Complications After Arthroscopic Coracoclavicular Reconstruction Using a Single Adjustable—Loop-Length Suspensory Fixation Device in Acute Acromioclavicular Joint Dislocation

Sang-Jin Shin, M.D., and Nam-Ki Kim, M.D.

Purpose: The purpose of this study was to evaluate clinical and radiological outcomes after arthroscopically assisted coracoclavicular (CC) fixation using a single adjustable—loop-length suspensory fixation device for acute acromioclavicular dislocation and to report intraoperative and postoperative complications. **Methods:** Eighteen consecutive patients with acute acromioclavicular dislocation underwent arthroscopically assisted CC fixation using a single TightRope (Arthrex, Naples, FL). Using the Rockwood classification, 3 patients had grade III dislocations, one patient had a grade IV dislocation, and 14 patients had grade V dislocations. **Results:** The preoperative CC distance of the injured shoulder was 16.1 ± 2.7 mm (range, 11.2 to 21.0 mm), and it increased by 99% ± 36% (range, 17% to 153%) on average compared with the contralateral shoulder. The average CC distance was 10.5 ± 2.5 mm (range, 7.7 to 15.5 mm), and it increased by 30% ± 30% (range, −9.4% to 90%) at the final follow-up. Compared with immediate postoperative radiographs, the CC distance was maintained in 12 patients, increased between 50% and 100% in 4 patients, and increased more than 100% in 2 patients at final follow-up. However, there was no statistical difference in Constant scores between 6 patients with reduction loss (95.6 ± 4.5) and 12 patients with reduction maintenance (98.4 ± 2.5; $P = .17$). Perioperative complications occurred in 8 patients, including one case of acromioclavicular arthritis, one case of delayed distal clavicular fracture at the clavicular hole of the device, 3 cases of clavicular or coracoid button failures, and 3 cases of clavicular bony erosion. **Conclusions:** Satisfactory clinical outcomes were obtained after CC fixation using the single adjustable—loop-length suspensory fixation device for acute acromioclavicular joint dislocation. However, CC fixation failure of greater than 50% of the unaffected side in radiological examinations occurred in 33% of the patients within 3 months after the operation. Additionally, 8 patients (44%) had complications associated with the adjustable—loop-length suspensory fixation device and surgical technical problems. Despite acceptable shoulder function restoration, adequate care should be exercised in surgical treatment of acute acromioclavicular dislocation with a single adjustable—loop-length suspensory fixation device for optimal radiological outcomes. **Level of Evidence:** Level IV, therapeutic case series.

Coracoclavicular (CC) ligaments are one of the most important anatomic structures for maintaining stability of the acromioclavicular (AC) joint, and hence recent surgical treatments for dislocation of the AC joint have focused on CC interval fixation. CC fixation has been performed using various fixation devices, such as screws, plates, synthetic tapes, and suture anchors.[1-5] However, previous fixation methods caused some complications, including implant breakage or migration, bony erosion of the clavicle, and recurrent dislocation; therefore, none of the methods could be the gold standard in the treatment of AC joint dislocation.[2,3,6] Ideal reconstruction methods should provide sufficient strength to maintain the CC interval until biological healing of the soft tissue around the CC ligaments occurs. Also, some movement of the AC joint must be allowed during the rehabilitation period. Reconstruction of the CC ligament using a suspensory fixation device or graft tendon is a recently introduced surgical technique designed to meet the concept of an ideal fixation method. The adjustable—loop-length suspensory fixation device is a fixation method used

From the Department of Orthopaedic Surgery, Global Top 5 Research Program, Ewha Womans University School of Medicine, Seoul, Korea.

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Address correspondence to Sang-Jin Shin, M.D., Department of Orthopaedic Surgery, Ewha Womans University School of Medicine, 1071 Anyangcheon-ro, Yangcheon-Ku, 158-710, Seoul, Korea. E-mail: sjshin622@ewha.ac.kr

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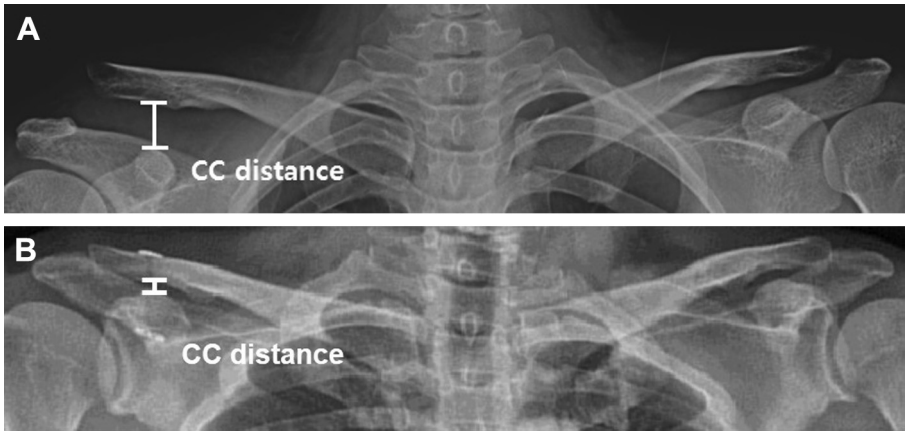

Fig 1. (A) Preoperative anteroposterior radiograph showing acute acromioclavicular joint dislocation type V according to the Rockwood classification. Coracoclavicular (CC) distance: The coracoclavicular vertical distance was measured between the uppermost border of the coracoid process and the lateral aspect of the conoid tubercle. (B) Postoperative anteroposterior radiograph showing satisfactory CC reconstruction using a single adjustable–loop-length suspensory fixation device.

to treat CC ligament disruption, and it lends stability to the AC joint by supplying suspensory fixation between the clavicle and the coracoid process.

The TightRope (Arthrex, Naples, FL) is one of the adjustable–loop-length suspensory fixation devices that can be used arthroscopically. Both ends of this device consist of an oblong coracoid button and a round clavicular button, and the 2 metal buttons are connected by No. 5 FiberWire (Arthrex, Naples, FL). The coracoid button engages under the coracoid process through the coracoid tunnel, and the clavicular button lies over the clavicle between the insertion sites of 2 CC ligaments. The CC interval is then maintained by the tension of the nonabsorbable suture material. CC fixation using an adjustable–loop-length suspensory fixation device showed promising results in previous studies.[7-10] However, some problems associated with the adjustable–loop-length suspensory fixation device were also reported, including increased CC distance over time, pullout of the clavicular or coracoid buttons at the attachment sites, and fracture of the clavicle.[9-13]

The purpose of this study was to evaluate radiological and clinical outcomes after arthroscopically assisted CC fixation using a single adjustable–loop-length suspensory fixation device for acute AC dislocation and to report intraoperative and postoperative complications. Our hypothesis was that AC reconstruction using a single adjustable–loop-length suspensory fixation device would provide satisfactory shoulder function restoration and acceptable radiological outcomes with minimal complications.

Methods

Eighteen consecutive patients with acute AC dislocation who underwent surgical treatment from February 2008 to June 2010 were included in this study. The indications for surgery included acute AC joint dislocation within 2 weeks after the injury with a grade III, IV, or V dislocation according to the Rockwood classification. The treatment of Rockwood type III AC joint dislocation has been a subject of controversy. Some orthopaedic surgeons advocate surgical treatment for type III injuries in young patients with high demands on the shoulder, in throwing or contact sports athletes, and in symptomatic chronic or unstable type III injuries. However, this study included 3 patients with acute Rockwood type III AC joint dislocations who wanted surgical treatment.

Patients with AC dislocation more than 2 weeks after the injury, those with previous shoulder injuries, and those with AC joint dislocation with a concomitant fracture or grade I or II AC dislocation were excluded. The diagnosis of AC dislocation was based on clinical and radiological assessments. Clinical diagnosis was based on the presence of pain and palpable step-off of the AC joint after the initial traumatic episode. Physical examination was performed by one orthopaedic surgeon (S-J.S.). Preoperative radiological evaluations included anteroposterior, axillary, and stress views of both shoulders. The grade of AC joint dislocation was determined by standard radiography. Standing anteroposterior radiographs with patients holding a 4-kg weight in each hand (stress view of both shoulders) were taken only when the grade of dislocation was unclear preoperatively. Radiographs of all patients were taken with their shoulders fixed in the same position and at the same distance from the x-ray beam to minimize the influences of projection changes that could affect the radiological outcomes.

The degree of displacement of the AC joint was measured using the CC vertical distance and compared with that of the contralateral shoulder in preoperative and postoperative standard radiographs. The CC vertical distance was measured between the uppermost border of the coracoid process and the lateral aspect of the conoid tubercle (Fig 1A). Mean values were recorded in millimeters for the vertical distance using a digital caliper in Picture Archiving and Communication

System (PACS) by 2 different orthopaedic surgeons (S-J.S. and N-K.K.) and averaged. Radiological evaluations including both shoulder anteroposterior and axillary views were performed immediately after operation, at 3 weeks postoperatively, at 3 and 6 months postoperatively, and then every 6 months. Both shoulder stress views were taken once at 6 months after the operation. Shoulder function outcomes were assessed 6 months postoperatively and at the final follow-up visit, using the Constant score, by a physician assistant who was not involved in this study.

The mean follow-up period was 25.6 months (range, 24 to 32 months). All patients underwent arthroscopically assisted AC joint reconstruction using a single TightRope system.

Surgical Technique

The patient was prepared in the beach chair position using an interscalene block combined with general anesthesia. A standard posterior portal was made approximately 2 cm inferior and medial to the posterolateral corner of the acromion. A 30° arthroscope was inserted in the glenohumeral joint through a posterior portal, and an 8.25-mm plastic threaded cannula was positioned through an anterior portal. The anterior portal was made at the superior margin of the subscapularis tendon and was used for instrumentation of the anteroinferior aspect of the coracoid base. Arthroscopic examination was then performed to find any concomitant lesions of the glenohumeral joint.

A radiofrequency ablator was introduced through the anterior portal, and rotator interval tissue was removed to approach the base of the coracoid process. After opening the rotator interval, the soft tissue on the undersurface of the coracoid process was removed using a radiofrequency ablator. If an adequate visual field was not obtained with a 30° arthroscope, a 70° arthroscope was used to clearly visualize the undersurface and medial and lateral margins of the coracoid process. It was very important to confirm the medial and lateral margins of the coracoid process to make the coracoid hole in the center of the base of the coracoid process. A 2-cm transverse skin incision was made approximately 3.5 cm medial to the AC joint, and the superior deltotrapezial fascia was exposed. After splitting and blunt dissection of the fascia along the long axis of the clavicle, the superior aspect of the distal clavicle was exposed. After exposure of the superior surface of the distal clavicle, the clavicular origin of the trapezoid and conoid ligament were estimated using an image intensifier. The center of the attachment of both ligaments was marked on the superior clavicular surface.

The C-shaped drill guide was introduced into the subcoracoid space through an anterior portal. Under arthoscopic guidance, the inserted aiming arm was placed at the base of the coracoid process as far posterior as possible and in the center of the coracoid base mediolaterally to avoid coracoid fracture or drill-hole blowout. After the aiming arm was positioned at the desired point on the undersurface of the coracoid process, the bullet-nosed drill sleeve of the C-shaped guide was positioned at the marked point on the superior surface of the clavicle. Before drilling the hole, the dislocated AC joint was manually reduced to its anatomic position, and the anatomic reduction was maintained while the hole was drilled. With the C-shaped drill guide held in position, and under direct arthroscopic viewing, a 2.4-mm guide pin was drilled from superior to inferior through both cortices of the clavicle and the base of the coracoid process. After drilling the clavicle and the coracoid, the C-shaped drill guide was removed leaving a 2.4-mm guide pin in the drilled hole. The guide pin was overdrilled with a 4.0-mm cannulated drill bit through the clavicle and the coracoid process. Care should be exercised while drilling the hole through the coracoid base because overdrilling caudally might cause neurovascular injury. Hence, the coracoid base should always be observed through the arthroscope.

A looped wire was inserted along the hole created from the superior surface of the clavicle and was passed through the holes of the clavicle and the coracoid process and then through the anterior portal, where one end of the looped wire was retrieved. A traction suture attached to the oblong button of the single adjustable—loop-length suspensory fixation device was connected to the clavicular side of the looped wire, and by pulling the looped wire from the anterior portal, the fixation device and the traction suture were passed through the hole of the clavicle and moved to the CC space. Using continuous traction, the traction suture and the attached coracoid button were passed vertically through the tunnel of the coracoid process and into the subcoracoid space. When the traction suture of the clavicular side was pulled upward, the coracoid button changed its position horizontally and attached to the undersurface of the coracoid process under arthroscopic visualization. While maintaining anatomic reduction of the AC joint, the suture of the clavicular button at the superior surface of the clavicle was tied to maintain appropriate tension. The reduction of the AC joint was confirmed by the image intensifier, and the surgical wound was closed. Although there is no consensus regarding primary resection of the distal clavicle, resection is usually indicated in patients who underwent a ligament transfer procedure, in those who want to prevent AC joint arthritis, or in those with chronic symptomatic AC joint dislocation. However, distal clavicle resection was not performed in all patients in this study.

Table 1. Patients Demographics

Age, yr, mean ± SD (range)	45.4 ± 11.9 (30-66)
Sex	Male/female = 17/1
Dominant arm	7 (38.9%)
Mean time to surgery, days (range)	6.1 (1-14)
Grade of AC dislocation (%)	
III	3 (16.7)
IV	1 (5.6)
V	14 (77.8)
Causes of injury, n (%)	
Bicycle accident	5 (27.8)
Motor vehicle accident	3 (16.7)
Sports activity	6 (33.3)
Fall from a height	4 (22.2)
Associated pathologic conditions, n (%)	
SLAP lesion	6 (33.3)
Partial-thickness rotator cuff tear	1 (5.5)

Postoperative Rehabilitation

A shoulder sling was worn for 4 weeks. Passive range of motion exercise began 4 weeks after the operation. Strengthening exercises began at 8 weeks, and the patients were allowed heavy weight lifting at 3 months after the operation. Contact sports were not permitted until 6 months after the operation.

Statistical Analysis

Statistical analysis was performed using PASW Statistics, version 18.0 (SPSS, Chicago, IL), with a confidence interval of 95%. Data were reported as the average and standard deviation. For comparisons of CC distances at each time point, a paired *t* test was used. A Mann-Whitney test was used to compare clinical outcomes between patients with CC distance restoration and loosening. $P < .05$ was statistically significant.

Results

The cohort consisted of one woman and 17 men, with a mean age of 45.4 years (range, 30 to 66 years) at time of surgery (Table 1). The dominant shoulder was involved in 7 patients. The mean time between trauma and surgery was 6.1 days (range, 1 to 14 days). Injuries were caused by sports in 6 patients, bicycle accidents in 5 patients, a fall from a height in 4 patients, and motor vehicle accidents in 3 patients. According to the Rockwood classification, 3 patients had grade III, one patient had grade IV, and 14 patients had grade V AC joint dislocations. Among 18 patients with AC joint dislocation, SLAP type I lesions were also seen in 4 patients, SLAP type II lesions were seen in 2 patients, and a partial-thickness articular rotator cuff tear less than 50% of the tendon thickness was seen in one patient. All SLAP lesions and partial-thickness articular rotator cuff tears were debrided arthroscopically because no patient had shoulder discomfort before injury.

Clinical and Radiological Outcomes

The preoperative Constant score was not available to evaluate because patients had pain and discomfort after injury. The mean Constant score was 95.6 ± 3.3 (range, 88 to 100) at 6 months after the operation and 97.5 ± 3.4 (range, 88 to 100) at the final follow-up. There was no significant improvement in Constant score from 6 months to the final follow-up ($P = .14$). Limitation of range of motion of the shoulder joint caused by postoperative adhesive capsulitis or septic arthritis did not occur.

The mean CC vertical distance value was classified according to the grade of AC dislocation (Table 2). The mean CC distance of the affected side was 16.1 ± 2.7 mm (range, 11.2 to 21.0 mm) preoperatively, and compared with the mean 8.1 ± 1.0 mm (range, 7.1 to 10.4 mm) of the unaffected side, it increased by 99% ± 36% (range, 17% to 153%) on average. The CC distance of the affected side was 7.3 ± 1.4 mm (range, 5.1 to 10.5 mm) immediately after the operation, which was decreased by an average of −11% ± 15% (range, −33% to 17%) compared with 8.2 ± 1.0 mm (range, 7.2 to 10.7 mm) of the unaffected side. The CC distance in 7 patients was restored to the same length as the unaffected side, whereas that in 11 patients was overcorrected. However, the CC distance was not maintained in 6 (33%) of 18 patients within 3 months after operation. The mean CC distance of the affected side was 9.3 ± 2.5 mm (range, 5.3 to 12.5 mm) and that of the unaffected side was 7.9 ± 1.1 mm (range, 6.1 to 10.2 mm). The mean CC distance of the affected side increased to 19% ± 33% (range, −16% to 91%) compared with the unaffected side at 3 months after the operation. At the final follow-up, the mean CC distance of the affected side was 10.5 ± 2.5 mm (range, 7.7 to 15.5 mm) and that of the unaffected side was 8.1 ± 1.1 mm (range, 6.7 to 10.2 mm). The mean CC distance of the affected side increased to 30% ± 30% (range, −10% to 90%) compared with the unaffected side at the final follow-up. The mean CC distance showed no significant difference between 3 months postoperatively and the final follow-up ($P = .09$). However, the mean CC distance of the affected side at the final follow-up decreased significantly compared with before surgery ($P = .002$). There were no significant differences in CC distance of the affected side between radiographs taken under stress (11.9 ± 3.1 mm; range, 6.9 to 16.3 mm) and those taken at rest (10.1 ± 2.6 mm; range, 7.2 to 15.2 mm) 6 months after the operation ($P = .27$).

The mean CC distance at the final follow-up was maintained in 12 patients without a loss of reduction (8.1 ± 1.1 mm; range, 7.7 to 11.1 mm) compared with the unaffected side (8.9 ± 1.3 mm; range, 6.7 to 10.2 mm; 11% ± 11%) (Fig 1B). However, the mean CC distance increased between 50% and 100% in

Table 2. Mean Coracoclavicular Distance and Mean Percentage Ratio of the CC Distance Difference Between the Affected Side and the Unaffected Side

Rockwood Classification	Side	Preoperatively	Postoperatively	3 Weeks	3 Months	6 Months	Final Follow-up
III (n = 3)	Unaffected, mm	8.9 ± 1.4 (7.3-9.8)	8.4 ± 1.0 (7.4-9.4)	8.8 ± 1.5 (7.8-9.9)	8.1 ± 1.1 (7.3-9.3)	8.5 ± 1.6 (7.4-9.6)	8.3 ± 1.6 (7.2-9.4)
	Affected, mm	11.7 ± 1.7 (11.2-13.7)	7.7 ± 2.7 (5.3-10.5)	9.4 ± 1.6 (8.2-10.5)	9.5 ± 1.9 (8.5-11.8)	9.8 ± 2.1 (8.3-11.3)	9.9 ± 1.7 (8.7-11.1)
	Ratio, %	33.2 ± 14.1 (17.1-43.8)	−9.0 ± 2.0 (−28.6-11.5)	6.1 ± 0.7 (5.5-6.6)	16.2 ± 7.2 (11.1-12.1)	15.3 ± 3.9 (12.1-17.7)	18.7 ± 1.5 (17.7-19.8)
IV (n = 1)	Unaffected, mm	7.93	7.4	7.5	7.4	7.4	7.3
	Affected, mm	12.9	7.8	7.8	8.7	8.8	8.9
	Ratio, %	62.3	5.4	4.3	18.4	18.3	22.2
V (n = 14)	Unaffected, mm	8.0 ± 1.0 (7.1-10.4)	8.2 ± 1.0 (7.2-10.7)	7.9 ± 0.9 (7.0-9.3)	8.0 ± 1.2 (6.1-10.2)	8.1 ± 1.0 (7.0-10.1)	8.1 ± 1.1 (6.7-10.2)
	Affected, mm	17.2 ± 1.9 (14.6-21.0)	7.2 ± 1.2 (5.1-9.3)	7.9 ± 2.0 (5.6-12.0)	9.4 ± 2.7 (5.3-12.5)	10.3 ± 2.8 (7.2-15.2)	10.7 ± 2.7 (7.7-15.5)
	Ratio, %	115.2 ± 18.3 (100.3-153.0)	−12.38 ± 14.3 (−32.1-17.1)	1.36 ± 23.0 (−22.7-58.4)	19.7 ± 37.2 (−15.5-91.3)	26.8 ± 32.7 (−6.3-86.5)	32.8 ± 33.0 (−9.4-90.2)
Total	Unaffected, mm	8.1 ± 1.0 (7.1-10.4)	8.2 ± 1.0 (7.2-10.7)	8.1 ± 1.0 (7.0-9.9)	7.9 ± 1.1 (6.1-10.2)	8.1 ± 1.0 (7.0-10.1)	8.1 ± 1.1 (6.7-10.2)
(n = 18)	Affected, mm	16.1 ± 2.7 (11.2-21.0)	7.3 ± 1.4 (5.1-10.5)	8.1 ± 2.0 (5.6-12.0)	9.3 ± 2.5 (5.3-12.5)	10.1 ± 2.6 (7.2-15.2)	10.5 ± 2.5 (7.7-15.5)
	Ratio, %	99.4 ± 35.9 (17.1-153.0)	−10.7 ± 14.9 (−32.1-17.1)	1.0 ± 20.7 (−22.7-58.4)	19.1 ± 33.1 (−15.5-91.3)	25.1 ± 29.3 (−6.3-86.5)	30.2 ± 29.8 (−9.4-90.2)

Values are mean ± standard deviation (range).
The percentage ratio was calculated as dividing the difference of the coracoclavicular (CC) distance between the affected and unaffected sides by the CC distance of the unaffected side.

Table 3. Postoperative Complications After Coracoclavicular Reconstruction Using a Single Adjustable–Loop-Length Suspensory Fixation Device

Complications	No. of Patients
Clavicular bony erosion	3
Failure of the coracoid button	2
Failure of the clavicular button	1
Fracture of the distal clavicle at the clavicular hole	1
Arthritis of the acromioclavicular joint	1

4 patients (73% ± 16%) and increased more than 100% in 2 patients (111% ± 2.1%) compared with the distance immediately after the operation. One reduction loss was related to a grade III AC injury, and 5 reduction losses were related to grade V injuries. The average Constant score of the 6 patients with reduction loss was 96.6 ± 4.5 (range, 88 to 100). However, there was no statistically significant difference in Constant score between 6 patients with reduction loss and 12 patients with reduction maintenance (98.4 ± 2.5; $P = .17$) at the final follow-up.

Complications

One AC joint arthrosis, one delayed distal clavicle fracture at the clavicular hole, 3 fixation failures, and 3 cases of clavicular erosion were found in 8 patients (44%) associated with the adjustable–loop-length suspensory fixation device or surgical technical problems (Table 3). Only one patient with a delayed clavicle fracture underwent a second operation with plate fixation. Three complications related to fixation button failures resulted in a greater than 50% increase of the CC distance on simple radiographs at the final follow-up compared with immediately after the operation. Another 5 patients with complications had a CC distance equal to or increased to less than 50% of the unaffected side. The average Constant score of the 8 patients with complications was 95.2 ± 3.9 (range, 88 to 100). There was no statistically significant difference in the Constant score between patients with and those without complications ($P = .15$).

AC joint arthrosis was observed in a 32-year-old patient 6 months after surgery (Fig 2). However, no clinical symptoms appeared during the continuous follow-up period of more than 2 years. A distal clavicular fracture at the clavicular hole of the adjustable–loop-length suspensory fixation device occurred in a 42-year-old patient who had fallen 4 months after surgery. Open reduction and internal fixation using an anatomic plate was performed in response. CC fixation failure occurred in 3 patients. Among patients with CC fixation failure, coracoid button failure occurred in 2 patients and clavicular button failure occurred in one patient. For one patient with coracoid button failure, the coracoid hole was

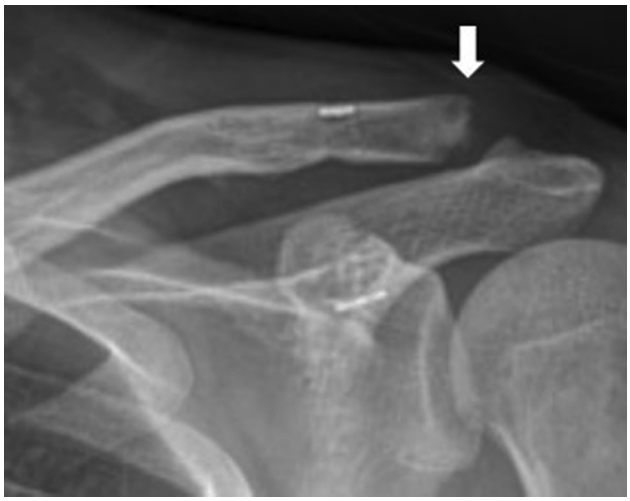

Fig 2. Radiograph showing osteoarthritis of left acromioclavicular joint 6 months after operation. Bony erosion (arrow) was found in the distal clavicle.

made too laterally, and the lateral cortex of the coracoid process was broken when the suture was tied on the clavicle (Fig 3). Thus, an additional 2 suture anchors were inserted to augment the CC fixation. In the other patient with coracoid button failure, the button migrated to the medial side of the coracoid base during the postoperative rehabilitation period. In the patient with clavicular button failure, the clavicular hole was made too anteriorly, and after CC fixation the clavicular button migrated inferiorly to the subcoracoid region (Fig 4). Clavicular erosion caused by the round button of the device was found in another 3 patients on plain radiographs at 6 months after operation (Fig 5). The mean CC distance of these 3 patients was −14% compared with the unaffected side immediately after surgery; however, the mean CC distance increased to 25% at the final follow-up.

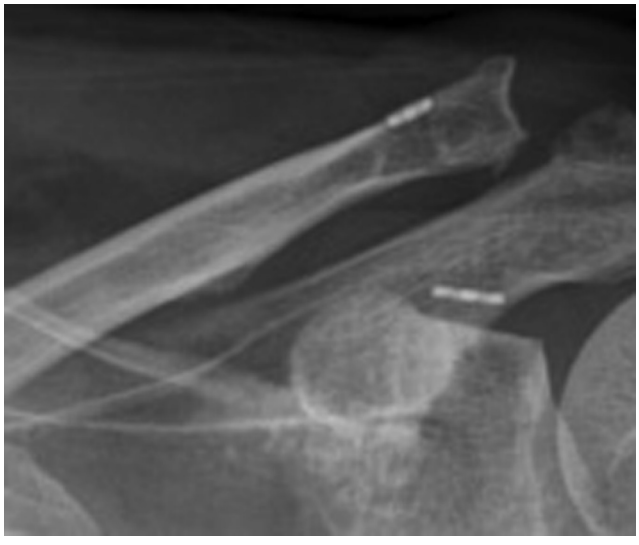

Fig 3. Left acromioclavicular joint showing coracoclavicular (CC) interval reduction loss by coracoid button failure with coracoid lateral wall breakage.

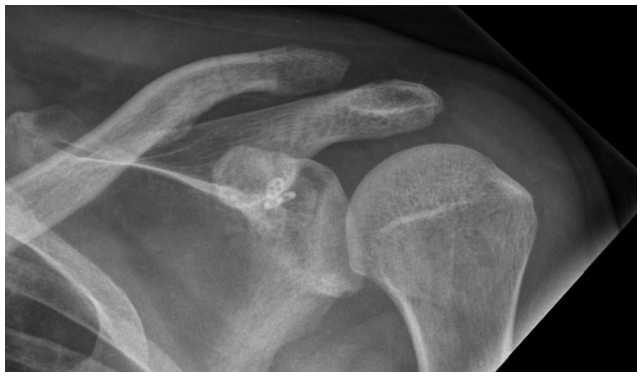

Fig 4. Left acromioclavicular joint showing coracoclavicular (CC) interval reduction loss by clavicular button failure. The clavicular button is displaced distal to the coracoid process area.

Discussion

In this study, satisfactory clinical outcomes were obtained after CC fixation using the single adjustable−loop-length suspensory fixation device for 18 patients with acute AC dislocation. Although clinical

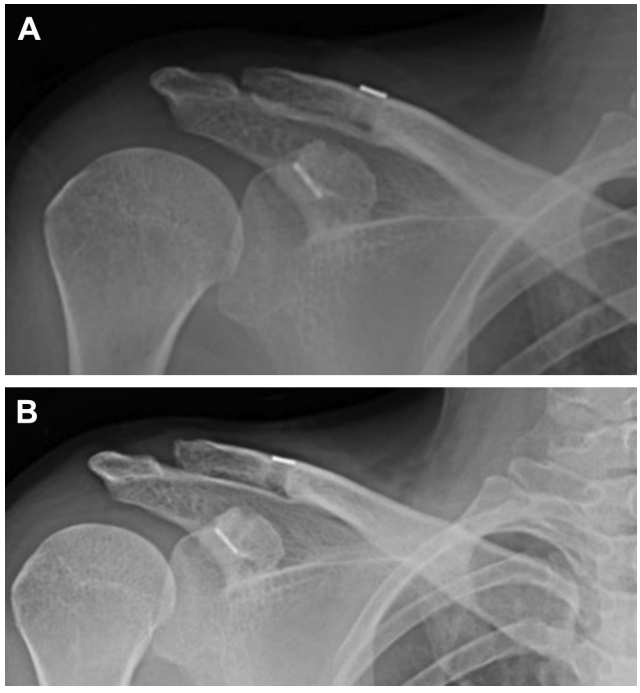

Fig 5. (A) Postoperative radiograph showing coracoclavicular (CC) reconstruction using a single adjustable−loop-length suspensory fixation device. The clavicular button is fixed on the superior surface of the clavicle. (B) Anteroposterior radiograph showed increased CC interval caused by superior cortical surface erosion of the clavicle by the clavicular button 6 months postoperatively.

outcomes were satisfactory, the CC distance increased more than 50% compared with the unaffected side in 6 patients (33%), and 8 complications (44%) associated with the adjustable–loop-length suspensory fixation device and surgical technical problems occurred.

An adjustable–loop-length suspensory fixation device has several advantages in the treatment of a displaced AC joint compared with current surgical techniques. In comparison with transacromial Kirschner wire fixation, the adjustable–loop-length suspensory fixation technique avoids the risk of migration or breakage of devices. This suspensory fixation device makes a hole in the coracoid process for transosseous fixation, which may avoid potential neurovascular injury that can be caused by approaching the base of the coracoid process to position the fixation material in the coracoid sling techniques,[8,9,14] Additionally, 4 strands of superior strength braided double polyethylene thread of the adjustable–loop-length suspensory fixation device provided stronger fixation in the CC interval compared with suture anchor fixation, which is loaded with weaker sutures.[15] Satisfactory clinical outcomes have already been reported regarding treatment of AC joint dislocation using the adjustable–loop-length suspensory fixation device.[7-10] Wellmann et al.[8] fixed the CC interval in 15 patients using a flip button/polydioxanone system, which has a structure that is similar to the TightRope, and obtained excellent radiological results. They showed that this system avoided subcoracoid preparation, which carries a risk of neurovascular injury, and reduced anatomic mismatch between the clavicle and the coracoid process by making the bony tunnel in a slightly anterior position at the clavicular site compared with CC reconstruction using a cerclage loop. El Sallakh[9] also reported that the adjustable–loop-length suspensory fixation caused less morbidity and provided excellent cosmesis and early rehabilitation.

In this study, the clinical outcomes of CC fixation using the arthroscopically assisted adjustable–loop-length suspensory fixation technique for acute AC dislocation showed satisfactory shoulder function recovery without a limitation of shoulder motion in all patients. However, the adjustable–loop-length suspensory fixation technique introduced several new potential complications, despite satisfactory clinical outcomes. Three (17%) of 6 patients who had a reduction loss greater than 50% compared with the unaffected side had a reduction loss without any device button failure in this study. One of the reasons for the CC interval reduction failure was that the single adjustable–loop-length suspensory fixation device could not restore 2 components of the native CC ligaments anatomically. The 2 components of the native CC ligaments have different anatomic attachments and provide different functions for AC joint stability. The adjustable–loop-length suspensory fixation device, however, provided only single-point vertical fixation, and the clavicular button is placed between the native attachment of the conoid ligament and the trapezoid ligament on the clavicle.[7,9,10,16] Moreover, horizontal stability of the AC joint could not be restored using this device because the AC ligament was not also reconstructed. Another important cause for gradual loss of AC joint reduction after a single adjustable–loop-length suspensory fixation procedure is because of excessive stress concentrated on the bone–metal button interface, resulting in bony erosion of the clavicle or pull-through of the coracoid process by the metal button. The loss of reduction after internal fixation using the single adjustable–loop-length suspensory fixation device has also been reported in other reports. Lim et al.[10] showed a 50% fixation failure rate 6 months after CC fixation using this suspensory fixation device in 8 patients with acute AC dislocation. Other studies reported fixation failure rates between 16.6% and 23.1% after CC fixation using the single adjustable–loop-length suspensory fixation device.[12,13]

Nevertheless, good or excellent functional outcomes were reported regardless of the radiological CC fixation loss. Murena et al.[17] showed a Constant score average of 97 in 16 patients with AC dislocation treated by the double flip button technique, although one fourth of the patients showed a reduction loss. The average Constant score in patients of the current study showed similar good results, regardless of complications or radiological fixation loss. Fracture of the coracoid process caused by drilling or pull-through of the subcoracoid metal button has been reported after adjustable–loop-length suspensory fixation procedures.[9,13] Pull-through of the coracoid button after CC fixation may occur because the coracoid hole was not made in the center of the coracoid process. Malposition of the coracoid hole during the early rehabilitation period occurred in 2 patients because of surgical errors. In these patients, the coracoid holes were made eccentrically because the medial and lateral margins of the coracoid base were not appropriately exposed under the arthroscope. If the coracoid hole is not made in the center of the coracoid base, and the coracoid button is passed through an eccentric hole placed to the medial or lateral side, the coracoid button may cause fracture or cortical breakage of the coracoid process after the tension of the device is deployed. To prevent malposition of the coracoid hole, appropriate exposure of both margins of the coracoid base is crucial so that the guide pin of the adjustable–loop-length suspensory fixation device can be passed through the center of the coracoid base.

Several surgical modifications to overcome the limitations of CC fixation using the single adjustable–loop-length suspensory fixation device might be considered.

One of the alternatives is reconstruction of the conoid ligament and trapezoid ligament independently, close to their original anatomic locations, using 2 adjustable–loop-length suspensory fixation devices.[18-20] Reconstruction using 2 adjustable–loop-length suspensory fixation devices showed greater vertical strength and horizontal strength compared with the native ligament in a cadaveric biomechanical study. Hosseini et al.[21] suggested that simultaneous use of both the coracoacromial ligament transfer and the CC fixation technique using the single adjustable–loop-length suspensory fixation device can be effective for the treatment of AC joint dislocation.

We recommend this combined technique for its safety and its ability to achieve sufficient reduction of the AC joint without intraoperative complications. CC fixation using the tendon graft combined with an adjustable–loop-length suspensory fixation device was introduced as another alternative to the single adjustable–loop-length suspensory fixation device.[22,23] The GraftRope (Arthrex, Naples, FL) has a structure similar to that of the TightRope; however, it is designed for better biological healing potential and is a stronger device because it positions the grafted tendon between 2 metal buttons. DeBerardino et al.[22] reported that all patients returned to a preinjury level of activity without any loss of reduction or complications after CC reconstruction using this combined device. Meanwhile, an 80% reduction loss with only a 50% good functional outcome was also reported within 7 weeks after a tendon graft combined with adjustable–loop-length suspensory fixation for AC dislocation in a military population.[23] The authors concluded that the current form of tendon graft combined with an adjustable–loop-length suspensory fixation could not be recommended, especially in young active patients.

Limitations

This study has several limitations. The number of patients included in the study was too small to evaluate the optimal clinical and radiological outcomes after treatment using the single adjustable–loop-length suspensory fixation device. The small number of patients also made it impossible to compare clinical results according to different grades of AC injuries. However, the high rate of early radiological complications in the study is enough to show the need to modify the current surgical technique and device. For the clinical outcomes assessment, specific measurement tools to evaluate the AC joint status were not used. Although a few different appraisal methods have already been proposed for assessing shoulder function related to AC injury, the validation of these appraisal methods has lacked statistical rigor.[24] Moreover, CC fixation using the single adjustable–loop-length suspensory fixation device was not compared with other treatment methods, despite a prospective cohort study. This study is to let other orthopaedic surgeons know the complications of CC fixation using a single adjustable–loop-length suspensory fixation device. We were unaware of the high complication rate of this technique. Furthermore, there was no report regarding a high complication rate when we were using this technique. We do not use this single adjustable–loop-length suspensory fixation device in CC fixation currently.

Conclusions

Satisfactory clinical outcomes were obtained after CC fixation using the single adjustable–loop-length suspensory fixation device for acute AC joint dislocation. However, a CC fixation failure of greater than 50% of the unaffected side seen in radiological examinations occurred in 33% of the patients within 3 months after the operation. Additionally, 8 (44%) patients had complications associated with the adjustable–loop-length suspensory fixation device and surgical technical problems. Despite acceptable shoulder function restoration, adequate care should be exercised in surgical treatment of acute AC dislocation with a single adjustable–loop-length suspensory fixation device for optimal radiological outcomes.

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