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SHOULDER

Concomitant intra-articular glenohumeral injuries in displaced fractures of the lateral clavicle

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Abstract
Purpose To detect concomitant intra-articular glenohumeral injuries, in acute displaced fractures of the lateral clavicle, initially missed due to unfeasible clinical evaluation of the acutely injured shoulder.
Methods All patients suffering from an acute displaced lateral clavicle fracture with indication to surgical treatment underwent diagnostic shoulder arthroscopy prior to open reduction and internal fixation. In case of therapy-relevant intra-articular glenohumeral injuries, subsequent surgical treatment was performed.
Results Intra-articular injuries were found in 13 of 28 patients (46.4 %) with initially suspected isolated lateral clavicle fracture. Additional surgical treatment was performed in 8 of 28 cases (28.6 %). Superior labral anterior-posterior (SLAP) lesions were observed in 4 of 28 patients (14.3 %; SLAP II a: 1; II b: 1; III: 1; and IV: 1). Lesions of the pulley system were found in 3 of 28 patients (10.7 %; Habermeyer III°). One partial articular supraspinatus tendon avulsion lesion (3.6 %) and one lesion of the subscapularis tendon (3.6 %; Fox and Romeo II°) were observed.
Conclusions Traumatic concomitant glenohumeral injuries in lateral clavicle fractures seem to be more frequent than expected in general. Subsequent surgical treatment of these formerly missed but therapy-relevant injuries may increase functional outcome and reduce complication rate.
Level of evidence IV.

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Introduction

Fractures of the lateral clavicle account for approximately 17 % of all clavicle fractures [27]. The most common mechanism of injury is a direct blow to the shoulder [19], rarely an indirect trauma, such as falling on the extended arm [29]. Despite good functional results and radiological bony union of precontoured locking plates with lateral extension [2, 32], previous studies report a considerable divergence of functional results with a partially high complication rate between 7 % in conservative treatment and 22 % in surgical treatment of lateral clavicle fractures [22].

In acute high-grade dislocation of the acromioclavicular joint, a comparable injury pattern [36], concomitant intra-articular glenohumeral injuries such as superior labrum anterior-posterior (SLAP) lesions, partial articular supraspinatus tendon avulsion (PASTA) lesions or rotator cuff tears could be identified in 15–18 % [24, 25, 33]. These previously missed occult lesions can lead to persistent pain or poor functional results possibly requiring secondary surgical intervention.

Although, to the best of our knowledge, there is no work in the literature analysing the precise force vectors inducing either an acromioclavicular joint dislocation or a lateral clavicle fracture, we hypothesize them to be nearly similar to a comparable mechanical impact on the glenohumeral joint. Hence, a similar rate of concomitant intra-articular injuries appears presumable [18, 35].

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Therefore, the purpose of this prospective study was to determine concomitant intra-articular glenohumeral injuries in patients suffering from acute displaced lateral clavicle fractures using diagnostic glenohumeral and subacromial arthroscopy. To the best of our knowledge concomitant intra-articular glenohumeral injuries in lateral clavicle fractures are reported for the first time.

Materials and methods

Patients suffering from acute displaced lateral clavicle fracture with indication to surgical treatment who presented to our academic emergency department were included in this prospective study. Fractures were classified according to the Jäger and Breitner (J&B) classification [16] as an extension of the Neer classification [21]. Fracture types J&B II a and II b as well as I and III with severe displacement were considered as an indication for surgical treatment. Between October 2012 and December 2014, 28 patients (20 men, 8 women) with a mean age of 41.8 ± 13.2 years (21–80 years) and acute displaced lateral clavicle fractures were enrolled in this prospective clinical study. The medical history of every patient did not reveal any suspicion of pre-existing pathologies of the affected shoulder. The mean interval between trauma and surgery was 4.9 ± 4.7 days (0–20 days). According to the Jäger and Breitner (J&B) classification, 4 (14.3 %) patients had a type I, 22 (78.6 %) patients had a type II a, and 2 (7.1 %) patients had a type II b fracture. Preoperatively, standard radiographs of the clavicle in anterior-posterior perpendicular as well as anterior-posterior 30° angled course of beam were performed. Patients with a history of any glenohumeral pathology, such as pre-existing rotator cuff tear, glenohumeral instability, AC joint instability, calcifying tendonitis or biceps pathology, were excluded from the study. Written informed consent was obtained from each patient.

Surgical technique

Patients were placed in a beach-chair position with the affected arm in a mobile position. Prior to open reduction and internal fixation (ORIF), all patients underwent diagnostic glenohumeral and subacromial arthroscopy. After identifying the bony landmarks (clavicle, acromion, acromioclavicular joint, coracoid process), a standard posterior arthroscopy portal was placed in the soft spot about 2 cm inferior and 2 cm medial to the postero-lateral corner of the acromion. At first, a subacromial bursoscopy was performed to detect bursa-sided rotator cuff tears followed by standardized diagnostic glenohumeral arthroscopy. Hemarthrosis and/or reddish blood tinged pathologies were considered to be associated with the recent shoulder trauma [24]. Supraspinatus tendon lesions were classified according to Ellman [9]. Subscapularis tendon lesions were classified according to Fox and Romeo [10]. Injuries of the superior labrum in relation to the biceps tendon anchor were classified according to Snyder et al. [28] and Maffet et al. [20]. Lesions of the pulley system were classified according to Habermeyer et al. [14]. The further placement of additional arthroscopy portals (e.g. anterior–superior or lateral) depended on the corresponding intra-operative findings. After diagnostic shoulder arthroscopy and subsequent surgical treatment of therapy-relevant intra-articular injuries, ORIF of the lateral clavicle fracture was performed using a locking compression plate (LCP) with lateral extension (LCP superior anterior clavicle plate, DePuy Synthes®, Zuchwil, Switzerland). Therefore, a transverse skin incision was made upon the clavicle with lateral extension to the lateral edge of the acromion. The AC joint capsule was not incised.

The study protocol was approved by the local ethics committee (Ethics Committee of the medical faculty, Technical University of Munich; study number 5536/12).

Statistical analysis

Data are given in terms of the arithmetic mean ± standard deviation and range in brackets. The representative study of Pauly et al. [24] was used to estimate the power and sample size. The authors reported the prevalence of concomitant intra-articular lesions to the glenohumeral joint following high-grade dislocation of the acromioclavicular (AC) joint with 15 % ($n = 6/40$). Based on these findings, a sample size of 22 is needed for a single proportion with a two-sided 95.0 % confidence interval and a normal approximation of 0.150. Sample size estimation was performed using nQuery Advisor (version 7.0; Statistical Solutions Ltd, Cork, Ireland).

The results were compared by calculating the Wilcoxon rank-sum test. Statistics were calculated using commercially available programs (SigmaStat 3.1, Systat Software Inc., Chicago, USA). A p-value <0.05 was considered as statistically significant.

Results

Diagnostic shoulder arthroscopy, subsequent treatment of relevant intra-articular lesions, if regarded to be necessary, and ORIF were performed by two experienced upper-extremity surgeons. Average duration of surgery accounted for 116.7 ± 26.1 min (66–180 min). Diagnostic shoulder arthroscopy with subsequent ORIF lasted for an average of 113.5 ± 28.3 min (66–180 min), whereas diagnostic shoulder arthroscopy with additional arthroscopic treatment and

consecutive ORIF took 124.6 ± 18.7 min (101–159 min; n.s.).

Intra-operative findings and additional treatment

Traumatic concomitant intra-articular injuries were found in 13 of 28 patients (46 %), and additional surgical treatment was required in 8 of 28 cases (29 %). Arthroscopic tenodesis of the long head of the biceps tendon (LHBT) using one anchor (Corkscrew® FT II, Arthrex, Naples, USA) was performed via an anterior–superior portal. Partial articular supraspinatus tendon avulsion (PASTA) lesions were repaired using two anchors (Corkscrew® FT II, Arthrex, Naples, USA). Subscapularis tendon repair was performed using two anchors (Corkscrew® FT II, Arthrex, Naples, USA). Electrothermal arthroscopic debridement of the SGHL with a bipolar TurboVac® (ArthroCare®, 42859 Remscheid, Germany) was performed in isolated lesions of the SGHL (Habermeyer I°) with a firmly anchored LHBT in the pulley system.

Discussion

The most important finding of the present study was the high number of therapy-relevant glenohumeral lesions in patients with a displaced fracture of the lateral clavicle. Despite the development of new fixed-angle implants [2, 32], the functional outcome after lateral clavicle fractures still shows a great variety with partially high complication rates [22]. In acute high-grade dislocation of acromioclavicular joint, trauma-related concomitant intra-articular injuries of the glenohumeral joint could be identified in 15–18 % [24, 25, 33]. Due to similar injury mechanisms in fractures of the lateral clavicle, associated intra-articular glenohumeral lesions could occur in a similar frequency and their un-diagnosis may lead to the reported poor treatment results. The data of this study demonstrate well that the therapy-relevant concomitant glenohumeral lesions could be identified in 29 % of the patients. Thus, subsequent treatment of formerly missed intra-articular injuries may help to increase the functional outcome in surgical treatment of lateral clavicle fractures.

Demographics

Since the present study collective consisted of 28 patients with a mean age of 41 years and a male–female ratio of 5:2 age, dominance of the male population are comparable to previously published studies of patients with lateral clavicle fractures [2, 15, 27]. In general, fractures of the lateral clavicle are very rare injuries with an incidence of 0.43 % of all fractures in humans [27]. Thus, the strength of the obtained results regarding the concomitant glenohumeral injuries in low-incident diseases, such as lateral clavicle fractures, can only provide the fundamental and a good starting point for further analysis.

Intra-operative findings and additional treatment

In the presented patient collective, superior labral anterior-posterior (SLAP) lesions of the glenoid labrum were found in 4 of 28 patients. In general, the clinical manifestation of SLAP lesions contains pain, mechanical symptoms, instability and loss in range of motion [13, 20]. In the literature, the optimal treatment strategy is controversially discussed [12]. However, in the recent years, the number of studies on arthroscopically performed SLAP repair considerably increased [38]. In contrast to primary SLAP repair, subpectoral biceps tenodesis has been identified as an acceptable alternative eliminating the requirement of direct tissue healing in a relatively avascular zone [13]. Thus, SLAP lesions constitute relevant concomitant glenohumeral injuries in lateral clavicle fractures with a similar frequency in comparison with acute AC joint dislocations [33], and subsequent treatment may avoid long-term sequelae concerning pain and functional impairment. Partial-thickness tears of the rotator cuff (RC) can lead to pain and disability [30] especially in young active patients, e.g. in throwing athletes [26]. In the literature, the recommendation that RC tears >50 % of the tendon thickness require repair is generally accepted [11] due to the potential risk of progression to full-thickness tears [37]. Transtendon partial articular-sided supraspinatus tendon avulsion (PASTA) repair, as performed in patient No VII, demonstrated high patient satisfaction and improvement in pain and function in long-term follow-up studies [7, 30] which emphasizes the therapeutic relevance of PASTA lesions also in lateral clavicle fractures. The subscapularis muscle (SSC) presents the sole internal rotator of the rotator cuff and additionally acts as anterior dynamic stabilizer of the glenohumeral joint [17]. Although isolated complete SSC tears are not very common, they are most commonly trauma associated and surgical treatment is recommended [8, 17]. Therefore, we performed subsequent all-arthroscopic SSC repair in patient No XVI, who demonstrated a complete tear of the upper 25 % of the SSC tendon. The biceps pulley system consisting of fibres of the coracohumeral ligament, the superior glenohumeral ligament, and the supraspinatus and subscapularis tendons [34] serves as a tissue sling stabilizing the long head of the biceps tendon [5]. Tears and dislocations of the LHBT due to an insufficient pulley system can result in anterior shoulder pain due to a high degree of innervation of the proximal third of the tendon [31]. In addition, medial or lateral dislocation of the tendon can lead to further damage of the supraspinatus or subscapularis tendon

[3, 5, 34], and the subluxated LHBT loses its anterior stabilizing effect on the glenohumeral joint and allows anterior humeral translation [23]. Therefore, tenodesis of the LHBT is recommended in biceps tendon pathologies resulting in subluxation or instability [6], e.g. in a combination of a lesion of the SGHL and a deep surface tear of the subscapularis tendon (type III pulley lesion according to Habermeyer et al. [14]) because it constitutes for an extremely safe and reliable procedure leading to only minimal complication and revision rates [4]. In contrast, the stability of the pulley system in isolated lesions of the SGHL (type I pulley lesion according to Habermeyer et al. [14]) is not impaired, and electrothermal arthroscopic debridement of the SGHL without tenodesis is reported to be adequate [1].

Therefore, immediate identification and subsequent surgical treatment of relevant injuries may improve clinical outcome avoiding long-term sequelae with secondary operative intervention.

Despite the prospective nature of the present study, several limitations have to be mentioned. First of all, the number of included patients is relatively low, and therefore the reliability of significance is limited. However, since fractures of the lateral clavicle are a rare injury and the presented study reports to the best of our knowledge concomitant intra-articular glenohumeral lesions for the first time, the results are considered as relevant. Furthermore, the findings of previous studies assessing concomitant glenohumeral injuries in acute dislocations of the acromioclavicular joint, an injury with similar trauma mechanisms in comparison to lateral clavicle fractures, demonstrated similar results regarding frequency and nature of concomitant injuries, which confirm our results. Another well-known bias in topic-related studies constitutes the relevance of intra-operative arthroscopic findings, which strongly depends on the subjective assessment of the surgeon.

To sum up, glenohumeral injuries in displaced fractures of the lateral clavicle are more frequent than previously suspected. Shoulder arthroscopy with subsequent treatment of therapy-relevant glenohumeral lesions in addition to open reduction and internal fixation may improve the functional outcome of lateral clavicle fractures.

Conclusions

In the present study, concomitant glenohumeral lesions in lateral clavicle fractures have been reported for the first time. Additional surgical treatment regarding the concomitant glenohumeral lesions was required in 8 of 28 patients (29 %). The identification and subsequent treatment of these formerly un-diagnosed but therapy-relevant injuries may decrease post-operative pain and improve the functional outcome in locking plate fixation of lateral clavicle fractures.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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