ABSTRACT

Objectives: In this study, it was aimed to evaluate the mid-term clinical and radiological outcomes of coracoclavicular (CC) ligament reconstruction using knotless ZipTight fixation system in acute acromioclavicular (AC) joint dislocations.

Methods: Twenty-seven patients who underwent surgery with ZipTight (Zimmer Biomet, Parsippany, NJ) fixation system were included in this retrospective clinical study. Twenty-three of the patients are male; 4 of them were female and the mean age was 32.9 ± 9.8. Ten patients had Rockwood type III and 17 patients had type V acute AC joint dislocation. Patients were evaluated clinically with Constant score, American Shoulder and Elbow Surgeons (ASES) score and visual analogue scale (VAS) pain score at the final follow-up. The radiologic assessment included standard anteroposterior views of the coracoclavicular (CC) distances.

Results: The mean follow-up time was 36.2 ± 13.6 months. At the last follow-up, mean Constant score was 91.6 ± 6.18; the ASES score was 89.9 ± 6.3 and the VAS pain score was 0.33 ± 0.62. When they were divided into two subgroups as type III and type V AC joint dislocations, the two groups were found to be similar in terms of clinical outcomes (p > 0.889). CC distance measurements obtained in radiographic evaluation were measured as 20.04 ± 4.84 mm at preoperative period; it was 7.55 ± 0.78 mm in the early postoperative period and 7.76 ± 0.79 mm at the last follow-up. A statistically significant improvement was observed in the measurements in the early postoperative period compared to the measurements at preoperative period (p = 0.001). There was no significant difference between the measurements in the early postoperative period and those at the last follow-up (p = 0.001).

Conclusions: In the treatment of acute AC joint dislocations, successful clinical and radiological outcomes can be obtained in the mid-term with CC ligament reconstruction using ZipTight fixation system.

Key words: Acromioclavicular dislocation, coracoclavicular, Rockwood, ZipTight

Introduction

Acromioclavicular (AC) joint injuries are common in the active young population and constitute approximately 9% of all shoulder girdle injuries [1,2]. Most of these injuries affect 20-40 ages and are seen 8.5 times more frequently in males than in females [3]. Based on the coracoclavicular (CC) distance, AC joint dislocations are radiographically classified into...
six groups according to Rockwood criteria [4]. Type I and II injuries are considered as minor injuries and are treated non-operatively as a standard [5]. In type III-VI injuries, a complete tear occurs in the AC and CC ligaments, and consequently, both vertical and horizontal instability occur [6]. While operative treatment is recommended for type IV-VI injuries; the treatment of type III injuries is still controversial [7,8]. Although the activity level of the patient, the preference of the patient and the response to non-operative treatment are determinative in the treatment of type III injuries, it has been reported in a survey study that 73% of surgeons prefer operative treatment [9,10]. Successful long-term outcomes have been obtained with surgical treatment in type III AC joint dislocations [11,12]. Although successful clinical outcomes have been reported with non-operative treatment, non-operative treatment was associated to be more prominent and radiographically wider AC joint than operative treatment [8].

CC ligaments are the most important structures that determine the stability of the AC joint, and therefore, restoration of the CC interval is aimed in surgical treatment methods [13]. Although various surgical treatment methods have been used until today, hook plate fixation and CC ligament fixation using a suspensory loop device (SLD) are the two main treatment methods frequently preferred recently. Suspensory loop fixation can be applied by various methods such as tightrope, endobutton, synthetic ligament and absorbable polydioxansulfate sling [14]. Successful results of CC ligament reconstruction with SLD in acute AC joint dislocations have been reported in clinical and biomechanical studies [15,16].

ZipTight (Zimmer Biomet, Parsippany, NJ) fixation system is a suspensory loop fixation device that prevents knot-linked swelling at the clavicle superior due to its knotless feature. In present study, it was aimed to evaluate the mid-term clinical and radiological results of CC ligament reconstruction with knotless ZipTight system in type III and type V acute AC joint dislocations. Our hypothesis was that CC ligament fixation applied with the ZipTight system was an effective and safe method in acute AC joint dislocations.

Patients and Methods
In this retrospective clinical cohort study, patients who underwent surgical treatment with ZipTight (Zimmer Biomet, Parsippany, NJ) fixation system between 2014-2018 for acute AC joint dislocation were evaluated. The study data were retrieved from the archiving system consisting of patient files during the hospitalization and follow-up cards used in the outpatient clinic. Inclusion criteria were defined as isolated Rockwood type III and type V injuries, patients undergoing surgical treatment with ZipTight fixation system, patients with a minimum follow-up of 12 months, and patients 18 years of age or older. Patients who have passed more than three weeks after the first trauma, patients who have previously been exposed to AC injury, patients with open dislocation, patients with massive swelling, patients with incomplete patient records, and patients whose shoulder functions were affected due to a musculoskeletal or neurological disease were excluded from the study. Twenty-seven patients met the selection criteria and were included in the study. Written informed consent was obtained from each patient. The study was conducted in accordance with the principles of the Declaration of Helsinki.

All operations were performed under general anesthesia and in the beach chair position by a single surgeon. After the shoulder was prepared and covered in a sterile fashion, a 5-6 cm transverse skin incision was applied over the clavicle by centering the attachment points of the conoid and trapezoid ligaments to the clavicle. The deltotrapezial fascia was opened and the clavicle was disclosed, and the base of coracoid was found by blunt dissection. The attachment places of the CC ligaments were determined and preserved for primary repair. The clavicle and coracoid were drilled at the same time in cases where proper alignment was
The drilling procedure is performed in the clavicle from the attachment places of the CC ligaments (that is approximately 25 mm medial to the distal clavicle); in coracoid, it is performed from the base of the coracoid process. First, a 2.4 mm guide pin, then a 4.5 mm cannulated drill was used over this pin. If the clavicle and coracoid were drilled together, the oblong button was placed under the coracoid with the button pusher and the round button was fixed at the superior side of the clavicle (Figure 1A, B). Otherwise, an oblong button was placed under the coracoid first, and the threads were taken retrograde to the superior of the clavicle through the hole in the clavicle. Then the threads passed through the round button on the clavicle were fixed after fluoroscopic control and reduction control. Sutures passed through the ruptured ligaments before reduction were used for primary repair. The wounds were then closed in layers (Figure 1C). Patients used shoulder sling for 4-6 weeks postoperatively. During this period, the sling was allowed to be removed for wrist and elbow exercises. Pendulum exercises after the first week; passive joint movements started after the fourth week. Active assistive exercises were started from the sixth week; active resistive exercises were started after the eighth week. White-collars workers were recommended to returning to work after the second month; heavy workers were recommended after the third month.

The information regarding the patient age, gender, affected side, and the time from injury to surgery were noted. Patients were evaluated clinically with Constant score [17], American Shoulder and Elbow Surgeons (ASES) score [18] and visual analogue scale (VAS) pain score at the last follow-up. The Constant score consists of pain, activity level, arm positioning, strength of abduction and range of motion. In the VAS pain score, 0 indicates ‘no pain’ and 10 indicates ‘severe pain.’ The radiologic assessment included standard anteroposterior views of the CC distances. The CC distance was defined as the vertical distance between the anteroinferior border of the clavicle and the superior border of the coracoid process. CC distance measurements obtained before operation, early postoperative period and final follow-up were compared. Complications such as infection, implant failure, osteolysis, degenerative change in the AC joint, calcifications along the CC ligaments and loss of reduction were noted. Clinical and radiological evaluation was made by a physician assistant who was not associated with the study.
**Statistical Analysis**

The SPSS 25.0 software package was used in the statistical analysis of the data. Categorical measurements were expressed in numbers and percentages and continuous measurements were expressed in mean and standard deviation (median and minimum - maximum, where necessary) values. Distributions were analyzed for a comparison of continuous measurements between the groups, where in the Student’s t test was used for variables with a parametric distribution and the Mann-Whitney U test for variables with a non-parametric distribution. Pre-post variables were analyzed Wilcoxon test. P < 0.05 was considered statistically significant in all tests.

**Results**

In the study, 23 of 27 patients are male; 4 of them were female and the mean age was 32.9 ± 9.8 (Table 1). While the right shoulder was affected in eighteen patients; the left shoulder was affected in nine patients.

The mean follow-up time in the study was 36.2 ± 13.6 months (range, 12-56 months). The time from trauma to operation was 4.2 ± 4.5 days. Ten of the 27 patients in the study were Rockwood type III; 17 of them were type V AC joint dislocations.

Mean Constant score at the last follow-up was 91.6 ± 6.18; the ASES score was 89.9 ± 6.3 and the VAS pain score was 0.33 ± 0.62 (Table 2). When divided into two subgroups as type III and type V AC joint dislocations, the two groups were found to be similar in terms of clinical outcomes (p > 0.889). CC distance measurements obtained in radiographic evaluation were 20.04 ± 4.84 mm before operation; it was found to be 7.55 ± 0.78 mm in the early postoperative period and 7.76 ± 0.79 mm at the last follow-up (Table 3). A statistically significant improvement was observed in the measurements in the early postoperative period compared to the measurements before operation (p = 0.001). There was no significant difference between the measurements in the early postoperative period and those at the last follow-up (p = 0.001).

As a complication; superficial infection treated with antibiotherapy in one patient, degenerative changes in the AC joint in three patients, osteolysis around the clavicular button in two patients, calcifications along the CC ligaments in two patients, and implant failure in the coracoid button in one patient. In total, nine complications occurred in six patients, and the complication rate was found to be 22%. Loss of reduction was not observed in the radiographic evalua-

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<th>Table 1. Preoperative patient demographics.</th>
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<td>Age, mean ± SD, yr</td>
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<td>Gender, male/female, n</td>
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<td>Affected side right/left, n</td>
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<td>Time from trauma to surgery, mean ± SD, day</td>
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<td>Type of AC joint dislocation, n</td>
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AC: acromioclavicular; SD: standard deviation.

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<th>Table 2. Postoperative clinical results, comparison of type III and type V subgroups.</th>
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<td>Follow-up, mean (SD), mo</td>
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<td>Constant score, mean ± SD</td>
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<td>VAS pain score, mean ± SD</td>
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Values are expressed as mean ± SD.
*P values refer to comparison between type III and type V AC joint dislocations.
ASES: American Shoulder and Elbow Surgeons; SD: standard deviation; VAS: Visual Analogue Scale.
tion of the patient who had implant failure. In addition, this patient’s Constant score was 80; the ASES score was 80.01 and accordingly, the clinical results of this patient were evaluated as good.

Discussion

Various methods have been described for the surgical treatment of AC joint dislocations. However, there is no consensus in the literature regarding the gold standard treatment option. Temporary fixation methods, which were first applied with Kirschner wires, are rarely used today [10]. These methods are not recommended because of complications such as degenerative changes in the AC joint, pin breakage and pin migration [10,16]. Due to the determining effect of CC ligaments on AC joint stability, hook plate fixation and CC ligament fixation using a SLD have become the two main treatment methods frequently preferred in recent years. In the systematic review performed by Arirachakaran et al., it was reported that CC ligament fixation with SLD were associated with better functional outcomes and less pain than hook plate fixation. However, the risk of postoperative complication was found to be higher in CC ligament fixation with SLD [14]. However, unlike hook plate fixation, the need for a second surgical procedure to remove the implants is an important advantage of CC ligament fixation with SLD.

There are various methods for CC ligament fixation with SLD, and TightRope is the most widely used of these methods. In the retrospective study of Ozcafer et al., 15 patients with Rockwood type V AC joint dislocation were followed up for an average of 19.3 months, and the mean Constant score was reported as 93.2 [19]. ZipTight fixation system is also a suspensory loop fixation device and its most important advantage is that it is knotless. In this way, an uncomfortable swelling on the clavicle after fixation is prevented. As far as we know, there are very few studies on the treatment of acute AC joint dislocations with the ZipTight fixation system. In one of these, Kurtoglu et al. reported the mean Constant score of 87.2 ± 3.2 after an average of 18.6 months of follow-up of 25 patients with type III and type V AC joint dislocations [20]. In the present study, as a result of an average follow-up period of 36.2 ± 13.6 months, the average Constant score was 91.6 ± 6.18; the mean ASES score was 89.9 ± 6.3 and the mean VAS pain score was 0.33 ± 0.62. In present study, successful clinical and functional results were obtained in the treatment of acute AC joint dislocations with the ZipTight fixation system and these results are consistent with our hypothesis.

CC ligament fixation with SLD can also be applied arthroscopically. Arthroscopic fixation has theoretical advantages such as better cosmetic results and the ability to intervene in glenohumeral pathologies that may accompany [21]. However, in a new meta-analysis, Gowd et al. reported that there was no difference between open and arthroscopic AC joint reconstruction in terms of loss of reduction, complication rate and revision rate [22]. In addition, the risk of iatrogenic chondral damage and additional portal incisions are the disadvantages of arthroscopic fixation. One of the disadvantages of open reduction is the need for more soft

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<th>Table 3. Comparison of CC distance measurements (mm) obtained preoperative, early postoperative period, and final follow-up.</th>
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| **Pre-operative** | **Post-operative** | **P*** | **Final follow-up** | **P** **

| Type III (n = 10) | 17.11 ± 3.4 | 7.42 ± 0.89 | 0.005 | 7.61 ± 0.94 | 0.011 |
| Type V (n = 17) | 21.77 ± 4.79 | 7.63 ± 0.72 | 0.001 | 7.86 ± 0.7 | 0.001 |
| Total (n = 27) | 20.04 ± 4.84 | 7.55 ± 0.78 | 0.001 | 7.76 ± 0.79 | 0.001 |

Values are expressed as mean ± standard deviation.

*P values represent the comparison of CC distance measurements obtained preoperative and in the early postoperative period.

**P values represent the comparison of CC distance measurements obtained in the early postoperative period and at the final follow-up.
tissue dissection. However, open reduction also enables primary repair of CC ligaments. There are concerns regarding the suitability of teared CC ligaments for primary repair after acute AC joint dislocations and the stability of the primary repair [23,24]. However, in present study, primary repair of the ligaments was performed in addition to CC reconstruction in more than half of the cases. We think this repair can contribute to stability.

The most common complications of CC ligament fixation methods with SLD was reported as; infection, coracoid or distal clavicle fracture, implant failure, ligament/hole calcification, and osteolysis of the distal clavicle, with an overall failure rate of 20.8% and an overall complication rate of 14.2% [22]. Martetschlager et al. reported 23% complications in the short term with CC ligament fixation with SLD [25]. Ozcafer et al. reported implant failure with a rate of 13.3% and osteolysis around the clavicular button with a rate of 26.6% with TightRope [19]. Kurtoglu et al. reported a 24% loss of reduction with ZipTight [20]. In the last two studies mentioned, it was emphasized that radiological complications do not negatively affect clinical and functional results. In our study, implant failure was observed in one patient and complications were detected in 22.2% of the patients. Similar to the literature, complications did not negatively affect functional results in present study.

This study has some limitations. First, this study is of retrospective design and there is small number of patients. Secondly, we did not compared ZipTight fixation system with other surgical methods, making it difficult to understand whether it is superior or not. We think that this study will contribute to the literature since the results of ZipTight fixation system are few in the literature. In addition, the fact that the clinical scoring systems used in this study are the most specific and widely used scoring systems related to AC joint injuries strengthens this study [26].

As a result, the ZipTight fixation system provides anatomic CC reconstruction in the treatment of acute AC joint dislocations. Successful clinical and radiological results can be obtained with CC ligament fixation applied with the ZipTight system and this method is effective and safe in the treatment of acute AC joint dislocations. The advantages of this technique are that there is no need for a second surgery for implant removal and it does not cause an uncomfortable swelling in the upper part of the clavicle.

Conflict of interest statement
The authors have no conflicts of interest to declare.

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