

Long-term outcome of a proximal humerus fracture predicted after 1 year

A 13-year prospective population-based follow-up study of 47 patients

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Background Earlier reports of results after proximal humerus fractures have often been short- or medium-term studies. The aim of this investigation was to follow an unselected group of patients prospectively and assess the long-term results in relation to fracture type and health, and to evaluate the possibility of predicting the long-term results after 1 year.

Method 258 consecutive urban patients who sustained a proximal humerus fracture in 1987 were followed prospectively and examined after 1 and 13 years. 158 patients had died by the year 2000 and 47 of the surviving patients were available for clinical and radiographic evaluation. The Constant-Murley score (CM-score) was used in the clinical assessment. In the final follow-up group, all patients except 1 were treated nonoperatively.

Results 21 patients had asymptomatic, pain-free shoulders. In 26 patients with shoulder symptoms, 11 had severe pain and 10 had moderate pain, and only 2 of these 21 patients had normal shoulder function. The remaining 5 patients in the symptomatic group had no shoulder pain but had reduced shoulder function. Shoulders with a displaced fracture and also injured shoulders of patients with a chronic disease were significantly worse at the long-term follow-up. The 1-year examination had been able to predict the long-term results with 71% sensitivity for protracted pain and 88% sensitivity for persistent shoulder dysfunction.

Interpretation Our results suggest that there is a substantial mortality in patients with a proximal humerus fracture, as we have previously reported, and that surviving patients frequently have persistent symptoms that can be predicted as early as after 1 year. ■

Fractures of the proximal end of the humerus have been studied extensively. There have been reports on epidemiology (Horak and Nilsson 1975, Nordquist and Petersson 1995, Kannus et al. 2000) and on various treatments—both nonoperative and surgical (Neer 1970, Leyshon 1984, Resch et al. 1997). There have been many reports on the outcome after treatment, based both on classification of the fracture (Kristiansen and Christensen 1987, Koval et al. 1997, Court-Brown and McQueen 2002) and on the method of treatment (Young and Wallace 1985, Szyszkowitz et al. 1993, Court-Brown et al. 2001). To our knowledge, no randomized controlled trials have been published concerning treatment. The follow-up periods and the methods of evaluation have varied widely and the results, most frequently measured as pain and shoulder function, have generally been classified as favorable—especially in patients with minimally displaced fractures.

In this study, we evaluated the importance of fracture-related and health-related factors on the long-term results. We also assessed the possibility of predicting the long-term results 1 year after the fracture.

Patients and methods

Malmö, a city in southern Sweden, has a well-defined population. In 1987 there were about 230,000 inhabitants. Medical care is provided by a single university hospital, Malmö University Hospital. Virtually all major injuries, including frac-

Table 1. 258 patients with a proximal humerus fracture in 1987

	Deceased	Living in year 2000				Total	Total
		Examined	Not examined				
			Study subjects	Dementia & disabling disease	Migrated		
All, n	158	47	22	14	17	100	258
Men	32	9	4	4	6	23	55
Women	126	38	18	10	11	77	203
Mean age (SD) at injury							
All	78 (9)	59 (13)	69 (11)	49 (22)	60 (15)	60 (15)	71 (14)
Men	74 (10)	50 (18)	55 (15)	50 (20)	59 (13)	53 (16)	65 (16)
Women	79 (8)	61 (11)	73 (6.4)	48 (23)	61 (17)	62 (15)	73 (14)
Fracture displacement							
Undisplaced, n (rate)	115 (0.7)	38 (0.8)	14 (0.6)	11 (0.8)	16 (0.9)	79 (0.8)	194 (0.8)
Displaced, n (rate)	43 (0.3)	9 (0.2)	8 (0.4)	3 (0.2)	1 (0.1)	21 (0.2)	64 (0.2)
Treatment							
Nonoperative, n (rate)	147 (0.9)	46 (1.0)	19 (0.9)	13 (0.9)	16 (0.9)	94 (0.9)	241 (0.9)
ORIF, n (rate)	7 (0.0)	1 (0.0)	3 (0.1)	1 (0.1)	1 (0.1)	6 (0.1)	13 (0.1)
Arthroplasty, n (rate)	4 (0.0)	–	–	–	–	–	4 (0.0)

tures, are seen at the emergency unit of this hospital. In 1987, all fractures of the proximal humerus in Malmö residents were registered prospectively. Residents with a proximal humerus fracture who were mainly treated elsewhere but who were subsequently referred to the hospital were included in the study, whereas patients with a proximal humerus fracture who were not Malmö residents were excluded. 268 patients with a fracture of the proximal humerus were registered in 1987. We excluded 8 children (< 14 years) and also 1 patient with bilateral fracture. 1 patient with incomplete data was also excluded, leaving 258 patients for the study. All these patients were re-examined and interviewed by one of the authors (AN), 1 or 2 days after the injury. Data including former health, earlier fractures, medication, living and mobility of the patient were registered, as well as trauma data involving circumstances, classification of the fracture, and magnitude of the trauma. Trauma magnitude corresponding to a fall from standing or slow walking was classified as moderate, and trauma corresponding to a fall from more than half a meter or occurring at a speed greater than ordinary walking was classified as severe.

13 patients with severely dislocated fractures with ad latus or rotational fragment displacement were operated on with internal fixation, and 4

patients with displaced four-part fractures (including 2 fracture-dislocations) were operated on with primary hemi-arthroplasty. The remainder were treated nonoperatively with 2–4 weeks sling fixation before mobilization with physiotherapy. All patients were then followed prospectively, and surviving patients living in Malmö who were able to attend the outpatient clinic of the Department of Orthopedics were re-examined clinically and radiographically in 1988, 1992 and 2000.

In the year 2000, 158 patients had died and 14 patients had moved from Malmö. 86 patients living in Malmö were offered a re-examination. 22 patients declined due to old age, immobilizing disease or dementia. 17 patients did not turn up and did not reply to several pre-addressed letters of invitation (Table 1). 5 patients were older than 80 and another 3 of these patients were registered alcohol abusers.

50 patients were re-examined, but 1 of them had severe rheumatoid arthritis and 2 patients turned out to have dementia. Thus, 47 of the 100 surviving Malmö residents with a fracture of the proximal humerus in 1987 were involved in the final follow-up evaluation in the year 2000, including interview, clinical and radiographic examination. The outcome classification was based on pain, function, mobility and strength and scored according to Constant and

Murley (1987). The radiographic examination with standard views, a true anteroposterior and a transcapular lateral view of the shoulder was used to evaluate healing and secondary arthrosis defined as being at least Kellgren-Lawrence (1958) grade 2.

We obtained approval for the study from the local hospital ethics committee.

Statistics

Basic data are presented as mean and standard deviation (SD). We used non-parametric tests, Spearman correlation test and Mann-Whitney U test, as appropriate to test the relation between prognostic factors and long-term results. A cross-tabulation of the 1-year results and the long-term results was used in evaluating the predictability by calculation of the sensitivity (i.e. pain/dysfunction), and the specificity (i.e. pain-free/normal function). The level of significance was set at $p < 0.05$. All calculations were performed using STATISTICA 99 (StatSoft Inc.).

Results

34 patients had sustained their proximal humerus fracture after a moderate trauma and 13 patients experienced severe trauma. In the examination after 13 years, 21 of 47 patients (with a mean age of 59 years at injury) had a pain-free and well-functioning shoulder. The mean CM-score was 85 (62–100), and the mean relative CM-score comparing the injured and the normal shoulder was 96 (79–100) (Table 2). All patients except 3 had declared that the shoulder was pain-free and functioning normally at the 1-year follow-up. 1 woman, aged 71 at fracture, with a displaced two-part fracture had severe shoulder pain and dysfunction 1 year after her proximal humerus fracture, but was pain-free with normal function in 2000. Another woman, aged 63 at fracture, with a minimally displaced fracture had severe pain and dysfunction of the shoulder after 1 year, but was pain-free and had normal function at the final follow-up. A third patient, a man of 71 at fracture, had complained of shoulder pain at the 1-year follow-up but was pain-free at the final evaluation. All other patients in the pain-free group had had minimally displaced fractures. At the final radiographic follow-up exami-

nation, 16 shoulders were well united and 5 were mal-united. 9 patients reported poor health and concomitant disorders, including 3 cases of cardiovascular disease at follow-up.

14 patients, with a mean age of 59 (36–79) years when they got their fracture, had intermittent pain and/or reduction of function in the injured shoulder at the final follow-up. The mean CM-score for this group was 72 (42–88) and the mean relative CM-score was 87 (59–100). 8 patients complained of pain or dysfunction at the 1-year follow-up, whereas 6 patients who had stated that their injured shoulder was asymptomatic at the 1988 examination experienced deterioration and developed shoulder symptoms before the final examination. None of these patients had experienced any new shoulder trauma after 1987. All fractures had been treated nonoperatively and 11 had been minimally displaced. At the radiographic examination in 2000, 6 fractures were well healed and 8 were mal-united or deformed. 7 of the 14 patients reported co-morbidity.

12 patients with a mean age of 60 (43–76) years at fracture complained of continuous pain and/or dysfunction of the shoulder. The mean CM-score was 47 (22–68) and the mean relative CM-score was 60 (26–89). At the 1-year follow-up examination, all patients except 2 had reported painful shoulder symptoms after their proximal humerus fracture. 7 fractures had been classified radiographically in 1987 as minimally displaced. At the final radiographic follow-up examination, 3 fractures were well healed, 7 had healed with deformity or arthrosis, and 2 were not united. All patients except 1 in this group had been treated nonoperatively. 10 of the 12 patients had concomitant disorders.

13 patients with poor health and co-morbidity at the final follow-up evaluation had chronic disorders at the initial examination in 1987, whereas another 13 patients had developed chronic disorders during the posttraumatic period. Mean CM-score for 26 patients with registered co-morbidity was 65, as compared to a mean score of 79 in 21 healthy patients. There was a weak but significant correlation between poor health and fracture results, registered as a lower Constant-Murley score ($rs = -0.36$, $p = 0.01$).

35 patients (mean CM-score 75) were medication-free and 6 patients (mean CM-score 70) used

Table 2. Injury- and follow-up data of 47 patients with a proximal humerus fracture in 1987

		1987							1988							2000							
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	
1	M	24	1	2	0	0	0	2	1	1	180	85	1	1	1	180	80	1	0	100	100	Good	
2	M	29	1	2	0	0	0	2	1	1	180	60	1	1	1	180	90	1	0	98	98	Good	
3	F	36	1	2	0	0	0	2	2	1	160	60	3	2	2	180	60	3	0	76	87	Fair	
4	M	41	1	2	0	0	0	1	1	1	180	60	1	1	1	180	80	1	0	98	100	Good	
5	M	41	1	1	0	0	0	2	1	1	180	70	1	2	2	170	80	1	0	80	80	Fair	
6	F	43	2	2	0	0	0	1	2	1	180	30	1	1	2	170	60	1	0	78	82	Fair	
7	F	43	2	3	0	0	1	2	2	2	150	50	1	3	3	150	95	2	0	53	59	Poor	
8	F	43	1	1	0	0	0	1	1	1	180	70	1	1	1	180	90	1	0	91	100	Good	
9	F	45	1	1	1	2	0	2	1	1	180	80	1	3	2	170	80	1	1	63	67	Poor	
10	M	46	1	3	1	0	0	2	2	2	130	10	3	3	3	140	70	3	1	61	67	Poor	
11	F	51	1	1	0	0	0	1	1	1	180	80	1	2	1	170	80	1	0	88	94	Fair	
12	F	52	1	2	1	1	0	2	1	1	180	85	1	1	1	170	90	1	0	84	95	Good	
13	F	53	1	1	0	0	0	1	1	1	160	75	1	1	2	150	90	1	0	83	96	Fair	
14	F	53	1	1	1	1	0	1	2	2	160	70	1	3	3	145	50	3	1	31	36	Poor	
15	F	54	1	1	1	1	0	1	2	1	180	70	1	2	1	170	80	1	1	78	96	Fair	
16	F	56	2	3	0	0	0	1	3	3	70	40	3	3	3	90	30	4	0	30	48	Poor	
17	F	56	2	1	0	0	0	1	2	2	160	60	3	3	2	140	20	4	1	52	74	Poor	
18	F	56	1	1	0	0	0	1	1	1	160	60	1	1	1	160	80	1	0	81	98	Good	
19	M	56	1	1	0	0	0	1	1	1	170	30	1	1	1	170	80	1	1	93	100	Good	
20	F	58	2	1	0	0	0	1	1	1	180	70	1	1	1	150	80	3	1	71	79	Good	
21	F	59	1	2	0	0	0	1	1	1	180	80	1	1	1	170	90	1	0	86	100	Good	
22	F	59	2	1	0	0	0	1	2	1	160	30	1	2	2	180	90	1	1	80	96	Fair	
23	F	60	2	1	0	0	0	1	2	2	140	20	1	2	2	160	20	4	1	68	80	Fair	
24	F	61	2	4	0	0	0	2	1	1	140	50	3	2	2	140	80	3	1	62	91	Fair	
25	F	63	2	1	1	2	0	2	3	2	145	50	1	1	1	170	55	1	1	85	96	Good	
26	F	63	2	1	0	0	0	1	1	1	180	80	1	1	1	170	85	1	1	82	100	Good	
27	F	65	2	3	0	0	0	1	2	2	150	30	1	1	2	160	40	3	1	81	91	Fair	
28	F	65	1	1	0	0	0	2	3	2	120	45	1	3	2	105	50	3	1	35	39	Poor	
29	F	66	1	1	1	2	0	1	1	1	160	45	1	3	2	160	45	5	1	68	82	Poor	
30	F	67	2	4	1	2	0	1	3	3	80	20	2	3	3	80	20	2	1	22	26	Poor	
31	F	67	1	1	0	0	0	1	1	1	170	70	1	1	1	180	90	1	0	87	100	Good	
32	F	68	2	1	0	0	0	1	1	1	170	45	1	1	1	170	80	1	1	87	100	Good	
33	F	69	2	1	1	0	0	1	1	1	150	70	1	1	1	170	85	1	1	87	100	Good	
34	M	68	1	1	1	1	0	1	1	1	160	60	1	1	1	160	80	3	0	88	92	Good	
35	F	68	1	1	0	0	0	1	1	1	160	60	1	1	2	160	60	3	1	70	80	Fair	
36	M	70	1	1	0	0	0	2	1	1	155	60	1	1	1	160	80	1	0	95	100	Good	
37	F	71	2	1	0	0	0	1	1	1	170	50	1	1	1	170	90	3	0	77	95	Good	
38	F	71	2	1	1	0	0	1	2	3	90	20	1	1	2	125	80	3	0	60	82	Fair	
39	M	71	2	1	0	0	0	2	2	1	150	70	1	1	1	165	50	3	1	91	96	Good	
40	F	71	1	4	1	2	0	1	2	2	110	30	1	2	3	100	30	3	1	49	63	Poor	
41	F	71	1	3	0	1	0	1	3	2	170	30	1	1	1	140	50	1	1	62	86	Good	
42	F	73	2	1	1	1	0	1	2	2	150	40	-	3	2	140	80	1	1	58	89	Poor	
43	F	73	2	1	1	0	0	1	1	1	170	45	3	1	1	160	80	3	1	78	92	Good	
44	F	73	2	1	0	0	0	1	1	1	160	80	1	1	1	150	80	1	0	70	93	Good	
45	F	76	1	1	1	0	0	1	2	2	120	45	1	3	3	130	70	1	1	40	69	Poor	
46	F	78	1	1	0	0	0	1	1	1	170	50	1	2	1	140	60	3	0	55	100	Fair	
47	F	79	2	4	1	2	0	1	2	2	90	30	3	2	2	80	0	5	1	42	59	Fair	

one medicine. 6 other patients (mean CM-score 55) used 2 or more medicines. A weak but significant correlation was found between medication and Constant-Murley score ($r_s = -0.31$, $p = 0.04$).

9 patients with displaced proximal humerus fractures in 1987 had more shoulder pain ($p = 0.05$) and lower Constant-Murley score (mean CM-score

51) compared to 38 patients with minimally displaced fractures (mean CM-score 76) at follow-up ($r_s = -0.48$, $p < 0.001$).

Only 1 patient had used a walking aid and no patients had lived in institutions in 1987. 25 patients (mean CM-score 72) had been free of prevalent fractures at time of their proximal humerus frac-

A Sex	K Flexion (degrees)
M Male	L External rotation (degrees)
F Female	M Radiographic evaluation
B Age at trauma	1 Well healed
C Side	2 Nonunion
1 Right	3 Deformity/malunion
2 Left	4 Arthrosis
D Fracture type, modified Neer-classification	5 Deformity/malunion and arthrosis
1 Minimally displaced	N Shoulder pain
2 Undisplaced greater tubercle	1 None or slight
3 Displaced 2-part	2 Intermittent
4 Displaced 3-part	3 Continuous
5 Displaced 4-part	O Function
E Co-morbidity	1 Normal
0 No disorders	2 Reduced
1 One or several disorders	3 Dysfunction
F Medication	P Flexion (degrees)
0 No medication	Q External rotation (degrees)
1 One medicine	R Radiographic examination
2 Two or several medicines	1 Well healed
G Treatment	2 Nonunion
0 Nonoperative	3 Deformity/malunion
1 ORIF	4 Arthrosis
H Trauma magnitude	5 Deformity/malunion and arthrosis
1 Moderate	S Co-morbidity
2 Severe	0 No disorders
I Shoulder pain	1 One or several disorders
1 None or slight	T Constant
2 Intermittent	U Constant score (% of the contralateral shoulder score)
3 Continuous	V Outcome – final results
J Function	
1 Normal	
2 Reduced	
3 Dysfunction	

ture in 1987, whereas 16 patients (mean CM-score 77) had reported 1 previous fracture and 6 patients (mean CM-score 52) had had 2 or more fractures. There was no correlation between the fracture history of the patients and late fracture results (expressed as Constant-Murley score).

Mean CM-score was 60 for 22 patients with fracture malunion and/or joint deformation, including two patients with nonunion, after healing, which can be compared to a mean CM-score of 81 for 25 patients with normal fracture union ($p < 0.001$). The long-term results could be predicted at the 1-year examination with 71% sensitivity for pain and 88% sensitivity for reduced shoulder function. The specificity for painless and normal-functioning shoulders was 77% and 71%, respectively.

Discussion

Several studies on the outcome of fractures of the proximal humerus, analyzing both short-term and

long-term results after different fracture types and after various treatments, have been reported (Neer 1970, Clifford 1980, Mills and Horne 1985, Young and Wallace 1985, Kristiansen and Christensen 1987, Rasmussen et al. 1992, Koval et al. 1997, Zyto et al. 1997, Court-Brown et al. 2001, Court-Brown and McQueen 2002).

To our knowledge, there have been no earlier studies following a population-based group of patients with a proximal humerus fracture prospectively— from injury and for over a decade. One important conclusion that can be drawn from our 13-year investigation of all Malmö citizens who had a proximal humerus fracture in 1987 is, as we have reported earlier (Olsson et al. 2003), that there is a substantial mortality amongst aged patients. More than half of the old (> 65 years) patients died before the final follow-up examination, which includes nearly all of the patients treated surgically due to dislocated fractures. This should be taken into consideration when planning the treatment of an old patient with a dislocated proximal humerus fracture.

All but one of our patients had been treated without surgery. Earlier reports have indicated that the results of nonoperative treatment of proximal humerus fractures are better if the fracture is minimally displaced (Clifford 1980, Leyshon 1984, Kristiansen and Christensen 1987). This is in agreement with our findings. However, more than half of our patients with symptomatic shoulders (pain and reduced function) were originally minimally displaced, indicating a less favorable outcome than is generally assumed (Koval et al. 1997). One reason for this discrepancy might be differences in scoring of the results. In our study, only the patients with pain-free shoulders that functioned normally were classified as asymptomatic. Also, in some patients with a minimally displaced proximal humerus fracture, there may be a concomitant periarticular soft tissue injury, resulting in a persistent symptomatic shoulder with decreased mobility after fracture healing, as observed in several of our patients.

In the present study, 21 of our patients had asymptomatic shoulders at the final examination. The mean age of these patients at injury was 59 years, the same as in the patients with moderate and severe persistent shoulder symptoms. Earlier studies (Szyzkowitz et al. 1993, Court-Brown and McQueen 2002, Gaebler et al. 2003) have found age to be a main determinant of outcome after fractures of the proximal humerus. However, as the follow-up period in these studies was shorter than in the present study, the results are not comparable, as most of the aged patients in our study had died at the time of the long-term examination.

Gaebler et al. (2003) also reported that co-morbidities were associated with worse outcome after proximal humerus fractures. This is in agreement with our findings. One reason for this may be that a patient with poor health is less likely to follow a vigorous shoulder-training program after a fracture. This should also be an important consideration when planning the treatment of a fresh proximal humerus fracture. Our results suggest that the long-term result of such a fracture can be predicted early, and with a reasonably high degree of accuracy. Shoulder symptoms that exist at the 1-year control will probably remain—which might be of interest also in insurance statements.

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