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Predictive Factors for Functional Outcome after Conservative Treatment of Midshaft Clavicular Fractures: A Retrospective Cohort Study

Hockers NP[1*], Hillen RJ[2], Fransen BL[1], Willems JIP[1], Hoozemans MJM[3] and Burger BJ[1]

Abstract

Background

The aim of this study is to identify factors based on radiological characteristics and nature of presenting history, that are predictive in functional outcome at two to nine years follow-up, in patients that were treated conservatively after a midshaft clavicle fracture.

Methods

We performed a retrospective cohort study of all patients that presented to the emergency department of Noordwest Ziekenhuisgroep Alkmaar in the Netherlands, between 2004 and 2006. Follow-up was performed at 2 to 3 years and at 7 to 9 years after injury. This resulted in a total amount of 48 and 31 included patients, respectively. The Disabilities of the Arm, Shoulder and Hand score (DASH score) was used to assess patient reported functional outcome. Statistical analyses were performed to detect correlations between characteristics of the patient or fracture and functional outcome.

Results

There was a significant decrease of 4.3 in DASH scores between the mid-term and long-term follow-up of patients with complete angulation of their fracture (p=0.041) and of 2.6 in DASH of patients who were not involved in a high energetic trauma (p=0.031).

Conclusion

With regard to completely angulated clavicular fractures and non-involvement in a HET, an increase of functional outcome is to be expected from mid- to long-term.

Keywords

Midshaft; Fracture; Clavicle; Outcome; Functionality

Introduction

A fracture of the clavicle is a common injury and makes up about 2.6%-4% of all fractures and nearly 35% of all shoulder girdle injuries. Over 75% of all clavicular fractures are fractures of the midshaft, Allman type 1 or Edinburgh type 2 fractures. When displaced (Edinburgh type 2B fractures), these fractures tend to shorten the clavicle [1,2].

Dislocation of the clavicle is caused by the combined effect of the sternocleidomastoid muscle pulling on the medial fragment superiorly and posteriorly, whilst the pectoralis major muscle, the deltoid muscle and gravity are pulling the lateral fragment inferiorly and anteriorly. The net effect of these forces is dislocation of the fracture ends relative to each other, with the lateral fragment lower than the medial fragment. Shortening, in turn, is caused by the force components of the pectoralis, the trapezoid and the latissimus dorsi muscles pulling the shoulder girdle medially. The shortening therefore is an ongoing process after a fracture [3]. This means that the amount of shortening on presentation can be less than after fracture (mal-) union [4,5]. Various techniques of closed reduction have proven to be unsuccessful in obtaining and maintaining alignment of the fracture [1,6-8]. Dislocation occurs in about 73% of midshaft clavicular fractures [2] and the rate of non-union is found to be up to 15% [1,4,6]. Therefore the majority of conservatively treated midshaft fractures result in a malunion.

In the past, shortening has been considered to be of little or no clinical relevance [9]. However, published data in the last decades strongly suggest persistent residual symptoms associated with malunion of conservatively treated clavicular fractures [1,3,4,7-12]. These persistent symptoms include pain, weakness, rapid fatigability, numbness or paraesthesia of the arm and hand as well as cosmetic complaints. The optimal treatment option for acute dislocated midshaft clavicular fractures as an isolated injury remains a matter of discussion [1,8,13]. Recent studies show a trend towards operative intervention for dislocated midshaft clavicle fractures, with lower complication rates and increased functional outcome [14,15]. It remains unclear which factors influence outcome after conservative treatment. Therefore, these factors should be further recognised to aid in decision making for the choice of treatment.

To determine which patients should be selected for surgical treatment, identification of factors that can predict poor functional outcome upon initial presentation is vital. The aim of this study is to identify factors based on radiological characteristics and nature of presenting history that are predictive in functional outcome at two to nine years follow-up, in patients that were treated conservatively after a midshaft clavicle fracture.

Methods

Study design and study population

We performed a retrospective cohort study of all patients that presented to the emergency department of the Noordwest Ziekenhuisgroep Alkmaar in the Netherlands, between 2004 and 2006. Our inclusion criteria consisted of age over 18 years, a midshaft clavicle fracture as an isolated injury, no previous injury to the affected shoulder and a conservative treatment. This resulted in a total amount of 75 included patients.

Conservative treatment consisted of immobilization of the affected shoulder in a sling for a week, followed by mobilization as tolerated. Follow-up in the outpatient clinic was performed at one and six weeks after injury with a second X-ray at six weeks.

***Corresponding author:** Hockers NP, Noordwest Ziekenhuisgroep Alkmaar, Wilhelminalaan 12, 1815 JD, Alkmaar, the Netherlands, Tel: +31 622131196; E-mail: nielshockers@gmail.com

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Procedure

The electronic filing system of the before mentioned hospital was used to select patients according to the inclusion criteria. After obtaining informed consent, a questionnaire was sent. Patients were contacted by phone when a response was lacking.

Functional outcome

Mid-term (MT) follow-up measurements were performed between 2 and 3 years after injury. All patients were sent a questionnaire that included the validated Dutch version of the Disabilities of the Arm, Shoulder and Hand score (DASH score). The DASH score is a self-reported questionnaire that includes 30 items on function of the upper limb. Scores range from 0 to 100, with a higher score indicating more impairment of daily function [16]. Long-term (LT) follow-up was performed between 7 and 9 years after injury by once again obtaining the DASH score. For the interpretation of the DASH score, to our knowledge, no official cut-off point for serious impairment has been described so far. The smallest clinically relevant change in DASH score is considered to be 16.3 points [17] We decided for the current study that a score above 20 represented serious impairment of the upper extremity in daily activities.

Predictive factor for high DASH scores

All X-rays made on presentation were rated by the second author (Hillen) with respect to dislocation and comminution. Complete dislocation was defined as no visual osseous contact between the medial and lateral fragment in one or both X-ray views. Angulation was defined as dislocation where there is still visual osseous contact between the medial and lateral fragment in both X-ray views. Comminution was defined as one or more loose fragments between the medial and lateral part of the clavicle in either direction on X-ray. In all cases a second X-ray was made after a minimum of 6 weeks to determine the presence of (mal) union of the fracture. No contralateral X-rays were available to adequately compare for shortening of the clavicle, and since shortening of the clavicula after injury is considered to be an ongoing process, we did not analyse shortening on presentation as a risk factor.

Besides complete dislocation, angulation and comminution, gender, whether or not the fracture occurred during a high energy trauma (HET) and if the fracture was in the patients' dominant arm, were assessed by questionnaire whether they were associated with functional outcome at mid- and long-term. Separate DASH scores were calculated with the patients grouped for these variables to examine whether there was a difference in the groups with or without that variable. To determine whether a combination of the chosen variables influenced the DASH scores a regression model analysis was also performed. When possible, odds ratios were calculated to determine if the chosen variables influenced the chance of achieving a DASH score of 20 and above.

Statistical analysis

Normality of the DASH scores was assessed using histograms, Q-Q plots, box-plots, Kolmogorov-Smirnov tests and z-values for skewness and kurtosis. Since the distribution of most scores was skewed, we performed non-parametric tests on all DASH scores. A p-value of <0.05 was considered significant.

We compared groups using a non-parametric test. Secondly, we created dichotomous variables of DASH outcome measurements with a low DASH score of <20 and a high DASH score of 20 or above. Then we performed univariate logistic regression analyses to determine differences between both groups in obtaining a high DASH score.

Furthermore, odds ratios and corresponding 95% confidence intervals (95% CI) were calculated in univariate analyses for all dichotomous predictor variables with two levels (gender, HET, dislocation (LT only), dominance and comminution). All statistical analyses were performed using SPSS Statistics, version 20 (IBM Corporation, Armonk, NY, USA).

Ethical approval

This study was done in compliance with the Helsinki Declaration [18]. According to Dutch law for medical research, a retrospective cohort study such as this does not require approval by an ethical committee [19]. Written consent to participate in filling out the questionnaires was obtained from each participant.

Results

Participants and descriptive data

Patient characteristics are shown in Table 1. At mid-term follow-up the questionnaire was returned by 52 patients (69%), and after file analysis 48 patients were included of whom all characteristics and a complete questionnaire were available. Of these patients, 31 (65%) returned the questionnaire for the long-term follow-up measurements.

Functional outcome

At mid-term follow-up the median DASH score was 4.5 and at long-term follow-up the median DASH score for all patients was 1.3 (of a maximum score of 100) (Table 1).

There was a significant decrease of 4.3 in DASH scores between the mid-term and long-term follow-up of patients with complete dislocation of their fracture and of 2.6 in DASH of patients who were not involved in a HET. There were no significant differences in DASH scores between mid-term and long-term follow-up for any of the other predictive variables.

Predictive factors for high DASH scores (≥20)

No significant differences in DASH scores were found at both follow-up measurements for any of the predictive factors (gender, type of trauma, dominance, dislocation, and comminution) when looking at the individual variables (Table 2).

The univariate logistic regression analysis showed no significant associations between the predictive factors and having a DASH score of ≥20 at mid- or long-term follow-up. The odds ratios for achieving a DASH score of 20 or above are shown in Table 3.

Discussion

The aim of this study is to identify factors based on radiological characteristics and nature of presenting history; those are predictive in functional outcome at two to nine years follow-up. We performed a retrospective cohort analysis of 48 patients who were treated conservatively for a midshaft clavicle fracture. The results of this study indicate a significant improvement from mid-term to long-term in functional outcome in patients presenting with a completely dislocated midshaft fracture of the clavicle. Secondly, a significant difference in functional outcome was shown from mid- to long-term follow-up for patients who were not involved in a HET.

Table 1: Patient Characteristics.

	Mid-term follow-up	**Long-term follow-up**
	N=48	N=31
Age at time of accident	40.9 (20-62)	44.3 (23-62)
Gender		
Female	11 (77%)	7 (77%)
Male	37 (23%)	24 (23%)
Dislocation		
Complete	35 (73%)	22 (71%)
Angulated	1 (2%)	0 (0%)
None	12 (25%)	9 (29%)
HET		
Yes	15 (31%)	8 (26%)
No	33 (69%)	23 (74%)
Dominant side		
Yes	40 (83%)	26 (84%)
No	8 (17%)	5 (16%)
Comminution		
Yes	21 (44%)	13 (42%)
No	27 (56%)	18 (58%)
Data in Mean (range) or Number (percentage); HET = High Energy Trauma		

Table 2: DASH scores.

	Mid-term follow-up			**Long-term follow-up**			**MT versus LT**
DASH	**Median (IQR)**	**Range**	***p*-value**	**Median (IQR)**	**Range**	***p*-value**	***p*-value**
All patients	4.5 (14.9)	0-61.8		1,3 (6.7)	0-50		0,101
Gender			0,139			0,530	
Female	11,8 (21,1)	0-31,6		2,6 (15,8)	0-23,7		0,345
Male	3,9 (14,7)	0-61,8		0,7 (3,9)	0-50,0		0,187
Dislocation			0,455			0,746	
Complete	5,0 (21,7)	0-61,8		0,7 (6,9)	0-50		0,041
Angulated	-	-		-			
None	1,8 (14,1)	0-15		2,6 (9,0)	0-42,1		0,917
HET			0,521			0,943	
Yes	6,6 (12,7)	0-34,2		1,3 (9,5)	0-42,1		0,799
No	3,9 (16.1)	0-61,8		1,3 (6,7)	0-50		0,031
Dominant side			0,193			0,568	
Yes	5,3 (19,1)	0-61,8		1,7 (7,8)	0-50		0,098
No	2,6 (9,9)	0-13,2		0,0 (21,7)	0-42,1		0,498
Comminution			0,720			0,718	
Yes	3,9 (19.4)	0-36,8		0,0 (9,9)	0-23,7		0,721
No	5,3 (14,5)	0-61,8		1,5 (7,8)	0-50		0,136

Table 3: Odds Ratios for having a score ≥20.

	Mid-term		**Long-term**	
DASH	**OR**	**95% CI**	**OR**	**95% CI**
Gender (Female/Male)	1.9	0.4 – 9.5	1.2	0.1 – 13.4
Dislocation (Complete or angulated/None)	-	-	1.3	0.1 – 14.1
HET (Yes/No)	1.1	0.2 – 5.3	1.0	0.1 – 10.7
Dominant side (Yes/No)	-	-	0.5	0.0 – 6.4
Comminution (Yes/No)	1.8	0.4 – 7.7	1.5	0.2 – 11.9

In current literature no differentiation has been made in functional outcome between mid- and long-term results. Our study shows a significant improvement in functionality for patients presenting with a completely dislocated fracture and for patients who were not involved in a HET. However, in the final follow-up these findings were not significantly different in DASH scores from patients with a complete dislocation or patients who were not involved in a HET respectively.

Given our results, the question rises what caused the registered increase in functionality for the before mentioned groups between mid- and long-term assessment. Since complete (mal)union and healing of the bone has been achieved before mid-term follow-up, an

explanation might be found in coping with and adjusting lifestyle to the affected shoulder, but also muscle training. This might result in an increase of reported functionality even after mid-term follow-up.

A Strength of this study is that we included two separate follow-up measurements, with a minimum of four years in between assessments. We also included most factors that are thought to influence outcome after a clavicle fracture in our analysis. A weakness of this study lies in the interpretation of dislocation on X-rays by a single author, because of a possible inter-observer variability. A second weakness, the absence of an adequate analysis on the effect of shortening, has been discussed. Thirdly, no data was available in particular of the degree of involvement in sports or overhead work.

Conclusion

This paper sheds some light with respect to decision making in the treatment of midshaft clavicular fractures. With regard to completely dislocated fractures and non-involvement in a HET, an increase of functional outcome is to be expected. It is of the utmost importance that for each patient individually, the most suitable treatment is applied. Our findings could aid in managing patient expectations with regard to functionality.

Competing Interests

The authors declare that they have no competing interests.

Author's Contributions

NH collected data for the long-term follow-up and participated in writing of the manuscript.

RH rated all X-rays, collected data for the mid-term follow-up and contributed to writing of the manuscript.

BF participated in the statistical analysis of data and provided help in revising of the manuscript.

JW collected substantial data for the long-term follow up.

MH contributed to the statistical analysis of data and provided help in revising of the manuscript.

BB is the senior author and provided overall help in design of the study and writing of the manuscript.

All authors read and approved the final manuscript.

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Author Affiliations

Top

[1]*Noordwest Ziekenhuisgroep Alkmaar, Wilhelminalaan 12, 1815 JD, Alkmaar, the Netherlands*

[2]*Waterland Hospital, Waterlandlaan 250, 1441 RN, Purmerend, the Netherlands*

[3]*VU University Amsterdam, van der Boechorstraat 9, 1081 BT, Amsterdam, the Netherlands*