiotherapy showed no correlation between the 1-year Neer scores and the duration of the physiotherapy treatment between 1 week and 6 months.

The patients returned to shopping at an average of 8 weeks. They were able to dress independently at 5 weeks and undertake personal hygiene at 5 weeks. They were able to return to housework after an average of 8 weeks.

Discussion

Given the frequency with which the impacted varus proximal humeral fracture occurs, it is surprising that there has been no previous study relating to its treatment or the factors that affect outcome. We believe that the impacted varus fracture is unique among surgical neck fracture variants of the proxi-

mal humeral fracture in that it continues to displace during the initial treatment phase, as illustrated in Figure 1. We did not observe this with the two other common fracture variants, the translated surgical neck fracture (Court-Brown et al. 2001b) and the impacted valgus fracture (Court-Brown et al. 2002). Late angulation can be dramatic, as shown in Figure 3 where a fracture with very little initial varus angulation has displaced markedly by 4 weeks. Given these radiographical appearances, it is not surprising that there is concern that increasing angulation will cause pain and restriction of movement. We found no correlation between increased varus angulation and decreased shoulder function, however; most patients had an excellent or good result no matter what final varus angulation was achieved. It may be of interest to surgeons that the average age of patients with final varus angulation of more than 30° was about 70 years. Thus any surgery undertaken to correct the varus would be difficult. There was no correlation between pain and increasing varus angulation, suggesting that late pain from impingement syndrome is not a significant problem in these patients.

We considered the possibility that increasing varus angulation might cause pain or decreased flexion, extension or rotation at 6, 13 or 26 weeks, but not at one year. We found no correlation between pain or glenohumeral movement and increased varus angulation at these times, however. We therefore conclude that despite the radiographical appearances, there is little evidence that increasing varus angulation causes increased pain or significantly decreased function.

As with the other proximal humeral fractures, the main determinant of outcome is age. Good results can be expected in younger patients (Figure 1) but the results deteriorate with increasing age, although even between 80 and 99 years of age the average one-year Neer score is compatible with good function. The return to activities of daily living is also relatively fast given the age of the patients. Constant (1986) has shown that there is deterioration of shoulder function with increasing age and it is interesting to note that, as with other proximal humeral fractures in the elderly, the perception of treatment success is greater than that suggested by the measurement of glenohumeral function and power. Thus, it appears that nonoperative management gives good results which are unlikely to be improved by surgery in the elderly population.

Physiotherapy is assumed to be important in the treatment of proximal humeral fractures, but we failed to demonstrate its usefulness in the treatment of this fracture. The poor outcome of the group that did not receive physiotherapy was related to increasing age and it was interesting to note that increasing the duration of physiotherapy did not improve final outcome. It could be argued that the physiotherapists appropriately discharged their patients when a suitable outcome had been achieved, but this would seem rather unlikely and we believe that the role of physiotherapy may not be as important as previously believed. This requires further investigation.

No competing interests declared.

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