

Does the ZipTight™ effective to maintain reduction after the treatment of acute acromioclavicular joint dislocation?

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Abstract

Background: The present study evaluated the functional and radiographic outcomes of acute acromioclavicular (AC) joint reconstruction performed using the mini-open technique and a knotless suspensory loop device

Methods: A total of 25 patients (20 male and 5 female patients; mean age, 30.7 years; standard deviation, 10 years; range, 17–57 years) who fulfilled the inclusion criteria were included in the study. A functional assessment was performed using the Constant and University of California Los Angeles score. The radiologic assessment included standard anterior-posterior views of the AC and coracoclavicular (CC) distances.

Results: The mean follow-up period was 18.6 months (range, 12–23 months). The mean Constant score was 87.2 ± 3.2 , and the mean University of California Los Angeles score was 30.1 ± 2.4 at the final follow-up. Radiological evaluation at the last follow-up of the patients: Although there was no statistically significant increase in the AC and CC values of the patients (Fig. 2) at the last follow-up, the average CC value in 6 (24%) of the 25 patients was greater than 50% compared with the unaffected side CC and early postoperative CC values. However, there was no statistically significant difference in the Constant and UCLA scores between the 6 patients with reduction loss and the 19 patients with reduction maintenance ($P = .86$).

Conclusions: Clinical results of fixation of acute AC joint dislocations using the ZipTight™ knotless suspensory loop device system and mini-open technique were favorable in terms of functional recovery and pain relief. However, the major disadvantage of this method was radiological loss of AC joint reduction when compared to the contralateral shoulder.

Abbreviations: AC = acromioclavicular, AP = anterior-posterior, CC = coracoclavicular, SD = standard deviation, SLD = suspensory loop device, SPSS = statistical package for the social sciences, UCLA = University of California Los Angeles.

Keywords: acromioclavicular joint dislocation, coracoclavicular ligament, endobutton technique, mini-open technique

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This study has been approved by the research ethics committee of Sakarya University. Written informed consent was obtained from the patient for publication of this study and accompanying images.

Consent for publication was not applicable.

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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1. Introduction

Acromioclavicular (AC) joint dislocation is 1 of the most common injuries of the shoulder girdle in young adults.^[1,2] Treatment is commonly guided by Rockwood's classification.^[3] According to this classification, there is a consensus that minor dislocations, such as type I and type II, are best treated nonoperatively; however, type IV through type VI should be managed with surgical reconstruction.^[4] Treatment of type III injuries should be personalized based on the patient's request, activity level, and response to conservative treatment.^[5] Although conservative treatment is recommended by some studies, good clinical results after operative procedures have been reported.^[6,7] In a recent study involving a nationwide survey, 73% of the responding surgeons preferred performing surgical procedures to treat Rockwood type III injuries.^[8]

Coracoclavicular (CC) ligaments anatomically contribute to the stability of the AC joint. Therefore, recently proposed surgical techniques for the treatment of AC joint dislocation have focused on CC interval fixation.^[9] Surgical methods used for the fixation of the CC interval include AC joint pinning, CC loop cerclage, hook plates, CC screws, CC ligament repair, and ligament or muscle transfer.^[10] However, previous fixation methods have caused some complications, including implant breakage or migration, bony erosion of the clavicle, and recurrent dislocation; therefore, serious concerns still exist.^[9,11,12] Sufficient strength to maintain the CC interval should be provided until biological healing of the soft tissue around the CC ligaments occurs.

Furthermore, some movement of the AC joint must be allowed during the rehabilitation period.^[9] The suspensory loop device (SLD), which is used to treat CC ligament disruption, provides stability to the AC joint by suspensory fixation between the clavicle and the coracoid process.^[9] Reconstruction of the CC ligament using the SLD system has been proven to be an effective technique for the management of acute AC joint dislocations in biomechanical and clinical studies.^[13,14] The ZipTight (Zimmer Biomet, Parsippany, NJ) endobutton system is an SLD that eliminates the knot profile on top of the clavicle due to its knotless feature. The present study evaluated the functional and radiographic outcomes of acute AC joint reconstruction using the mini-open technique and knotless SLD system.

2. Material and methods

After approval by the local ethics committee, a retrospective clinical cohort study (level III) was performed to evaluate patients who were diagnosed and treated at our institution between May 2014 and December 2016. All patients provided written informed consent. The electronic database at our institution was used to obtain all demographic data and injury mechanism data.

Inclusion criteria were as follows:

- (1) isolated acute Rockwood type III and type V AC dislocations
- (2) no previous shoulder symptoms or surgery
- (3) no associated injuries and fractures
- (4) follow-up examinations for at least 12 months after surgery
- (5) age older than 17 years
- (6) operative treatment using the ZipTightTM (Zimmer Biomet) adjustable SLD

Exclusion criteria were as follows:

- (1) being unfit for surgery (eg, acute infection, massive swelling)
- (2) neurological disorder affecting the shoulder function
- (3) any disorder that may cause an inaccurate evaluation of the clinical outcome (eg, musculoskeletal disorders, psychiatric disorders, or metabolic disorders)

2.1. Clinical and radiological assessments

Clinical data regarding age, sex, hand dominance, mechanism of injury, range of motion of the affected shoulder, time from surgery to the return to daily activities, and length of follow-up

were collected. A functional assessment was performed by 2 independent reviewers using the Constant score^[15] and University of California Los Angeles (UCLA) score.^[16] The radiologic assessment included standard anterior-posterior (AP) views of the AC and CC distances. The AC distance was defined as the middle of the clavicle and the middle of the acromion. The CC distance was defined as the vertical distance between the anterior-inferior border of the clavicle and the superior border of the coracoid process.

All measurements were performed and analyzed preoperatively, in the early postoperative period, and at the time of the last follow-up by 2 blinded investigators. The affected AC joint was also evaluated for any signs of postoperative degenerative arthritis, loss of reduction, and osteolysis. In our study, we identified 2 criterias for radiological failure. First; comparison of CC distance of the patients measured immediately after the surgery and at the last follow-up. Second; comparison of CC distances measured on the operative side and unaffected side at the final follow-up. Radiological failure was defined as greater than 50% increase in CC distance in 1 of both measurements.^[9]

2.2. Surgical technique and rehabilitation

All patients underwent surgery by the same surgeon within the first 2 weeks after trauma. The patient was placed in the beach chair position and examined under anesthesia to assess shoulder stability and reducibility of the AC joint. The upper extremity was prepared and draped in the usual sterile manner, and appropriate antibiotic prophylaxis was administered before the incision. A mini-open technique was used for all cases. A vertical 1-cm skin incision was created at the top of the clavicle, 2.5 cm medial to the AC joint. A second 2-cm incision was created over the coracoid process, followed by meticulous dissection down to the base of the coracoid process (Fig. 1). Under C-arm visualization, the bony tunnels to the clavicle and coracoid process were drilled during separate steps. First, a 2.4-mm guide pin was inserted in a cephalad to caudal direction at the base of the coracoid process. The guide pin was aimed at the center of the coracoid process and close to the neck, where the scapula branches off the coracoid. A 4.0-mm cannulated drill was used, and care was taken to avoid advancing the guide pin while drilling. Then, the bony tunnel to the clavicle was drilled in a similar manner at the center of the distance between the anterior and posterior borders of the clavicle. The guide wire and drill were removed; the ZipTightTM (Zimmer Biomet) was inserted

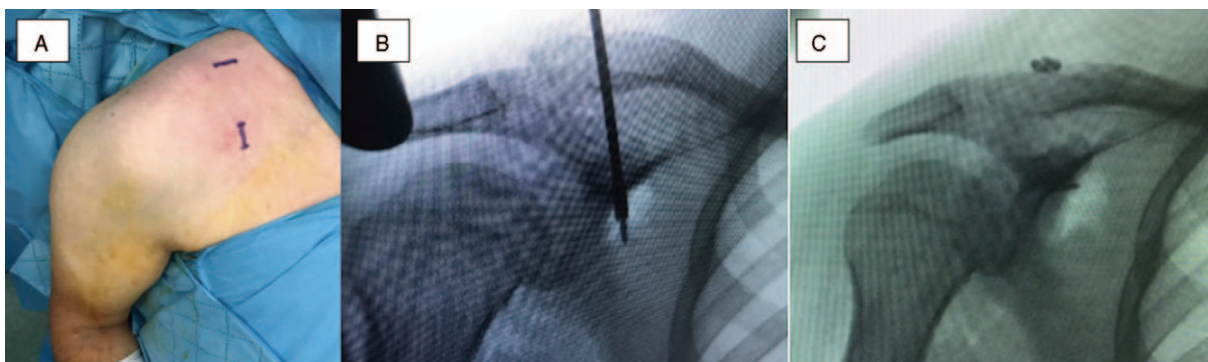


Figure 1. (A) Mini-open technique with 2 incisions, (B) and (C) Fluoroscopic visualization of reducing the AC joint. AC = acromioclavicular.



Figure 2. (A) Pre- and (B) postoperative X rays of type V AC joint dislocation showing good reduction and at the last follow up (C) with reduction maintenance. AC = acromioclavicular.

through the clavicle, and then through the coracoid tunnel using the button inserter. The oblong button was flipped and seated underneath the coracoid process using a pusher. Finally, the AC joint was reduced and placed in the anatomical position under fluoroscopic visualization, and the round button was advanced to the cephalad surface of the clavicle (Fig. 1). The subcutaneous tissues and skin were closed in the usual manner.

2.3. Postoperative course

All patients were made to use a sling immobilizer postoperatively for 4 weeks. Gentle pendulum and Codman's exercises were started on postoperative day 1. At 4 weeks postoperatively, physiotherapy with passive motion and cuff isometrics was started. A resistive exercise program was started at 8 weeks postoperatively. Patients were generally allowed to return to manual work at 2 to 4 months, depending on the level of rehabilitation. Contact sports were not allowed before 6 months postoperatively.

3. Statistical analysis

Data were evaluated using statistical package for the social sciences (SPSS) for Windows 21.0 software (SPSS Inc, Chicago, IL). Descriptive statistics were calculated as frequency and percentage for categorical variables, and as the mean, standard deviation (SD), and median for numerical variables. Comparisons of the numerical variables of 2 independent groups were analyzed with the Student *t* test under normal distribution conditions, whereas the Mann Whitney *U* test was performed for cases without normal distribution conditions. Numerical variables were tested using the Friedman analysis when the parametric test conditions were not provided for the multi-dependent groups. During subgroup analyses, when the numerical variables for the dependent groups provided normal distribution conditions, the paired *t* test was performed; however, the Wilcoxon analysis was performed when normal distribution conditions were not provided. The ratios of the groups were compared using the Chi-square analysis. Relationships between numerical variables were evaluated using the Spearman correlation analysis when parametric tests could not be performed. Significance was set at 0.05.

4. Results

A total of 25 patients (20 male and 5 female patients; mean age, 30.7 years; SD, 10 years; range, 17–57 years) fulfilled the

inclusion criteria. All patients were available for the study after a mean follow-up period of 18.6 months (range, 12–23 months). Clinical details of the patients are presented in Table 1. The preoperative Constant and UCLA scores were not available to evaluate because patients experienced pain and discomfort after injury. The mean Constant score was 87.2 ± 3.2 and the mean UCLA score was 30.1 ± 2.4 at the final follow-up examination. There was no statistically significant difference between the type III and type V groups according to the Constant and UCLA scores ($P = .6$ and $P = .56$).

Radiological evaluations demonstrated a significant reduction in AC dislocation when compared with the healthy side.

Immediate radiological evaluation after surgery: AC joint reduction was achieved successfully in all patients compared with the unaffected side. The mean CC distance demonstrated no statistically significant difference during the immediate postoperative period or at the final follow-up examination ($P = .562$).

Radiological evaluation at the last follow-up of the patients: Although there was no statistically significant increase in the AC and CC values of the patients (Fig. 2), the average CC value was increased by 50% in 6 (24%) of the 25 patients compared with the unaffected CC and early CC values and defined as radiological reduction loss (Fig. 3). For 2 patients, reduction loss was related to type III AC injuries; in 4 patients, reduction loss was related to type V AC injuries. However, there was no statistically significant difference in the Constant and UCLA scores between the 6 patients with reduction loss and the 19

Table 1

Clinical patient details.

Age, yr, mean \pm SD (range)	30.7 \pm 10.0 (17–57)
Sex, male/female	20/5
Dominant arm	11 (44%)
Mean time to surgery, d (range)	5 (2–14)
Etiology, n (%)	
Fall from a height	7 (28)
Motor vehicle accident	10 (40)
Sports activity	8 (32)
Type of AC joint dislocation*	
III	12 (48)
IV	0
V	13 (52)

AC = acromioclavicular, SD = standard deviation.

*According to the Rockwood classification system.



Figure 3. (A) Pre- and (B) postoperative X rays of type III AC joint dislocation showing good reduction and at the last follow up (C) with reduction failure. AC = acromioclavicular.

patients with reduction maintenance ($P=.86$). A summary of radiological outcomes is presented in Table 2.

4.1. Complications

Two AC joint arthrosis cases, one fixation system failure, and three clavicular erosion cases were found in 6 patients (24%); these were associated with the adjustable SLD or surgical technical problems (Fig. 4). However, there was no statistically significant difference in the Constant and UCLA scores of patients with and without complications ($P=.54$).

5. Discussion

In our study, we obtained satisfactory clinical outcomes with CC fixation by using the single adjustable SLD. Despite these satisfactory clinical outcomes, the CC distance had increased more than 50% when compared with the unaffected side of 6 patients (24%), and 6 complications (24%) associated with the SLD and surgical technical problems occurred. AC joint dislocation is a common sports-related injury; however, data regarding sports activity after AC joint injury are lacking.^[17] According to the literature, 42.9% of AC joint injuries are sports-related.^[13] However, in the present study, we found that motor vehicle accidents were the most common cause (40%); sports-related accidents were the second most common reason (32%) in our study. We think the main reason for this could be the busy vehicle traffic and highly industrial region where our institution is

located. Another reason could be the low interest in sports of the inhabitants of this region.

Surgical treatment of AC joint dislocations has dramatically changed in the past decade. Although the use of the formerly popular K-wire techniques has decreased (from 37% in 2001 to 6% in 2014), temporary fixation with pins or cerclage is no longer recommended because of the increased incidence of degenerative AC joint changes, bony erosion, pin breakage, and intrathoracic migration. A second procedure for implant removal is also necessary.^[3,14] Currently, 2 modern techniques are frequently used, including hook plate fixation and CC ligament fixation using the SLD.^[2,10] In a recent meta-analysis, it was concluded that the SLD results in higher shoulder function scores and less postoperative pain when compared to hook plate fixation.^[10] Klemens et al compared the clinical results of the SLD technique compared with K-wire fixation and reported that the SLD technique was a safe method for Rockwood type III AC joint dislocations.^[3] In addition, 2 studies of the SLD technique reported excellent functional results at short-term and mid-term follow-up examinations for high-grade (Rockwood type V) AC joint separations.^[18,19] In the present study, type III and type V dislocations were included. Satisfactory clinical results were found, and there was no significant difference between type III and type V injuries. Moreover, radiographical loss of reduction following button stabilization was documented in some studies.^[18,19] Furthermore, loss of reduction and recurrence were found to be the most frequent complications after use of the endobutton.^[9,20] This may be due to slipping of the suspension

Table 2
Mean acromioclavicular and coracoclavicular distances of the affected side and unaffected side.

	Type III* (n = 12)	Type V* (n = 13)	Total (n = 25)	P
Acromioclavicular distance (mm), (mean±SD, median)				
Unaffected side	0.0±0.0	0.0±0.0	0.0±0.0	
Affected side, preoperative	13.1±1.9	23.7±3.5	18.6±3.1	<.001
Affected side, immediate postoperative	0.4±0.7	1.2±1.3	0.8±1.0	.112
Affected side, final follow-up	6.8±4.0	5.8±4.0	6.8±4.0	.224
P	<.001	<.001		
Coracoclavicular distance (mm), (mean±SD, median)				
Unaffected side	7.1±1.6	8±1.5	7.5±1.5	.152
Affected side, preoperative	18.2±2.2	31.1±7.2	24.9±4.8	<.001
Affected side, immediate postoperative	7.6±1.7	7.2±1.8	7.3±1.7	.026
Affected side, final follow-up	9.7±3.4	9.1±3.9	9.3±3.6	.691
P	<.001	<.001		

* According to the Rockwood classification system.



Figure 4. (A) Loss of reduction, failure at the (B) coracoid and (C) clavicular side. AC = acromioclavicular.

sutures, passing the buttons through the coracoid process or the clavicle (generally because the position of the upper button is too distal), or a fracture of the distal clavicle.^[20] In the present study, loss of reduction was observed in 6 (24%) patients. Two reduction losses were related to type III and four reduction losses were related to type V AC injuries. However, there was no statistically significant difference in Constant and UCLA scores for 6 patients with reduction loss and 19 patients with reduction maintenance. Horizontal stability of the AC joint could not be restored using this SLD because the AC ligament was not reconstructed. This may have been the reason for reduction loss. Another important cause of the gradual loss of AC joint reduction after a single adjustable loop-length suspensory fixation procedure is excessive stress concentrated in the bone-metal button interface, resulting in bony erosion of the clavicle or pull-through of the coracoid process by the metal button.^[21] Lim et al showed a 50% fixation failure rate 6 months after CC fixation using this suspensory fixation device for 8 patients with acute AC dislocation.^[22] Other studies reported fixation failure rates between 16.6% and 23.1% after CC fixation using the single adjustable SLD.^[18,23] However, these radiological complications were not found to have a significant impact on functional outcomes.^[18,19] We observed three clavicular erosion cases and 1 implant failure case, and all were related to reduction losses. To prevent reduction loss, the double SLD technique was used by some surgeons.^[14,18] The double SLD technique enables stronger reconstruction than the native CC ligament and prevents reduction loss; however, shoulder mobility may adversely affect this method.^[24] Patzer et al^[18] compared the results of the single tight rope versus double tight rope technique for Rockwood type III and type V injuries and found no significant differences in CC distances and outcomes for both groups. In our study, despite the 24% rate of reduction loss for type III and type V injuries, we found satisfactory clinical results using a single SLD.

The SLD technique may be applied using the open technique or arthroscopically.^[5,10,25] The theoretical advantages of the arthroscopic approach are better cosmetic results and the ability to address any conditions associated with AC joint dislocation, such as associated glenohumeral pathology.^[25] The excellent functional outcomes reported after arthroscopic AC joint reconstruction have caused some authors to recommend this procedure for any acute AC joint reconstruction and to reserve the open approach for subacute and chronic cases.^[26] The disadvantages of the open technique are detachment of part of the

deltoid insertion and extensive soft tissue dissection that places neurovascular structures at risk.^[20] In the present study, we describe a mini-open approach that can effectively restore the complex AC joint and CC ligament anatomy. The procedure can be performed quickly and relatively simply. Through 2 small skin incisions created on top of the clavicle (1 cm) and on the coracoid process (2.5 cm), both bone tunnels can be drilled with minimal damage to the soft tissues, such as detachment of part of the deltoid insertion surrounding the CC ligaments, while allowing adequate palpation of the coracoid for accurate tunnel placement.

A systematic review of treatment using an SLD by Wood et al found good radiographic results and a high rate of hardware irritation (more than one-third of patients) at the superior surface of the clavicle due to the metallic implant and knots on the implant. Implant irritation was the most common reason for postoperative pain. Depending on the study, the rate of irritation was 25% or more.^[27] We did not perform any implant removal or observe any implant irritation, possibly because we used a knotless SLD system. Although in this series we did not observe certain complications that have been reported in the literature such as vascular or nerve injuries,^[28,29,30] surgeons should be aware of the risks when a medial or inferior approach must be used for the coracoid process. This study has certain limitations. First, this was a retrospective study with no randomization. Second, small number of patients and third, we didn't compared ZipTight knotless loop device with other conventional methods, making it difficult to understand whether its superior or not.

6. Conclusion

Our data showed that the clinical results of fixation of acute AC joint dislocations using the ZipTight (Zimmer Biomet) SLD system and mini-open technique were good in terms of function and pain relief. The major disadvantage of this method was the radiological loss of AC joint reduction compared to the contralateral shoulder; however, this did not directly affect the activities of daily living. We think that this technique is not the ideal method because of the high failure rates and needs to be developed.

Author contributions

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