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Decision-making in the treatment of diaphyseal clavicle fractures: is there agreement among surgeons? Results of a survey on surgeons' treatment preferences

Hinrich J.D. Heuer, MD[a], Robert E. Boykin, MD[a], Charles J. Petit, MD[b], Juliane Hardt, Dipl.-Psych.[c,1], Peter J. Millett, MD, MSc[a,1,*]

[a]*Steadman Philippon Research Institute, Vail, CO, USA*
[b]*Cascade Orthopedics & Sports Medicine Center P.C., The Dalles, OR, USA*
[c]*Institute of Social Medicine, University of Lübeck, Lübeck, Germany*

Background and hypothesis: Nonoperative treatment is standard for most diaphyseal clavicle fractures, but recent studies have demonstrated improved outcomes with operative treatment of displaced fractures. The objectives of this diagnostic study were to assess agreement of orthopaedic surgeons regarding their treatment preferences for diaphyseal clavicle fractures and to compare them with recent recommendations. Interobserver and intraobserver agreement in treatment decisions were hypothesized to be only slight.

Methods: Anonymized case vignettes of 50 acute diaphyseal clavicle fractures including medical history, physical examination findings, and radiographs were independently reviewed by 32 orthopaedic surgeons from the United States. Four treatment options were offered and decisions were compared with current treatment recommendations. Interobserver agreement was calculated using Fleiss' kappa coefficient. Average intraobserver agreement for surgeons who completed a retest review (minimum interval of 8 weeks) was calculated.

Results: Thirty-two surgeons completed the first round of reviewing and 27 completed the retest (mean interval, 22 weeks). Interobserver agreement was overall fair (kappa = 0.36) and moderate (kappa = 0.56) when operative options were compared with nonoperative options. Median intraobserver agreement was 74% for the 4 treatment options offered and 84% in deciding on operative vs. nonoperative means. Concordance with recent recommendations for operative vs. nonoperative treatment was seen in 91% of decisions (median).

Discussion and conclusions: Recent recommendations appear to have been adopted by a selected subgroup of U.S. orthopaedic surgeons, showing a surprisingly high median concordance of 91% in this study. However, only fair to moderate interobserver and intraobserver agreement was present, leaving potential for improvement.

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[1] Equally contributed as supervising authors.

*Reprint requests: Peter J. Millett, MD, MSc, Steadman Philippon Research Institute, 181 West Meadow Drive, Suite 400, Vail, CO 81657, USA.
E-mail address: drmillett@thesteadmanclinic.com (P.J. Millett).

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Level of evidence: Survey Study using Experts/Diagnostic Study (reliability).

Keywords: Agreement; clavicle fractures; concordance; intraobserver; interobserver; treatment preferences

Clavicle fractures are common, representing 5% of all adult fractures.[16,19] Up to 80% occur in the middle third of the clavicle (diaphyseal).[16,19,22] Traditionally, nonoperative treatment has been recommended, with older studies showing very low nonunion rates of less than 1%.[15,23] However, more recent studies have shown nonunion rates for nonoperative treatment up to 15% and unsatisfactory results in 23% to 31%.[3,5,12,26] The differences in the outcomes could be due to changes in follow-up, improvements in diagnostic techniques, modifications to outcome criteria, and increases in fracture severity. Treatment with a simple sling or a figure-of-eight bandage is the preferred treatment of undisplaced diaphyseal clavicle fractures.[11] A systematic Cochrane Review of 2009 found no statistically significant evidence for a clear advantage of either option in the current literature,[8] even though specific advantages and disadvantages are named for each method.[2]

Recently, operative treatment has been recommended in certain instances, such as higher degrees of displacement and shortening >20 mm.[11] With surgical treatment, mean nonunion rates of 2% to 3% were found for plate fixation[3,26] and 0% to 10% for intramedullary fixation methods.[6,13,14] Unsatisfactory results still range from 5% to 36% of cases.[6,13,14] Another Cochrane Review found no difference in outcomes with either intramedullary fixation or plate fixation.[9] Nevertheless, certain advantages and disadvantages are associated with both methods.[21] These more recent studies may have influenced the decision-making process of surgeons, particularly for displaced fractures in active patients. The purpose of this study, therefore, was to assess surgeons' decision-making in the treatment of diaphyseal clavicle fractures. At the time of the study design, the most recent recommendations regarding indications for operative treatment of diaphyseal clavicle fractures in very specific cases have been published by Altamimi and McKee[1] following an evidence-based approach.

The objectives of this study were to assess agreement of orthopaedic surgeons regarding their current treatment preferences of acute diaphyseal clavicle fractures and also to look at concordance with current treatment recommendations. This study included a retest review to examine intraobserver agreement. We hypothesized that there would be slight interobserver and intraobserver agreement among surgeons in the decision-making for treatment of diaphyseal clavicle fractures.

Materials and methods

Cases

Anonymized case vignettes were prepared from a series of 50 diaphyseal clavicle fractures, OTA (2007) type 15-B.[10] All fractures were the primary injury to the affected clavicle and were no more than 14 days beyond injury. Stratified sampling of the cases was performed to ensure a well-balanced distribution to represent the clinical spectrum. Vignettes included the patient's history, physical examination findings, and 2 initial plain radiographs. All cases were reviewed by the senior author before the study to ensure eligibility for the study. Fracture patterns for all cases were classified by displacement and shortening, the criteria of which are named by the current literature to be clinically relevant for decision-making.[1]

Figure 1 shows an example of a vignette. Details about the distribution of various parameters for all cases are shown in Table I.

Sample recruitment and questionnaire

The questionnaire and a document with 50 case vignettes were sent to 42 fellowship-trained orthopaedic surgeons who were acquainted with the research team (convenience sample). All surgeons completed their residency and fellowships at different hospitals or at different times in the United States. Personal characteristics of the surgeons, such as years of practice in orthopaedic surgery, area of subspecialization (e.g., shoulder, trauma), area of fellowship (e.g., sports medicine, trauma, shoulder), and approximate number of clavicle fractures treated per year, were included.

The questionnaire was created as an online survey (www.surveymonkey.com, CA/OR, USA), accompanied by a PDF version (Fig. 2). The 4 most frequently used treatment options were offered for each case: 2 nonoperative options (simple sling or figure-of-eight bandage) and 2 operative options (plate or intramedullary fixation).

Surgeons were asked to print out the questionnaire and to open the portfolio with the 50 case vignettes and the online questionnaire. Surgeons were then asked to mark the preferred treatment options for every case on both questionnaire versions to ensure that no data would be lost during online transmission. If it was more convenient, the completed printout could also be faxed to our clinical research department or sent as a scan via email. The surgeons were asked to destroy the printed copy when the reception of their results was confirmed.

For assessment of intraobserver agreement, a survey retest was conducted with the same case order and an interval of at least 8 weeks.

Figure 1 Case vignette example. In this case, 30 surgeons chose a nonoperative method as their preferred treatment option and agreed with the authors' choice for the recommended treatment on the basis of recommendations of international experts. *RHD,* right hand dominant; *PMH,* past medical history; *PE,* physical examination; *A/PROM,* active/passive range of motion; *NVI,* neurovascular intact.

Data analyses

Overall frequencies of treatment decisions were calculated for nonoperative (simple sling vs. figure-of-eight bandage) vs. operative (plate vs. intramedullary fixation) treatment.

Before distribution of the survey documents, a recommended treatment (nonoperative vs. operative) was determined by the authors for every case by use of recent recommendations in the literature,[1] mainly on the basis of displacement and shortening as well as other factors included in the vignettes. Following the recommendations of Altamimi and McKee,[1] nonoperative treatment would have been recommended for 22 cases (44%), and 28 cases (56%) would have qualified for operative treatment. The recommended treatment was compared with the surgeons' actual decisions for every case in terms of operative vs. nonoperative management. Median agreement (MD, 50%), first quartile (Q1, 25%), and third quartile (Q3, 75%) for the distribution of treatment decisions for 50 cases were calculated.

Interobserver agreement was analyzed using Fleiss' weighted kappa coefficient as described by Landis and Koch.[7] Kappa allows the evaluation of a corrected interobserver agreement or the observed agreement that exceeds the expected agreement. A kappa value of 0.00 indicates a level of agreement that would be expected; a value of 1.00 indicates perfect agreement of the observers. The classification by Landis and Koch[7] uses 6 categories of agreement (<0, poor; 0.00–0.20, slight; 0.21–0.40, fair; 0.41–0.60, moderate; 0.61–0.80, substantial; 0.81–1.00, excellent or almost perfect agreement). Kappa values were calculated taking into account all 4 treatment options as well as only the 2 basic treatment options (nonoperative vs. operative).

A retest was conducted for the analysis of intraobserver agreement. Answers of the 2 rounds were compared for each surgeon for all 4 options and for the basic 2 options, and median intraobserver agreement was calculated (raw agreement proportions of second vs. first survey).

Inferential statistics

Chi-square tests were used to test for statistical differences between all treatment decisions of surgeons and the predefined recommended treatments. Analyses for overall predictors of treatment decisions (surgeons' experience and age of patients) included stratified analyses, one-way ANOVA for group differences, and univariate linear regression analyses. These analyses were all administered with IBM SPSS 19.0 (IBM Corporation, Armonk, NY, USA).

Kappa values were calculated with Excel (Microsoft Corp., Redmond, WA, USA) and formulas by Landis and Koch.[7] Kappa statistics were verified and tested with the statistical software R.[20] As the interpretation of kappa values and significance testing for them is prone to popular fallacies, we recommend Sim and Wright[24] as a helpful overview for medical researchers.

The aim of inferential statistical testing was exploration of tendencies for substantial effects, not the statistical validation of effects for the total population of surgeons, as it would be for a population-based health care study. So, we abstained from adjustments for alpha-cumulation, as the available sample of surgeons was not considered to be representative of the general population of orthopaedic surgeons.

Results

Sample characteristics

Of the 42 orthopaedic surgeons, 32 completed one round of surveying (response rate, 76%), and 27 of the 32 surgeons (attrition rate, 16%) also completed the survey retest; 1600 treatment decisions were made by the 32 surgeons in the first survey, and 1350 decisions were made by the 27 remaining surgeons in the retest. Five surgeons did not participate in the retest. Data were complete for all 32 surgeons without any missings.

Interobserver agreement

Interobserver agreement was calculated with Fleiss' kappa for more than 2 treatment options and more than 2 observers (in this study, surgeons). Results are displayed in Table II. Overall interobserver agreement was fair for all 4 options and moderate for the 2 basic options (nonoperative

Table I Case details

Case	Age (y)	Dominant side injured	Displacement >100%	Shortening > 2 cm	2 cm > Shortening > 1 cm	Comminution or segmentation	Activity level or social history	Comorbidities (C), skin (S) integrity, neurovascular (NV) status of injured extremity
1	19	0	0	0	0	0	Moderate	No C; S and NV intact
2	61	0	0	0	0	0	Moderate	No C; S and NV intact
3	49	1	1	1	0	1	Moderate	No C; S and NV intact
4	27	1	1	1	0	1	Sedentary	No C; S tenting; NV intact
5	75	0	1	1	0	1	Sedentary	High blood pressure, status post myocardial infarction and stenting, warfarin medication; S and NV intact
6	26	1	1	0	1	0	Moderate	No C; S and NV intact
7	38	1	1	0	1	1	Laborer	Gastroesophageal reflux disease, smoker; S and NV intact
8	21	0	1	1	0	1	Moderate	No C; S and NV intact
9	16	1	0	1	0	1	Very high	No C; S tenting; NV intact
10	53	1	1	0	0	1	Moderate	No C; S and NV intact
11	14	0	1	0	1	1	High	No C; S and NV intact
12	24	0	1	0	1	1	Athlete	No C; S tenting; NV intact
13	11	0	0	0	0	0	Moderate	No C; S and NV intact
14	29	1	1	1	0	1	Laborer	No C; S and NV intact
15	52	0	1	1	0	1	Moderate	No C; S and NV intact
16	33	0	1	0	0	1	Moderate	No C; S and NV intact
17	31	0	1	0	0	0	Sedentary	Obese, type 2 diabetes; S and NV intact
18	44	0	1	0	1	1	High	Dyslipidemia; S and NV intact
19	65	1	1	1	0	1	Moderate	No C; S and NV intact
20	54	1	1	1	0	1	Moderate	No C; S intact; brachial plexus palsy; V intact; fragment piercing trapezius muscle
21	30	1	1	1	0	1	Athlete	No C; S and NV intact
22	64	1	1	1	0	1	Moderate	No C; S and NV intact
23	80	0	0	0	0	0	Sedentary	Smoker, status post stroke, warfarin medication; S and NV intact
24	33	0	1	1	0	1	Moderate	No C; S and NV intact
25	73	0	0	0	0	1	High	No C; S and NV intact
26	61	0	1	0	1	1	Moderate	Acute: pneumothorax, spleen rupture; S and NV intact
27	68	0	1	0	1	1	Moderate	Smoker; S and NV intact
28	48	0	1	0	0	1	Laborer	No C; S and NV intact
29	58	1	1	1	0	1	Moderate	No C; S and NV intact
30	21	1	1	1	0	1	Laborer	No C; S and NV intact
31	67	1	1	0	0	0	Moderate	No C; S and NV intact
32	14	1	0	0	0	0	Moderate	No C; S and NV intact
33	22	1	1	1	0	1	Moderate	No C; S and NV intact
34	51	1	1	1	0	1	Sedentary	No C; S and NV intact
35	46	0	1	0	0	0	Moderate	No C; S and NV intact
36	43	0	1	0	1	1	High	Kidney stones; first-degree open fracture; V intact; ulnar nerve injury
37	50	0	1	0	0	1	Moderate	No C; S and NV intact
38	61	1	1	0	0	0	Moderate	No C; S and NV intact
39	77	0	0	1	0	1	Sedentary	Status post myocardial infarction and coronary bypass; aspirin medication; S intact; obvious deformity; radial nerve injury
40	44	0	1	1	0	1	Athlete	No C; S and NV intact
41	72	0	1	1	0	1	High	No C; S tenting; NV intact
42	17	0	1	0	1	1	Moderate	No C; S and NV intact

(*continued on next page*)

Table I (*continued*)

Case	Age (y)	Dominant side injured	Displacement >100%	Shortening > 2 cm	2 cm > Shortening > 1 cm	Comminution or segmentation	Activity level or social history	Comorbidities (C), skin (S) integrity, neurovascular (NV) status of injured extremity
43	39	1	1	0	1	1	Moderate	Status post brain surgery; seizures; S and NV intact
44	16	0	1	1	0	1	Moderate	No C; S tenting; NV intact
45	35	0	1	0	0	0	Moderate	No C; S and NV intact
46	50	1	1	1	0	1	Laborer	No C; S dimpled; NV intact
47	36	0	1	1	0	1	Moderate	No C; S and NV intact
48	40	0	1	1	0	1	Moderate	No C; S and NV intact
49	47	1	1	1	0	0	Moderate	No C; S and NV intact
50	19	1	0	0	0	0	Athlete	No C; S and NV intact
	Mean 42	Total 22	Total 41	Total 24	Total 10	Total 37		

Questionnaire - Clavicle Study

Please indicate your management choice for each case (1-50). For each case please select one choice. Thank you for your time and input for this project!

Key: 1. Nonoperative treatment: a. simple sling (SS)
b. figure-of-eight bandage (F-8-B)
2. Operative treatment: a. plate fixation (PF)
b. intramedullary fixation (IMF)

Please also answer the following short questions in order to provide some additional personal information for us. All information will be treated highly confidential! If a question does not apply to you, please state N/A.

Your name: _____

The year when you started orthopaedic surgery residency: _____

Specialization (e.g. Shoulder, Trauma, Sports Medicine):_____

Completed or nearly completed fellowship in (e.g. sportsmedicine):_____

Approximate number of treated clavicle fractures per year: _____

Today's date:_____

Case No.	1a SS	1b F-8-B	2a PF	2b IMF
1				
2				
3				

…

Figure 2 PDF questionnaire example.

vs. operative). All surgeons completely agreed on 15 of the 50 cases for the 2 basic treatment options (nonoperative vs. operative), and these cases were also concordant with the recommended treatment.

Intraobserver agreement

Intraobserver agreement for those surgeons who completed a second round of surveying at a mean interval of 22.3 weeks averaged 76% (MD = 74%, Q1 = 68%, Q3 = 84%, range: 62%–98%) for all 4 options and 85% (MD = 84%, Q1 = 82%, Q3 = 88%, range: 72%–98%) for the 2 basic options (operative vs. nonoperative). Detailed results are presented in Table III. The intraobserver agreement found was rather low with a median of only 74% (4 options). It is especially interesting considering that in some cases less than two thirds of the case population would have received the same treatment twice from the same surgeon. On the

Table II Interobserver agreement of first survey round

Interobserver agreement	n	Decisions	Sling vs. F8 vs. plate vs. IM				Nonoperative vs. operative			
			Kappa value	Category*	*P* value	Complete agreement†	Kappa value	Category*	*P* value	Complete agreement†
U.S. surgeons	32	1600	0.364	Fair	< .001	1/50	0.561	Moderate	< .001	15/50

Sling, simple sling; *F8,* figure-of-eight bandage; *plate,* plate fixation; *IM,* intramedullary fixation.

* Classification of interobserver agreement by Landis and Koch.[7]

† Number of case vignettes with complete agreement of n observers.

Table III Intraobserver agreement of all 27 surgeons who did a retest at a minimum interval of 8 weeks

Intraobserver agreement				
Surgeon	Years of experience	Clavicle fractures treated per year	Sling vs. F8 vs. plate vs. IM	Nonoperative vs. operative
1	4	15	78%	90%
2	5	10	88%	88%
3	5	20	78%	84%
4	5	15	86%	88%
5	6	24	70%	94%
6	6	40	64%	88%
7	6	12	62%	76%
8	6	10	72%	84%
9	6	10	66%	84%
10	6	18	68%	84%
11	6	20	72%	82%
12	6	12	74%	76%
13	6	5	62%	86%
14	6	60	66%	72%
15	7	36	68%	90%
16	7	20	82%	82%
17	9	18	70%	90%
18	9	30	88%	90%
19	9	15	80%	84%
20	11	7	84%	84%
21	12	30	78%	82%
22	16	50	84%	84%
23	16	15	98%	98%
24	19	20	68%	78%
25	19	12	88%	88%
26	20	30	88%	88%
27	27	12	74%	82%
Median	7	17	74%	84%
1st quartile	6	12	68%	82%
3rd quartile	12	26	84%	88%
Range	4 to 27	5 to 60	62% to 98%	72% to 98%

F8, figure-of-eight bandage; *IM,* intramedullary fixation.

other hand, it was found that the intraobserver agreement was higher when limited to 2 options (operative vs. nonoperative), with a median of 84%. Further, a few surgeons managed to have very high intraobserver agreement values (as high as 98%) even if all 4 options were regarded. All of those surgeons (n = 5) used only 2 of the 4 given treatment options in deciding for a treatment. These were most likely to be a simple sling when nonoperative treatment was selected or plate fixation when operative fixation was selected.

Table IV Distribution of treatment decisions by the 32 surveyed U.S. orthopaedic surgeons looking at 50 cases in respect to all 4 options

	Absolute no. of decisions	Percentage
Nonoperative sling	598	37%
Nonoperative F8	40	3%
Operative plate	734	46%
Operative IM	228	14%
Total no. of decisions	1600	100%

F8, figure-of-eight bandage; *IM,* intramedullary fixation.

Concordance of treatment decisions with predefined recommended treatment

A descriptive analysis of the observed treatment preferences for all responding surgeons is displayed in Table IV. Nonoperative treatment was chosen in 40% and operative treatment in 60% of the 1600 treatment decisions. For nonoperative treatment decisions (absolute no. = 638), sling was preferred to figure-of-eight bandage (94% vs. 6%). For operative treatment decisions (absolute no. = 962), there was an overall tendency toward plating vs. intramedullary fixation (76% vs. 24%). Comparing treatment options chosen by the surgeons for every case to the equivalent recommended treatment, median agreement was 91% (range: 16%–100%, Q1 = 78%, Q3 = 100%, mean = 83%). In 15 cases (30%), all surgeons completely agreed with the expert-recommended treatment as determined by the authors (Fig. 3 and Table V). The surgeons' decisions for operative and nonoperative treatment did not differ significantly from the recommended treatments ($P = .660$).

Those results show various patterns of decision-making that cannot be explained by medical indication alone. So additional analyses examined whether treatment decisions were associated with age at injury or with the surgeons' experience (Table VI). The surgeons' average percentage of decisions for operative treatment was highest for cases with age at injury of 20 to 29 years and lowest for cases with age at injury of 70 years and older (significant group differences: $P = .008$). The regression analyses show a substantial effect for the association of age with an overall tendency toward operative rather than conservative treatment. The influence of surgeons' experience was less systematic for treatment decisions. The results show a slight but not significant effect for the years of experience (Table VI) and no systematic effect for the number of treated clavicle fractures per year ($\beta = .042$, $P = .818$) as predictors of the percentage of decisions for operative treatment.

Discussion

This study presents data on specialized orthopaedic surgeons' treatment preferences for diaphyseal clavicle fractures. The study also highlights the interobserver and intraobserver variability in treatment decisions for diaphyseal clavicle fractures including Fleiss' kappa calculations for interobserver agreement and concordance with treatment recommendations.

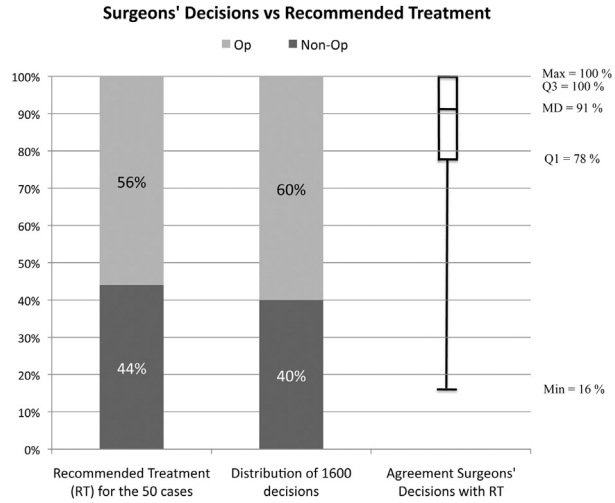

Figure 3 Comparison of the surgeons' decisions with the predefined recommended treatment for every case.

Overall, our hypothesis of slight interobserver agreement proved to be too conservative because values of fair or moderate agreement were present. However, these findings showed lower agreement than would be desirable with the background of recent treatment recommendations. We note that kappa statistics have their weaknesses, and the classification from poor to excellent as well as the statistical precision is discussed controversially in the literature. Nevertheless, it is a widely accepted method to calculate interobserver agreement.[4,17,25]

The findings for intraobserver agreement might imply that stable decision patterns are present in a subset of orthopaedic surgeons specialized in shoulder or sports medicine. For the very high intraobserver agreement of a few surgeons, one is tempted to refer this to the traditional surgical thinking, "Do what you do best and stick to it." This strategy of decision-making allows comprehensive experience with the chosen treatments, but the disadvantage is that new treatment strategies or procedures may not be attempted.

"Classic" teaching suggested that all clavicle fractures do well with conservative means.[15,23] However, recent studies show that operative treatment is preferable for specific cases (especially displaced fractures).[3,26] In this study, operative treatment decisions were recommended in 56% and chosen in 60% of cases. This is probably due to the selection of the case vignettes of our study, which had a high proportion of displaced fractures. As this study addresses decision-making, the cases were chosen to offer cases that actually require a decision between classic treatment traditions and recent evidence-based recommendations. It does,

Table V Distribution of the recommended treatment (RT) following the recommendations by Altamimi and McKee[1] and distribution of decisions by the 32 surveyed surgeons as well as the agreement with the RT

Case	RT (Altamimi and McKee[1])	Nonoperative decisions by surveyed surgeons	Operative decisions by surveyed surgeons	Agreement (percentage of surgeons agreeing with RT)	
1	Nonoperative	30	2	94%	
2	Nonoperative	32	0	100%	
3	Operative	0	32	100%	
4	Operative	0	32	100%	
5	Nonoperative	26	6	81%	
6	Operative	1	31	97%	
7	Nonoperative	16	16	50%	
8	Operative	0	32	100%	
9	Operative	2	30	94%	
10	Nonoperative	14	18	44%	
11	Operative	11	21	66%	
12	Operative	0	32	100%	
13	Nonoperative	32	0	100%	
14	Operative	0	32	100%	
15	Operative	5	27	84%	
16	Nonoperative	16	16	50%	
17	Nonoperative	29	3	91%	
18	Nonoperative	24	8	75%	
19	Operative	11	21	66%	
20	Operative	0	32	100%	
21	Operative	2	30	94%	
22	Operative	14	18	56%	
23	Nonoperative	32	0	100%	
24	Operative	0	32	100%	
25	Nonoperative	27	5	84%	
26	Nonoperative	17	15	53%	
27	Operative	10	22	69%	
28	Nonoperative	5	27	16%	
29	Operative	3	29	91%	
30	Operative	0	32	100%	
31	Nonoperative	27	5	84%	
32	Nonoperative	32	0	100%	
33	Operative	2	30	94%	
34	Operative	5	27	84%	
35	Nonoperative	25	7	78%	
36	Operative	0	32	100%	
37	Nonoperative	27	5	84%	
38	Nonoperative	25	7	78%	
39	Nonoperative	26	6	81%	
40	Operative	0	32	100%	
41	Operative	1	31	97%	
42	Operative	3	29	91%	
43	Nonoperative	12	20	38%	
44	Operative	1	31	97%	
45	Nonoperative	25	7	78%	
46	Operative	22	10	31%	
47	Operative	4	28	88%	
48	Operative	3	29	91%	
49	Operative	7	25	78%	
50	Nonoperative	32	0	100%	
	Nonoperative total 22	Total 638		Median	91%
	56%	60%		1st quartile	78%
	Operative total 28		Total 962	3rd quartile	100%
	44%		40%	Range	16%-100%

Table VI Association of cases' and surgeons' characteristics with treatment decisions (percentage of decisions for operative treatment)

Age at injury			Surgeon's experience		
Categories	n	M (SD)	Categories	n	M (SD)
10-19 years	8	44.1 (46.5)	1-5 years	5	53.6 (14.1)
20-29 years	7	98.7 (2.5)	6-10 years	17	58.8 (10.2)
30-39 years	8	59.4 (33.2)	11-15 years	3	67.3 (17.0)
40-49 years	8	75.0 (32.8)	16-20 years	5	66.0 (11.6)
50-59 years	7	66.1 (32.3)	20+ years	2	62.0 (8.5)
60-69 years	7	39.3 (26.8)			
70+ years	5	30.0 (38.2)			
Total	50	60.1 (37.5)	Total	32	60.1 (11.7)
One-way ANOVA for mean differences between groups					
F (*P* value)		3.37 (.008)	F (*P* value)		1.48 (.234)
Univariate linear regression (age and experience in years)					
β coeff. (*P* value)		−.240 (.094)	β coeff. (*P* value)		.216 (.234)

n, number; *M,* mean; *SD,* standard deviation; *coeff,* coefficient.

however, seem clear that operative treatment is becoming a more often chosen strategy.

Regarding concordance of treatment decisions with the recommended treatment (operative vs. nonoperative) predefined for every case by the authors on the basis of recent literature recommendations,[1] no statistical differences were found. This suggests that for the 32 orthopaedic surgeons who participated in the study, decision-making with a median concordance of 91% is already very high. That can be considered a desirable level of concordance in terms of treatment guidelines, although there is also a relatively high variability. Our finding that age at injury of the 50 cases had a substantial effect on the surveyed surgeons' average percentage of decisions for operative treatment might also be interpreted as good adoption of recent literature recommendations. In certain instances, operative treatment of displaced diaphyseal clavicle fractures may be indicated in cases of healthy, physically active patients between the ages of 16 and 60 years.[1] Further, McKee stated that on the basis of the literature, a significant percentage of young active patients with displaced diaphyseal clavicle fractures treated nonoperatively are developing symptomatic nonunion or malunion.[11] One can assume that patients aged 20 to 29 years may be the most healthy and active group of the general population. Hence, it may seem logical that with adoption of the named recent recommendations, decisions for operation would be made more frequently in this age group. Therefore, it might be said that the picture of good adoption of recent literature recommendations by the surveyed surgeons is completed through this finding.

For surgeons' preferences in treating this fracture entity and consistency in decision-making, published data are widely lacking. Pieske et al[18] published results on treatment preferences for diaphyseal clavicle fractures from a survey in 142 German trauma departments with an average of 26% diaphyseal clavicle fractures per year treated operatively. Unfortunately, the authors did not classify the type of fractures treated operatively. A plate was selected in 57% and intramedullary devices in 43% of cases with operative treatment decisions, a figure-of-eight bandage in 88%, a simple sling in 6%, and other means in again 6% of cases with nonoperative treatment decisions.[18]

The proportion of operative treatment in this German study[18] differs from our results, possibly because the German study used actual consecutive cases that were not especially selected to analyze decision-making as in our study. Thus it is not possible to draw conclusions about differences between U.S. and German surgeons.

Another interesting observation from the data of Pieske et al[18] is the use of figure-of-eight bandages in 88% of nonoperatively treated cases per year in German trauma centers.[18] In the early phase of our study, we surveyed a few surgeons from Germany and France and found that they also preferred a figure-of-eight bandage in more than two thirds of nonoperatively treated cases (unpublished data), whereas the 32 U.S. surgeons included in our study clearly preferred a simple sling (94%). Different treatment traditions[21] may explain this observation, but at present evidence is lacking,[8] and further studies are needed.

Limitations of our study include the selection of the surgeons surveyed. We attempted to recruit a sample of surgeons with specific expertise in shoulder surgery to test for agreement and adoption of recent recommendations in this specific expert group. In addition, a few surveyed surgeons were part of the same fellowship program even though they completed their residency at various centers in the United States. These two aspects may have introduced a selection bias and had an influence on the agreement. However, we believe the influence of a ''same-school effect'' would have shown larger amounts of agreement. The case selection in this study with a high proportion of displaced fracture patterns may also have introduced a bias that could have led to overestimation of the tendency toward operative treatment. Another limitation of the study was the limited amount of information that could be presented for the selected cases, especially for matters that might be gleaned from direct physical examination and the personal discussion with the patient about risks and benefits of various treatment methods. We believe this effect is probably minimal and the results can be generalized to actual clinical scenarios because physical examination does not typically add tremendously to the decision-making in treatment of clavicle fractures. A methodological issue refers to our strong hypothesis of only slight interobserver agreement, resulting in an open question of how much agreement is to be expected in a study on decision-making with anonymized cases and in a clinical context in which the diagnostic process uses further diagnostic assessments and contains several stages of decision-making.

Conclusions

The findings of our study revealed a rather large variance in decision-making of surveyed specialized orthopaedic surgeons. Nonetheless, a good concordance with recent treatment recommendations could be shown in the selected group of specialized orthopaedic surgeons. Need for further research exists in the form of large, randomized studies of surgeons' preferences as well as on the basis of evidence concerning treatment outcomes. These are essential to establish internationally accepted guidelines for the treatment of this specific fracture entity.

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