Humeral shaft fractures: retrospective results of non-operative and operative treatment of 186 patients

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Running title: Outcome after treatment of humeral shaft fractures

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ABSTRACT

Background: Humeral shaft fractures account for 1-3% of all fractures and 20 % of the fractures involving the humerus. The aim of the current study was to compare the outcome after operative and non-operative treatment of humeral shaft fractures**,** by comparing the time to radiological union and the rates of delayed union and complications.

Methods: All patients aged 16 years or over treated for a humeral shaft fracture during a five-year period were included in this retrospective analysis; periprosthetic and pathological fractures were excluded. Radiographs and medical charts were retrieved and reviewed in order to collect data on fracture classification, time to radiographic consolidation and the occurrence of adverse events.

Results: A total of 186 patients were included; 91 were treated non-operatively and 95 treated operatively. Mean age was 58.7 ± 1.5 years and 57.0% were female. In 83.3% of the patients only the humerus was affected. A fall from standing height was the most common cause of the fracture (72.0%). Consolidation time varied from a median of 11 to 28 weeks. The rate of radial nerve palsy in both groups was similar; 8.8% versus 9.5%. In 5.3% of the operatively treated patients the palsy resulted from the operation. Likewise, delayed union rates were similar in both groups; 18.7% following non-operative treatment versus 18.9% following surgery.

Conclusion: The data indicated that consolidation time and complication rates were similar after operative and non-operative treatment. A prospective randomized clinical trial comparing non-operative with operative treatment is needed in order to examine other aspects of outcome, meaning shoulder and elbow function, post-operative infection rates, trauma related quality of life and patient satisfaction.

INTRODUCTION

Fractures of the shaft of the humerus account for 1-3% of all fractures[1] and approximately 20% of all fractures involving the humerus.[2] The incidence is 14.5 per 100,000 per year, gradually increasing from the fifth decade and reaching its peak of 60 per 100,000 per year in the ninth decade. Also a minor peak is seen in the third decade.[1, 3]

Both operative and non-operative treatment is used in the management of humeral shaft fractures. Traditionally, the treatment has generally been non-operative, nowadays using the Sarmiento brace as functional bracing therapy.[4] Operative approaches include intramedullary nailing, plate osteosynthesis and an external fixation.[5]

Both non-operative and operative treatment strategies have their pros and cons. Although functional treatment is believed to be associated with a very low rate of delayed union and excellent functional results,[6] in certain groups of patients functional bracing does not provide sufficient immobilization. For instance, non-operative treatment in overweight patients result in a high rate of delayed union.[7]

There is substantial controversy on the best approach of humeral shaft fractures. Kocht et al. for example stated that though newer intramedullary techniques are probably less invasive and technically less complicated, the Sarmiento brace remains the gold standard and first treatment of choice.[8] Schratz et al. on the contrary favors intramedullary nailing.[9] Schittko et al. claimed that the operative therapy should be considered as the gold standard because of the development of new intramedullary and rotation stable implants in addition to the classical osteosynthesis using a plate.[5]

So the best treatment is still at debate and the type of treatment highly depends on the physician's personal view. The current literature lacks an answer to the question whether operative or non-operative treatment results in different clinical outcomes The aim of the current study was to compare the outcome after operative versus non-operative treatment of humeral shaft fractures, by comparing the time to radiological union and the rates of delayed union and complications.

PATIENTS AND METHODS

All patients aged sixteen years or over treated for a humeral shaft fracture in the Erasmus MC (Rotterdam, the Netherlands) between January 2002 and December 2006, the Albert Schweitzer Hospital (Dordrecht, the Netherlands) between January 2003 and December 2007, and the Maasstad Hospital (Rotterdam, the Netherlands) between January 2004 and December 2008 were included in this retrospective analysis. Periprosthetic and pathological fractures were excluded.

The patients were identified from the radiology program PACS (Picture Archiving and Communication System). Reports of all radiographs of the upper arm, including the shoulder and elbow, were searched using 'Humerus' AND 'Fracture' as search terms. Eligible patients with humeral shaft fractures were further identified by reading all radiology reports and reviewing all radiographs.

Humeral shaft fractures were defined as the area between the surgical neck and the area immediately above the supracondylar ridge. All fractures were classified using the AO-system[10] by reviewing the radiographs (K.C.M.).

Information about the affected side, the consolidation period, and presence of a delayed union were collected from the radiographs, radiology reports and the patient's hospital records. Radiological consolidation was defined as cortical bridging of at least three out of four cortices and was expressed in weeks from the day of the fracture. Delayed union was defined as a failure to heal at twenty-four weeks post fracture with no progress toward healing seen on the most recent radiographs.[11]

The medical charts of all patients were reviewed and the following items were retrieved: age, gender, trauma mechanism, other injuries besides the humeral shaft fracture, type of treatment and radial nerve palsy. The type of treatment was non-operative or operative. The decision between the two was made by the attending physician at each hospital and was based upon the surgeon's best judgment, knowledge and expertise.

The trauma mechanism was classified as a simple fall, meaning a fall from persons height, high-energetic (e.g., a traffic-related accident) or 'other'.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 16.0 for Windows. Outcome after operative and non-operative treatment was compared. Results of categorical variables (gender, AO-types and subtypes, delayed-union, radial nerve palsy, injuries, and trauma mechanism) were analyzed using Chi-square test. Results of numerical variables (age and consolidation time) were analyzed using the Mann-Whitney U-test. All tests were two sided. P-values < 0.05 were considered statistically significant.

RESULTS

In total 186 patients were included in this study. Table 1 shows the demographic data of this cohort for the patients in this study. Ninety one patients had been treated non-operatively. The majority was female (60.4%) and the mean age was 58.7 ± 1.5 years. The operatively treated group consists of 95 patients, 53.7% was female, with a median age of 61.1 years. No statistically significant difference could be found with respect to this data between the groups.

In the non-operatively treated group the left humerus was affected in 51.6% of patients, which was not statistically different from the operative group (62.2%). In 83.3% of the patients the humeral shaft injury was a solitary injury, and in 72% of patients the fracture resulted after a simple fall. No statistical difference was found between both groups. In the operative group 82.1% of the patients were treated using intramedullary nailing, 11.6% using plate osteosynthesis, 5.3% using external fixation and in 1 (1.1%) patient only Cerclage wires were used.

Figure 1 shows a detailed overview of fractures by AO subgroups. This shows type A humeral shaft fractures were found most frequently (50.0% of the patients) and type C was least common (8.1% of the patients). In the non-operatively treated group the A1 spiral fracture was the most common subtype (28.6%) and in the operatively treated group the A3 transverse fracture (26.3%).

Table 2 shows the time it took to achieve radiological consolidation in weeks from the day of the fracture per AO type and subtype. In the non-operatively treated group the time to achieve radiological consolidation ranged from a median of 11 weeks in the AO type A2 subgroup to 15 weeks in the B2 and A3 subgroups. In the operative group, time to consolidation

ranged from a median of 12 weeks (A2 subtype) to 28 weeks (B3 subtype), which did not differ statistically from the non-operative group.

Overall, 17 of the patients (9.1%) developed radial nerve palsy (Table 4). No statistically significant difference was found between the two groups. In the non-operatively treated group this originated from the trauma or fractures itself in eight patients. In the operatively treated group, radial nerve palsy originated from the trauma or fracture in 13 patients. In 4 patients it occurred after surgery.

Delayed union occurred in 18.8% of the patients, *i.e.*, in 18 patients treated non-operatively and in 18 patients treated operatively ($p>0.05$; 14 treated with intramedullary nailing, two with plate osteosynthesis, one with an external fixator and one with cerclage wires).

DISCUSSION

The aim of the current retrospective study was to compare the outcome after operative versus non-operative treatment of humeral shaft fractures, by comparing the the time to radiological union and the rates of delayed union and complications. In this series of 186 patients, no statistically significant differences were found in the time to radiological consolidation between the two groups, nor in the rates of delayed union or occurrence of radial nerve palsy.

The demographic data of the current study are to a large extent in agreement with published epidemiologic studies on humeral shaft fractures.[1, 3] In the most recent epidemiologic study the average age of patients with a humeral shaft fracture was 62.7 years,[1] the average age of the patients in our study was 58.7 years..

Data from previous studies showed delayed union rates of 2-23%[12-13] after non-operative treatment versus 15-30%[14] for operatively treated patients. Data of the current study (18.7% versus 18.9%, respectively) are consistent with the literature data. Increased delayed union rates as suggested previously[15] could not be confirmed in the current study.

Due to the high variability in fracture subtypes, our study lacked adequate statistical power to show statistically significant difference in time to radiographic healing between both groups. For the B3 type fractures, a trend was seen, suggesting that the time to radiographic healing was shorter in the non-operative group (median 12 weeks) than in the operative group (median 28 weeks).

In the current study 9.1% of the patients had radial nerve palsy. Rates between 2 and 17% are described of in the literature[16], but a review by Shao et. al reported an average rate of 11.8%.[17] Even though primary radial nerve palsy is considered by many an absolute indication

for surgery[5] the data of our study do not support this, as radial nerve palsies occurred equally frequent in both groups. In the operatively treated group less radial nerve palsies were seen as a result of the fracture or the trauma (8.8 vs 5.3%). Spontaneous recovery is seen in 70.7% of the patients treated conservatively for the palsy, and after including surgical management the overall recovery rate is 88.1% as reported by Shao et al.

The retrospective nature and the lack of randomization was a limitation of our study. The decision between operative and non-operative treatment was made by the attending surgeon, based upon his preferences and previous experience. Given the low and similar rates of delayed union in both groups, it is tempting to speculate that the surgeons were quite good at identifying which fractures should be operated. Whether of not this is true should be studied in more detail.

Data on other essential aspects of outcome were unavailable. Possible residual deformity of the arm or impaired function could be a disadvantage of non-operative treatment compared with operative treatment. Rotational or axial malalignment up to 20–25 degrees and shortening less than 2 cm are regarded as acceptable following non-operative treatment.[13, 18-19] Surgery could improve the alignment of the fracture site; but is unclear at this moment if improved alignment also results in better functional outcome. As a disadvantage of surgery shoulder impairment is often mentioned, though impaired shoulder function may also occur following non-operative treatment.[20] Moreover, infections after surgery, the time and ability to full resumption of activities of daily living, and patient satisfaction with the outcome are all important factors that should be taken into consideration in the treatment of humeral shaft fractures.

CONCLUSION

In conclusion, the current study revealed similar time to consolidation and rates of delayed union and radial nerve palsy after non-operative and operative treatment of humeral shaft fractures. A randomized clinical trial comparing non-operative with operative treatment is needed in order to examine all aspects of outcome, taking into account consolidation time, delayed union and radial nerve palsy rates as well as the shoulder and elbow function, pain, post-operative infection rates, numbers of patients returning to their previous work and residual deformity.

CONFLICT OF INTEREST STATEMENT

The authors state that no conflicts of interest, financially or otherwise, exist.

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TABLES AND FIGURES

Table 1: Characteristics of the study population by type of treatment

	Overall (N=186)	Non-operative (N=91)	Operative (N=95)	P-value
Female[1]	106 (57.0)	55 (60.4)	51 (53.7)	0.377[+]
Age[2] (year)	60.8 (44.2-76.5)	60.6 (45.7-77.7)	61.1 (39.7-74.7)	0.424[++]
Left side affected[1]	106 (57.0)	47 (51.6)	59 (62.1)	0.183[+]
Concomitant injuries:				0.092[+]
Monotrauma[1]	155 (83.3)	79 (86.8)	76 (80.0)	
Polytrauma[1]	29 (15.6)	10 (11.0)	19 (20.0)	
Unkown[1]	2 (1.1)	2 (2.2)	0 (0.0)	
Trauma mechanism:				0.147[+]
Simple fall[1]	134 (72.0)	69 (75.8)	65 (68.4)	
High energy[1]	32 (17.2)	10 (11.0)	22 (23.2)	
Other[1]	13 (7.0)	8 (8.8)	5 (5.3)	
Unknown[1]	7 (3.8)	4 (4.4)	3 (3.2)	

[+] Pearson Chi-square test, [++]Mann-Whitney U-test

Data are shown as [1] number of patients with the percentages given within brackets, or as [2] median with the first and third quartile given within brackets.

Table 2: Consolidation time in weeks from day of humeral shaft fracture per AO type and subtypes by type of treatment

		Overall	Non-operative	Operative	P-value
A	**all**	14 (11-18)	13 (8-18)	14 (11-19)	0.169
	A1	14 (10-18)	13 (9-18)	16 (11-18)	0.381
	A2	11 (8-13)	11 (6-13)	12 (10-20)	0.221
	A3	15 (12-22)	15 (11-22)	14 (12-23)	0.890
B	**all**	15 (12-22)	14 (11-21)	17 (13-23)	0.166
	B1	16 (12-21)	14 (9-18)	18 (14-23)	0.065
	B2	15 (12-21)	15 (14-26)	14 (11-20)	0.173
	B3	22 (12-31)	12 (9-22)	28 (23-34)	0.034
C	**all**	22 (16-24)	No data	22 (16-24)	N.A.
	C1	20 (16-24)	No data	20 (16-24)	N.A.
	C2	No data	No data	No data	N.A.
	C3	22 (22-22)	No data	22 (22-22)	N.A.

Data are shown as median with the first and third quartile given within brackets. P-values were calculated with the Mann-Whitney U-test.

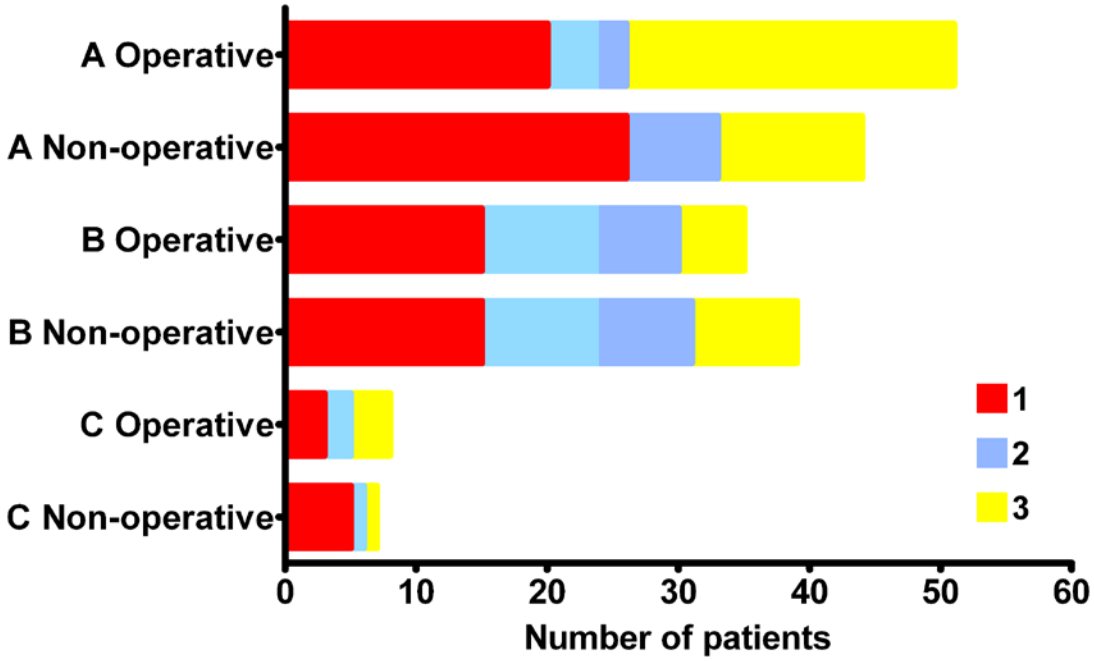
N.A., not applicable.

Table 3: Origin of radial nerve palsy and delayed union in patients with humeral shaft fractures by type of treatment

	Overall	Non-operative	Operative	P-value
Radial nerve palsy				
Trauma/fracture	13 (7.0)	8 (8.8)	5 (5.3)	
Surgery	4 (2.2)	N.A.	4 (4.2)	
Total	17 (9.1)	8 (8.8)	9 (9.5)	0.053
Delayed union	35 (18.8)	18 (18.7)	18 (18.9)	0.580

Patient numbers are displayed, with the percentages given within brackets. P-values were calculated with the Pearson Chi-square test.

N.A., not applicable.



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284 **Figure 1: Distribution of the humeral shaft fractures into AO types and subtypes by type of**

285 **treatment**