

# Surgical and non-surgical treatment for fully displaced lateral clavicle fractures have similar outcomes: An observational register study of 113 patients

Caroline Kihlström<sup>\*</sup>, Nils P. Hailer, Olof Wolf

Department of Surgical Sciences - Orthopedics, Uppsala University, SE-751 85 Uppsala, Sweden

## ARTICLE INFO

### Keywords:

Displaced  
Lateral clavicle fractures  
Treatment  
Outcome  
Patient-reported outcome measures  
PROM  
Robinson classification

## ABSTRACT

**Introduction:** Whether displaced lateral clavicle fractures should be treated surgically remains controversial. This study aims to compare outcomes after surgical versus non-surgical treatment of such fractures.

**Patients and Methods:** 113 patients with lateral clavicle fractures registered in the Swedish Fracture Register (SFR) during 2018 and with complete displacement on radiography were included in this cohort study. Linkage with the National Patient Register provided information on baseline medical comorbidities and further interventions. Patient-reported outcome measures (PROM) were assessed using the European Quality of Life Scale (EQ-5D-3L), the Short Musculoskeletal Function Assessment (SMFA), and the Quick Disabilities of the Arm, Shoulder and Hand (QDASH). The primary outcome was the total number of initial and delayed surgical procedures. The secondary outcome was difference in PROM between surgically and non-surgically treated patient groups.

**Results:** At a mean follow-up of 4.4 (range 3.9–4.9) years, 35 (67 %) of the 52 patients initially treated surgically had undergone a secondary procedure, mostly for implant removal. Of the 61 initially non-surgically treated patients, 3 (5 %) underwent delayed surgical treatment due to non- or malunion. 45 (40 %) patients responded to follow-up questionnaires, but no statistically significant differences were found in any PROM between groups.

**Conclusions:** Two thirds of surgically treated patients with displaced lateral clavicle fractures underwent two procedures. The need for delayed surgical treatment in non-surgically treated patients was low and PROM was similar in both treatment groups. Nonsurgical treatment should be considered as an option to surgery for fully displaced lateral fractures of the clavicle more often.

## Introduction

Whether displaced lateral clavicle fractures should be treated surgically remains controversial, and their management has considerable heterogeneity [1]. The goal of treatment is to optimize functional outcome and avoid unnecessary surgery. When deciding on treatment, the most important factors that surgeons consider are the degree of displacement, impending open fracture, and patient age [1]. While undisplaced lateral clavicle fractures are almost always treated non-surgically, displaced lateral clavicle fractures are often treated surgically because non-surgical treatment may cause nonunion in 6–44 % of patients [2–7]. Surgical treatment often necessitates secondary surgery for implant removal [8].

Whether surgical treatment is superior to non-surgical treatment is unclear, given that similar functional and patient-reported outcomes are

reported after both strategies [2–7,9–11]. However, modern studies comparing patient-reported outcome measures (PROM) between surgically and nonsurgically treated patients with displaced lateral clavicle fractures are scarce. The only randomized controlled trial (RCT) comparing surgical with non-surgical treatment to date was terminated before inclusion was completed because of declining recruitment and investigator fatigue [10]. This RCT was therefore underpowered to detect differences in functional outcome between groups. A retrospective cohort study of 115 patients with displaced Neer type II and V lateral clavicle fractures presented a nonunion rate of 12 % in surgically treated patients and 78 % in non-surgically treated patients [11]. However, only 22 % of non-surgically treated patients with nonunions had symptoms that warranted delayed surgical treatment. There were no differences in functional outcome between surgically and non-surgically treated patients or between union versus nonunion

<sup>\*</sup> Corresponding author at: Department of Surgical Sciences - Orthopedics, Uppsala University, SE-751 85 Uppsala, Sweden.

E-mail addresses: [caroline.kihlstrom@surgsci.uu.se](mailto:caroline.kihlstrom@surgsci.uu.se) (C. Kihlström), [nils.hailer@surgsci.uu.se](mailto:nils.hailer@surgsci.uu.se) (N.P. Hailer), [olof.wolf@surgsci.uu.se](mailto:olof.wolf@surgsci.uu.se) (O. Wolf).

patients.

Therefore, a considerable knowledge gap remains on whether surgical or non-surgical treatment should be chosen for patients with fully displaced lateral clavicle fractures. Thus, our primary aim was to compare the total number of initial and delayed procedures in patients primarily treated with or without surgery. A secondary aim was to compare PROM between groups.

**Patients and methods**

*Ethics*

The study was approved by the Swedish Ethical Review Authority (approval numbers 2021–04573, 2021–06848–02, 2022–02443–02) and performed in accordance with the Helsinki Declaration. We followed the STROBE guidelines for reporting observational studies.

*Sources of data*

The Swedish Fracture Register (SFR) is a national quality register that prospectively collects data on epidemiology, classification, and treatment of fracture patients. Data is registered for each individual patient by their attending physician. The goal is to register data on all patients sustaining any fracture. In the SFR clavicle fractures are classified using Robinson’s classification system, where fractures must have a 100 % translation between the major fracture fragments to be

classified as displaced. The SFR’s coverage is 100 % of Sweden’s hospital-based orthopedic departments. In 2020, the completeness for registration of clavicle fractures was 55 % compared to the National Patient Register (NPR) (SFR, internal assessment, 2021).

NPR, maintained by the Swedish National Board of Health and Welfare, collects data on all health care procedures and diagnoses in inpatient and outpatient specialist care in all health care units in Sweden.

The SFR also collects PROM by inviting patients to answer the European Quality of Life Scale (EQ-5D-3L) [12] and the Short Musculoskeletal Function Assessment (SMFA) [13] questionnaires. In the first invite, sent to patients a few weeks after the injury event, patients are asked to recall their functional status the week before the fracture occurred. Those who respond are invited to answer the same questionnaires again 1 year after the injury. Unfortunately, the response rate is relatively low, ranging from approximately 65 % as the best at injury time to 15 % as the lowest 1 year after the injury, depending on fracture type, age group, and treatment department [14].

*Patients*

Of 2036 clavicle fractures registered in the SFR during 2018, 424 fractures, in as many patients, were recorded as displaced lateral fractures, i.e., Robinson type 3B1 (extra-articular) or type 3B2 (intra-articular). Of the 424 patients, 70 were deceased, 28 were <18 years of age and 14 lacked radiographs (Flowchart, Fig. 1). After initial exclusion,

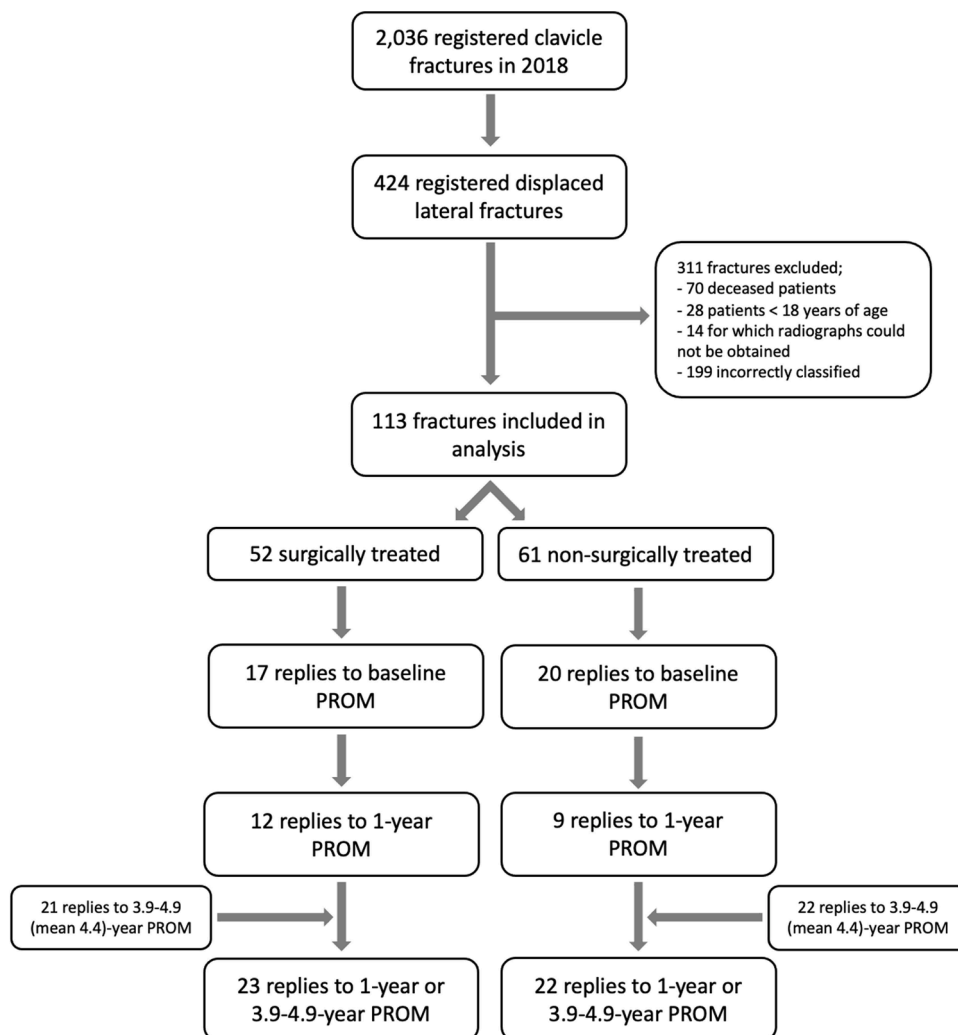


Fig. 1. Flowchart of the study design. PROM, Patient-reported outcome measures.

312 (74 %) patients remained for further analysis. A validation study of the classification of clavicle fractures in the SFR found that many partially displaced fractures were incorrectly classified as displaced [15]. Hence we suspected the accuracy of classifying fractures as displaced or undisplaced fractures in the SFR would be low. Therefore, radiographs were requested from each of the 39 treating orthopedic departments. All 312 fractures were re-classified by the authors according to Robinson's original classification, defining displaced fractures as 100 % translated or with no bone contact between the main fragments. A further 199 fractures were excluded because of incorrect classification in the SFR. After exclusion, 113 fully displaced fractures in 113 patients remained for final analysis.

Through their Swedish personal identification numbers, the patient cohort from the SFR was linked to the NPR, from which additional data were requested to increase data completeness in case any surgical procedures were missing from the SFR. Data from the NPR included all information registered in the patient's electronic record during inpatient and outpatient health care events during 2018–2020 as dates and other concurrent diagnosis codes, such as complications, surgical procedure codes, and presence of comorbidity, including smoking. Because of the selected period, follow-up of diagnoses in the NPR ranged from 2.0 to 3.0 (mean 2.5) years post-injury.

## Methods

PROMs where patients were asked to recall their functional status the week before the fracture occurred are referred to as baseline PROMs. To increase the otherwise low PROM response rate in the SFR new questionnaires were sent to all patients 3.9–4.9 (mean 4.4) years after the injury (between the end of 2022 and the beginning of 2023), regardless of whether the patients had responded to the PROM questionnaires at baseline or 1 year post-injury. The questionnaires included the EQ-5D-3L and SMFA, with the addition of the upper extremity-specific outcome measure of QDASH (Quick Disabilities of the Arm, Shoulder and Hand).

The EQ-5D-3L is a health-related quality of life instrument describing a patient's health status for mobility, self-care, usual activities, pain/discomfort, and anxiety/depression [12]. The derivation of an EQ5D-3 L index in this study was accomplished by applying a Swedish experience-based value set [16], which has an index range from 0.34 to 0.97, with higher values indicating the best health status. The minimal clinically important difference (MCID) for the EQ5D index has been reported to vary between 0.03 and 0.54 for different medical conditions, with an average of 0.18 [17]. The MCID for shoulder pathology is not known. An MCID value was calculated for the PROM subgroup by a distribution-based method. It is defined as one-half of the standard deviation of the difference in scores between baseline and follow-up [18, 19], yielding an MCID index score of 0.04.

The EQ-5D-3L also includes the EQ-VAS, which records the patient's self-rated overall health on a visual analog scale where the endpoints are labeled "Best imaginable health state" (VAS 100) and "Worst imaginable health state" (VAS 0). The MCID for the EQ-VAS has not been established for upper extremity pathology. Using the same distribution method as for the EQ-5D Index, an MCID of 7 points was derived.

The SMFA was designed to identify differences in the functional status of patients with musculoskeletal disorders [13]. The questionnaire contains 34 questions about functional status, from which a function index is calculated, and 12 questions on mental and emotional problems, from which a bother index is calculated. Both indices range from 0 to 100, with 0 indicating the best function. The MCID for the function and bother indices has not been established for relevant orthopedic diagnoses. Using the same distribution-based method, the calculated MCID for the PROM subgroup was 5 points for the function index and 8 points for the bother index.

The QDASH is a validated shortened version of the widely used Disabilities of the Arm, Shoulder and Hand (DASH) outcome measure. It

comprises 11 items to measure physical function and symptoms in patients with upper limb disability [18]. Like the SMFA indices, it ranges from 0 to 100, with 0 indicating the best function. The MCID for QDASH has been reported to be 8 points for shoulder pathology [19].

PROM changes over time were calculated from baseline to follow-up 3.9–4.9 years post-injury if possible; if there were no 3.9–4.9-year follow-up PROM, a 1-year follow-up was conducted.

Patients were also asked how many surgical procedures they had undergone, including when and why, if they had any comorbidities, and if they were active smokers. An age-adjusted Charlson Comorbidity Index (CCI) was calculated for each patient based on the comorbidities recorded in the NPR, with additional information from the questionnaires at the 3.9–4.9-year follow-up post-injury for the patients who had answered these questionnaires. The CCI version used was one that has been adapted for register-based research in Sweden [20]. The CCI ranges from 0 to 37 points, with 37 points indicating the highest level of comorbidity. CCI was categorized into three groups: CCI = 0, CCI = 1–2, and CCI =  $\geq 3$ , representing no, moderate, and high comorbidity, respectively.

The primary endpoints were the number of reoperative surgical procedures in initially surgically treated patients and the number of delayed surgical procedures in initially non-surgically treated patients. Secondary endpoints were QDASH scores 3.9–4.9 years after the injury, followed by the EQ-5D-3L health index and EQ-VAS for overall health, the SMFA function index, and the SMFA bother index in surgically and non-surgically treated patients.

## Statistics

Data were described by medians, ranges, and first and third quartiles. All data were non-normally distributed, as assessed by histograms. Comparisons of medians of non-normally distributed data were made using the Wilcoxon rank-sum test. Estimation uncertainty was expressed using 95 % confidence intervals (CIs). The significance level was set to  $p < 0.05$ , and statistical analysis was performed using statistic software R version 4.3.0 [21].

## Results

The median age was lower for surgically than for non-surgically treated patients, 42 (CI 37–48) vs 53 (CI 47–58) years ( $p = 0.003$ ) (Table 1). The male:female ratio was roughly 2:1 in both treatment groups. Surgically treated patients most commonly sustained their fractures in a transport accident, whereas non-surgically treated patients most frequently sustained their fractures from a fall. Having sustained other concurrent fractures at the same time as the clavicle fracture was four times more common in the surgically treated group. All but one fracture were Robinson type 3A fractures, i.e., extra-articular. Active smoking and concurrent illnesses were rare in both treatment groups. Most patients in both groups had no comorbidities expressed as CCI.

### Initial treatment

Of the 113 study patients, primary surgical treatment was registered in 52 (46 %). The median time between injury and surgery was 7 days (interquartile range [IQR] 5–11 days). The preferred method for osteosynthesis was plate fixation. Hook plates were slightly more common than lateral clavicle plates (Table 2). 61 patients (54 %) were treated non-surgically.

### Reoperations and delayed surgery

34 of the 52 (65 %) surgically treated patients underwent a second procedure for implant removal. One patient had to undergo an early reoperation due to implant failure 3 weeks after initial surgery (Table 3). All patients who had received a hook plate ( $n = 25$ ) underwent

**Table 1**

Demographics of the study population. Numbers refer to the number of patients unless otherwise specified. CI 95 % confidence interval. CCI Charlson Comorbidity Index. <sup>1</sup>: Simple, unspecified and from furniture.

	Surgical treatment	Non-surgical treatment
<b>Patients</b>	52	61
<b>Median age, years (CI)</b>	42 (37–48)	53 (47–58)
<b>Sex</b>		
Male	35	41
Female	17	20
<b>Injury mechanism</b>		
Fall <sup>1</sup>	18	34
Transport accident	29	20
– Bicycle	22	16
– Motorcycle	4	0
– Truck	0	1
– Horseback riding	3	1
– Other	0	2
Other mechanisms	2	4
Unknown	2	3
<b>High-energy injury mechanism</b>	17	7
<b>Concurrent fractures</b>	20	5
<b>Fracture side</b>		
Left	27	39
Right	25	22
<b>Open type fracture</b>	0	1
<b>Fracture type</b>		
3B1	52	60
3B2	0	1
<b>Smoker</b>	3	3
<b>CCI</b>		
CCI 0	48	52
CCI 1–2	2	5
CCI ≥3	2	4

**Table 2**

Surgical method for 52 of 113 patients who received primary surgical treatment.

Osteosynthesis (number of patients)	
Hook plate	25
Lateral clavicle plate	21
Plate fixation without further specification	1
Combination of methods	2
Pin fixation or cerclage	3

**Table 3**

Complications and reoperations in surgically and non-surgically treated patients.

Outcome	Surgical treatment	Outcome	Non-surgical treatment
Reoperation due to implant failure	1	Delayed surgery due to nonunion/malunion	3
Reoperation due to nonunion	0	Other complications	0
Implant removal	34		
Other complications	0		

subsequent surgery for implant removal. 7 of 22 patients with another type of plate fixation and both with a combination of methods had subsequent implant removal. Implant removal was performed at a median of 109 days after initial surgery (IQR 92–143 days).

In the non-surgically treated group 3 of 61 (5 %) patients underwent delayed surgical treatment at 65, 283 or 627 days after the injury for nonunion ( $n = 2$ ) or for unknown reasons ( $n = 1$ ). All registered complications in both treatment groups led to reoperation or delayed surgery.

*Patient-reported outcome*

The response rates for PROM questionnaires in surgically and non-surgically treated patients are given in Fig. 1. For baseline and follow-up after 3.9–4.9 years, 88–91 % of the responding patients responded to all PROM. For the 1-year follow-up from the SFR, only 43 % of the responding patients responded to all PROM. The change in PROM from baseline to follow-up, either 1 or 3.9–4.9 years post-injury, was calculated for the 13 surgically and the 11 non-surgically treated patients that had answered both (or all three) PROM questionnaires. In the subgroup of patients that had responded to the PROM follow-up questionnaires either 1 and/or 3.9–4.9 years post-injury, there was no difference in median age between surgically and non-surgically treated patients, 47 (CI 40–54) vs 52 (CI 43–64) years ( $p = 0.5$ ). A greater percentage of the females replied to the PROM questionnaires, creating an almost identical male-to-female ratio close to 1:1 in both groups (Table 4, see supplementary data).

There was no difference in the QDASH score between the surgically and non-surgically treatment groups 3.9–4.9 years post-injury. There were also no differences in the EQ-5D health index, EQ-VAS for overall health, SMFA function index, or the SMFA bother index between the surgically and non-surgically treated groups at baseline, the 1-year follow-up or the 3.9–4.9-year follow-up. We found no difference in a change in PROM from baseline to follow-up between treatment groups (Table 5).

**Table 5**

Patient-reported outcomes in surgically and non-surgically treated patients. CI 95 % confidence interval.

PROM (median, CI)	Surgical treatment	Non-surgical treatment	P-value
<b>Baseline PROM</b>			
EQ-5D-3L Index value	0.97 (0.94–0.97)	0.97 (0.97–0.97)	0.3
EQ-VAS	95 (90–100)	90 (85–95)	0.2
SMFA function index	2.2 (0–2.9)	2.9 (0–6.3)	0.6
SMFA bother index	0 (0–4.2)	0 (0–4.2)	0.7
<b>1-year follow-up PROM</b>			
EQ-5D-3L Index value	0.94 (0.81–0.97)	0.89 (0.67–0.97)	0.8
EQ-VAS	88 (81–94)	75 (50–95)	0.6
SMFA function index	2.2 (0.7–6.6)	6.6 (0–5.2)	0.3
SMFA bother index	6.2 (2.1–12)	8.3 (0–40)	0.9
<b>3.9–4.9-year follow-up PROM</b>			
EQ-5D-3L Index value	0.97 (0.94–0.97)	0.97 (0.94–0.97)	1
EQ-VAS	84 (75–90)	85 (80–90)	0.4
SMFA function index	2.2 (0.7–6.6)	1.5 (0–5.2)	0.7
SMFA bother index	2.1 (0–6.3)	2.1 (0–2.1)	1
QDASH score	2.3 (0–2.3)	2.3 (0–6.8)	0.9
<b>1-year or 3.9–4.9-year follow-up PROM combined</b>			
EQ-5D-3L Index value	0.97 (0.94–0.97)	0.97 (0.94–0.97)	0.5
EQ-VAS	82 (75–90)	83 (80–90)	0.8
SMFA function index	2.2 (0.74–7.4)	3.3 (1.5–12)	0.6
SMFA bother index	2.1 (0–10)	2.1 (0–6.3)	0.4
QDASH score	2.3 (0–2.3)	2.3 (0–6.8)	0.9
<b>Change from baseline to 1-year or 3.9–4.9-year PROM<sup>1</sup></b>			
EQ-5D-3L Index value	0 (0–0.02)	0 (0–0)	0.6
EQ-VAS	–8 (–15–0)	0 (–20–5)	0.3
SMFA function index	0 (0–2.2)	0.7 (–1.5–13)	0.7
SMFA bother index	0 (0–2.1)	0 (–2.1–20)	0.7

<sup>1</sup> : PROM changes over time were calculated from baseline to the 3.9–4.9-year follow-up post-injury if possible or to a 1-year follow-up if there were no 3.9–4.9-year follow-up PROM.

## Discussion

### Main findings

Almost half ( $n = 52$ ) of the 113 patients with fully displaced lateral clavicle fractures were initially surgically treated. Surgically treated patients were younger and had sustained their fractures through high-energy injuries more often than non-surgically treated patients. Initial surgical treatment resulted in secondary surgery for implant removal in 2 of 3 surgically treated patients ( $n = 34/52$ ). Non-surgical treatment resulted in delayed surgery due to symptomatic nonunion or malunion in only 1 of 20 patients ( $n = 3/61$ ). The response rate for the patient-reported outcome questionnaires was low at follow-up, but no differences were found in any of the outcome measures between the two treatment groups. QDASH was similar between surgically and non-surgically treated patients, with no statistically significant differences between groups.

### Comparisons with other studies

Based on reports of high nonunion rates with nonsurgical treatment, most displaced lateral clavicle fractures are treated surgically [2–7]. Our proportion of surgical treatment, just under 50 %, was unusually low. A review article on the treatment of displaced lateral clavicle fractures found that many studies included populations where nearly 100 % (mean 85 %) of patients received surgical treatment [2].

By reviewing all radiographs in this national observational cohort, we included only truly displaced lateral clavicle fractures with displacement between the major fragments of at least 100 %, indicating different treatment algorithms in various departments or algorithms that assess more than the fracture itself. The difference in fracture pattern, barring the absence of impeding skin penetration, should not be a critical factor in deciding between surgical and nonsurgical treatment in light of this homogeneity.

The finding that surgically treated patients were younger, had more often sustained their fractures through high-energy injuries and had more often sustained concurrent fractures in addition to their clavicle fractures than non-surgically treated patients is an indicator of how the treating surgeons likely consider both the injury mechanism and the patient's age to be important factors in deciding between surgical and non-surgical treatment. Age being an important factor in a surgeon's decision between surgical and non-surgical treatment has been demonstrated in previous studies [1]. It can be seen as paradoxical that younger patients are recommended surgical treatment to a larger extent than older patients given that advancing age increases the risk of nonunion in non-surgically treated patients [3]. The reason might be that lateral clavicle fracture nonunion in younger individuals has a higher risk of being symptomatic than in older individuals due to higher physical demands. The higher nonunion rates in older individuals might also be a by-product of the age-focused clinical rationalization for surgery. The differences in baseline characteristics of the surgically and the non-surgically treated groups with regards to injury mechanism, the presence of concurrent fractures and age create an indication bias that is difficult to avoid unless intervention is randomized regardless of age and other patient characteristics and begs the question, although simplified: Are we comparing surgically and non-surgically treated patients or are we comparing young patients with high-energy injuries and old patients with low-energy injuries? This question cannot readily be answered by our study where only three patients were diagnosed with nonunion and their ages ranged from 18 to 53 years. What we can conclude is that the nonunion rate was low, regardless of age and primary treatment.

In our study's surgically treated group no nonunions were reported. Yet, surgical treatment does not guarantee fracture union [10,11,22–25].

Our study had a high rate of secondary surgical procedures for implant removal in surgically treated patients. The 100 % removal rate of hook plates was expected, as hook plates are removed per routine so

as not to cause discomfort and subacromial impingement [26]. Of the patients who were treated with other surgical methods, mainly other types of plate fixation, 1 in 3 still underwent surgical implant removal, producing an implant removal rate that was somewhat higher than in a review article where the removal rate of lateral clavicle plates was 18 % [8].

The need for delayed surgical treatment in non-surgically treated patients due to nonunion or malunion in our study was only 5 %, which seems low compared to nonunion rates of 6–44 % in many previous studies [2–7]. It is, however, probable that there are patients with asymptomatic nonunions that have not been detected by our study design. In a recent retrospective cohort study the nonunion rate among 82 non-surgically treated patients with displaced lateral clavicle fractures was as high as 78 %. Still, only 22 % of these patients had symptoms that warranted delayed surgical treatment [11].

In our study the initially non-surgically treated patients who underwent delayed surgical treatment had no subsequently reported reoperations, nonunions or other complications. Previous research has shown that the union rate in patients with unstable lateral clavicle fractures does not seem to be affected by the timing of surgery but that the complication rate in terms of infections and peri-implant fractures may be higher for initially non-surgically treated patients that have undergone delayed surgical treatment [22].

Many studies have reported good PROM for surgical treatment of displaced lateral clavicle fractures [5,10,11,22,24,25,27]. However, few studies have compared PROM between surgically and non-surgically treated patients. The only RCT conducted on completely displaced Neer type II lateral clavicle fractures failed to reach the calculated required sample size of 37 patients in each group, leading to underpowered statistical analysis [10]. The RCT, however, found no differences between 25 patients treated surgically by fixation with a hook plate or a lateral clavicle plate and 25 patients treated non-surgically in the DASH score or Constant-Murley score 1 year after the injury. The number of patients followed-up with PROM in this RCT was approximately the same as in our study. Another retrospective cohort study comprising 33 surgically treated and 82 non-surgically treated patients with displaced lateral clavicle fractures also found no differences between treatment groups in PROM, including QDASH. More interestingly, the study found no differences in PROM between non-surgically treated patients with united fractures and nonunions [11]. A small observational cohort study with 14 patients treated surgically by open reduction and coracoclavicular stabilization and 16 patients treated non-surgically found no significant differences in Constant-Murley, ASES or University of California-Los Angeles (UCLA) scores between treatment groups with Neer type II lateral clavicle fractures [5].

Different outcome measures have been used to assess PROM in clavicle fracture patients, but there is no consensus on which measures are most reliable. To facilitate cross-study comparisons it has been recommended to use at least two of the commonly reported PROM instruments [28]. The EQ-5D-3L and SMFA were used in this study because they are already included in the SFR, which collects information on all fracture types. However, these questionnaires are not commonly used for clavicle fracture assessment, as they are not specific to the upper limb. For this reason, we added the upper-limb-specific outcome measure (the QDASH), commonly used for shoulder pathology.

In our study the use of Robinson's classification system creates a cohort of displaced lateral clavicle fractures with an exceptionally high degree of displacement. Most studies on displaced lateral clavicle fractures are based on Neer's classification system, as modified by Craig, which has no prerequisite for the degree of displacement. Accordingly, direct comparisons of the present results to previous studies using the Neer classification are challenging.

### Strengths and weaknesses of the present study

This study combines data from two national quality registers with

high coverage and completeness from 39 treating orthopedic departments in Sweden to compare surgical and non-surgical treatment in patients with fully displaced lateral clavicle fractures regarding the total number of initial and delayed surgical procedures. The design should provide high data completeness and results representative of a nationwide treatment praxis by avoiding potential bias from local treatment traditions.

We suspected that the classification accuracy of clavicle fracture in the SFR would be low based on a validation study where partially displaced fractures were often incorrectly classified as displaced [15]. Radiographic imaging was evaluated for all fractures before inclusion to confirm that all included fractures were Robinson 3B with at least 100 % translation between the major fragments. By selecting only fully displaced lateral clavicle fractures, the study patients had similar fracture patterns. Studies comparing surgical and non-surgical treatment for displaced lateral clavicle fractures have used classifications in which fractures classified as displaced are likely to vary more in the fracture pattern. The more similar the fracture patterns of the patients are, the more straightforward the comparison between groups.

There is a limitation in the presentation of smoking habits in that data were only available for active smoking, not previous smoking or pack years.

We attempted to compare PROM between surgically and non-surgically treated patients. The prospective undertaking of the SFR to record PROM at baseline and follow-up has advantages in enabling comparisons of changes in PROM over time. The PROM subgroup also had the benefit of having relatively similar baseline characteristics between the surgically and non-surgically treated groups, where there was no difference in median age, male:female ratio or CCI.

A major weakness for the secondary endpoints of PROM comparisons was the low response rate in the already decimated cohort because of the high exclusion rate. Almost 2 in 3 fractures classified as displaced lateral clavicle fractures in the SFR were found to be incorrectly classified upon radiographic assessment by the authors. Although we managed to increase the response rate slightly to 40 % at follow-up by distributing new PROM questionnaires, the PROM subgroup was still relatively small for reliable analysis of potentially significant differences in PROM between surgically and non-surgically treated patients, but in line with the only RCT in the field [10].

#### Implications of the study

In this study fully displaced lateral clavicle fractures of very similar radiographic appearance were treated surgically or non-surgically. The finding that most surgically treated patients needed secondary surgery for implant removal while few non-surgically treated patients needed delayed surgery for nonunion supports the notion that non-surgical treatment should more often be entertained as a viable option to surgery. Patients offered surgical treatment should be informed of the high risk of metal removal. Our PROM subgroup was small and the results indicate no large differences in PROM between the two groups. If future studies could demonstrate no differences in PROM between surgically and non-surgically treated patients with fully displaced lateral clavicle fractures, non-surgical treatment should be considered the first step.

#### Conclusions

Fully displaced lateral clavicle fractures should be considered for non-surgical treatment more often. Due to low response rates to PROM questionnaires and various levels of confounding, further research is needed, preferably in the RCT format.

#### CRediT authorship contribution statement

**Caroline Kihlström:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original

draft, Writing – review & editing. **Nils P. Hailer:** Conceptualization, Methodology, Supervision, Writing – original draft. **Olof Wolf:** Conceptualization, Methodology, Supervision, Writing – original draft.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

#### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.injury.2024.111422](https://doi.org/10.1016/j.injury.2024.111422).

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