Endoscopically assisted reconstruction of acute acromioclavicular joint dislocation using a synthetic ligament. Outcomes at 12 months

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Summary
Objectives: The treatment for acute acromioclavicular (AC) joint dislocation remains controversial because of the elevated level of complications and related morbidity. The objective of this study was to evaluate clinical outcomes, radiographic results, and the complications after arthroscopic stabilization of acute stages III or IV (Rockwood classification) acromioclavicular dislocations.

Material and methods: Sixteen patients (15 males and one female) found to have Rockwood stage III or IV AC joint dislocation were operated. All the patients were stabilized arthroscopically with a synthetic ligament placed between the clavicle and the coracoid. The application of the synthetic ligament reduced the dislocation and stabilized the AC joint, allowing healing of the coracoacromial ligament. Results were assessed clinically (Constant score) and radiographically before and a mean 12 months after the treatment.

Results: Despite the excellent clinical results at the last follow-up both in terms of the Constant score (mean, 91 points; range, 60–100) and patient satisfaction, two patients required revision surgery while some had pain over the clavicular button. The X-rays showed three cases of partial loss of reduction due to distal migration of the flip button.
Introduction

Acromioclavicular (AC) dislocation frequently occurs in young subjects as a sports injury or a direct impact on the shoulder stump [1]. Lesion severity depends on the displacement of the clavicle and coracoclavicular and AC ligaments. Different classifications are used to describe these lesions, most frequently the Tossy and the Rockwood classifications [2,3]. We used the Rockwood classification to evaluate our series of patients.

Treatment for types I and II is functional with very satisfactory results, and surgical treatment is widely proposed for type IV and beyond [1–4].

Treatment of type III, which for all the classifications associates coracoclavicular and AC ligament rupture, is the subject of greater debate, particularly in young and active subjects [5]. Management of this type of recent lesion varies from functional treatment to sometimes complex surgical repair [6]. More than 60 interventions have been described, and the multitude of surgical techniques reported reflects the absence of optimal treatment and consensus on the subject [7]. A literature search showed only three early randomized series, with low numbers of patients, in which the modest results of the surgical treatment have left ample room for nonoperative treatment [4,8,9].

Arthroscopy and more specifically endoscopy because this is extra-articular surgery, have recently been proposed for treating Rockwood type III and IV AC dislocation [10–12]. It is hypothesized that minimally invasive endoscopy can reduce the morbidity and the early postoperative problems of this surgery, which is known for its complications, while providing anatomical and long-lasting reduction of the lesions.

The objective of this study was to assess the clinical and radiological results of endoscopically assisted stabilization of recent AC dislocation using a synthetic ligament between the coracoid and the clavicle.

Material and methods

Patients

We report a consecutive, retrospective study conducted in two centers between June 2007 and June 2009.

The series comprised 15 males and one female, with a mean age of 38 years (range, 24–58 years). The main inclusion criterion was the existence of an acute type III and IV AC fracture evaluated based on the Rockwood classification, in active subjects, with a minimum follow-up of 6 months. Thirteen patients (80%) presented type III dislocation and three patients type IV (20%). The injury mechanisms reported were for the most part direct impact on the shoulder stump in sports-related injury (nine patients, 56%). In five cases (30%), dislocation occurred during a fall from a motorcycle or scooter.

The mean time to surgery was 10 days (range, 0–21 days). All patients participated in recreational sports activity.

Surgical technique

Installation and anesthesia

The surgical intervention took place exclusively under general anesthesia associated with interscalene block. The patient was installed in a semi-sitting position with no traction, the head immobilized in a headrest. An image intensifier was positioned opposite the operated shoulder for intraoperative arthroscopic verification of appropriate dislocation reduction. Complete reduction of the dislocation through ascension of the shoulder was checked before beginning the procedure.

Arthroscopic approaches

Two standard approaches were used. The posterior gleno- humeral approach was used first, 2 cm below and inside the posterolateral edge of the acromion. The optical standard at 30° was used, and the instrumental anterosuperior portal was established through the rotator interval, using an outside-in technique.

Material

The Tightrope fixation (Arthrex, Naples, FL, USA), initially developed for reduction and stabilization of inferior tibial syndesmosis, was used [13] (Fig. 1). This fixation device consisted of two metallic buttons, one round and the other oblong, connected together by a continuous loop of Fiberwire® no. 5 (Arthrex, Naples, FL, USA). Two versions were successively used during the study: the initial model and then a more recent model, the second version with a wider clavicular button (10 mm versus 6.5 mm). The second’s greater contact surface with the clavicle should provide better resistance to the stresses exerted.

Arthroscopic exploration and exposure

First, a diagnostic shoulder arthroscopy was carried out to explore the glenohumeral cavity to check for associated lesions [14]. After opening the rotator interval, the base of the coracoid process was progressively exposed to the shaver and electrocoagulation. During this step, it is important to remain in contact with the bone so as to prevent any injury to the neighboring neurovascular structures. Once the inferior surface of the coracoid process has been exposed, a 1 cm incision was made within the AC joint to expose the distal clavicle. After careful incision of the deltotrapezius fascia, the anterior and posterior limits of the clavicle were localized to identify the center of the clavicle.

Discussion: Arthroscopically assisted treatment of acute AC joint dislocation is advantageous because it provides good clinical results and few complications. The rate of recurrence and the postoperative loss of reduction requires better definition of the indications and improvement of the surgical implants and technique.

Level of evidence: Level IV. Prospective cohort study.

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Figure 1  Photo of the synthetic implant with a double button.

Reduction and fixation
The C-shaped ancillary drill guide was then inserted through the anterior portal via an 8 mm-diameter canula positioned under the curve in the center of the coracoid process. The other end of the aimer was applied and centered on the distal clavicle that had been exposed between its anterior and posterior edge. A pin was then passed through the clavicle and the coracoid process, radioscopically guided by the ancillary instrumentation. The ring of the ancillary instrument was then removed, leaving the pin in place to guide the 4 mm cannulated drill. After drilling, the pin was removed. A guidewire pin was passed through the cannulated drill and retrieved through the anterior portal and the drill removed. The two traction wires of the device were passed through the metallic ring of the guidewire pin. These traction wires were retrieved through the anterior portal and then pulled until the system and the oblong button were visualized at the lower part of the coracoid process. Using independent traction on each traction wire, the button was rotated and centered under the coracoid process. The dislocation was reduced by simultaneously tightening its proximal end, like boat pulleys, checked with the image amplifier, and then four knots were tightened to secure the system in place. It was never necessary to perform open reduction using the short skin incision at the clavicle. Finally, the various incisions were closed, taking care to bury the proximal knots subcutaneously during suturing (Figs. 2 and 3).

Postoperative care
All the patients were treated in ambulatory surgery or short hospitalization (one night). The patients’ shoulders were immobilized for 4 weeks with the elbow against the body in a light removable sling. Beginning the 1st postoperative day, passive hanging movements were authorized. All the patients were seen at 1 month for the first radiological and clinical follow-up visit before starting active rehabilitation, at 3 months, and then at the last follow-up visit.

Figure 2  Right acromioclavicular dislocation before reduction.

Figure 3  Right acromioclavicular dislocation after arthroscopic reduction using a synthetic ligament.

Evaluation criteria and patient follow-up
Postoperative follow-up took place in consultation, with systematic measurement of shoulder mobility, the Constant score, as well as superior and inferior drawer tests (piano key test) or anterior and posterior drawer tests of the AC joint.

Standard AP X-rays of the shoulder were systematically taken. Coracoclavicular distance was considered, defined between the upper side of the clavicle and the lower side of the coracoid on a strictly AP X-ray of the shoulder as the radiographic reference. This is a reliable value that is simple to calculate, and most importantly, it is perfectly reproducible. This distance was calculated preoperatively, immediately postoperative, and then at the last follow-up (Fig. 4).

Statistical analysis
The results are expressed as means and ranges. The immediate postoperative coracoclavicular distances, as well as at the last follow-up visit, were compared using the parametric
Coracoclavicular distance (double arrow) used as the reference value for reducing and following up the dislocation.

ANOVA test for repeated measurements. A value of $p < 0.05$ was considered significant.

Results

The mean follow-up of the series was 12 months (range, 6–18 months) with a mean time from injury to surgery of 10 days (range, 5–21 days).

Complications

No or early or late cutaneous infectious complications were observed.

In this series, two recurrences of stage III AC dislocation were observed (2/16; 12%). The first occurred at 3 weeks in a patient who did not cooperate fully with shoulder immobilization. The second failure occurred in a patient who a priori had followed the instructions for postoperative immobilization and hanging rehabilitation. This occurred shortly after the end of the immobilization period (5 weeks). The patients underwent revision surgery with arthroscopic ligament augmentation using transplant of the gracilis and a synthetic stabilization ligament (Graftrope, Arthrex, Naples, FL, USA) with highly satisfactory radiological and clinical results to date.

Function

None of the patients complained of residual pain at the last follow-up. A minimal deformity of the shoulder was observed in 40% of the cases.

The mean value of active shoulder mobility seemed normal, with 155° (range, 140°–160°) anterior elevation, 155° (range, 140°–160°) abduction, 45° (range, 30°–60°) external rotation and mean internal rotation at T7 (range, T4–T12). These mobility values were comparable to the contralateral side, which were evaluated at 160° (range, 150°–180°) anterior elevation, 160° (range, 150°–180°) abduction, 50° (range, 40°–60°) external rotation, and internal rotation at

Radiological analysis

The mean immediate postoperative coracoclavicular distance was 37 mm (range, 27–46 mm) and was similar to the unoperated contralateral side.

At the last follow-up, there was an increase in this mean distance: 38.2 mm (range, 30–46 mm). The difference was not significant ($p > 0.05$).

This very slight increase was not related to a loss in general correction of the reduction obtained in all the patients. It was only consecutive to the mediocre results obtained in five patients (including the two recurrences), which substantially lowered the mean distance at the last follow-up (Figs. 5 and 6). It should also be noted that these five patients had received the first version of the implant, i.e., a 6.5 mm-diameter clavicular button.

The small number of patients did not allow us to determine whether there was a statistical relation between time to surgery and loss of correction.

Discussion

This study reports the results of the endoscopic stabilization technique for acute Rockwood type III and IV AC dislocations. The principle of stabilizing the joint in the acute phase consists of maintaining a satisfactory reduction using cora-
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Described initially as open surgery, coracoclavicular ligament augmentation, here combined with endoscopy, reduced the morbidity of a surgery that was unpopular because of its postoperative complications, in particular recurrence varying from 10 to 30% depending on the series [5,15]. Other complications include migration of osteosynthesis pins, osteolysis around artificial Gore-tex ligaments, fracture or dismantling of the clavicular screws, excessive resection of the distal extremity of the clavicle, and operative-site infections [1,9,16,17]. This initial technique has resulted in surgeons preferring conservative treatment [7,18,19]. The lower rate of complication in the present series (12% recurrence) can be seen as an advantage in the arthroscopic technique, which keeps the deltoid musculature intact and makes shorter or ambulatory hospitalization possible. The same surgical time can be used to search for and treat associated lesions of the glenohumeral joint. For Pauly et al., 15% of dislocations also present rupture of the deep aspect of the rotator cuff or lesions of the superior glenoid labrum that occasionally need treatment [14].

The results obtained on reducing the dislocation are valuable in that we were able to obtain comparable coracoclavicular distance to the healthy contralateral side in all cases in the immediate postoperative period. Certain cases showed a loss of correction over time corresponding to a significant increase in the coracoclavicular distance at the last follow-up. Two recurrences of dislocation were recorded, one of which did not have a clear cause. Several hypotheses could explain these results.

This loss of correction may be related to low resistance of the synthetic ligament, which may have ruptured before the ligament healing that it was designed to promote. Two recent biomechanics studies analyzed the different possibilities available for AC joint reconstruction. Although semitendinous-type tendons present mechanical resistance to lengthening similar to the AC ligaments, they are less rigid [11,20]. Ligament reconstructions using the coracoacromial ligament (Weaver and Dunn procedure) often appear insufficient to stabilize the AC joint, which remains lax in all planes [21,22]. Mazzocca et al. reported that adding coracoclavicular cerclage in a modified Weaver and Dunn reconstruction remains even less stable and less rigid than artificial nonresorbable ligaments used in open or even arthroscopic coracoclavicular reconstruction [15,23]. These biomechanical results substantiate our use of artificial ligaments. In another experimental study, Motamedi et al. showed that there was no significant difference in terms of rigidity and resistance between conoid, trapezoid, and braided polyethylene (Fiberwire®) ligaments [24].

In our study, we used a single synthetic ligament. The use of two ligaments could prevent loss of correction. Recent anatomical studies have reported an increase in the rigidity of an assembly of two ligaments on cadaver subjects [24,25]. However, there is a risk of experimentally creating an equivalent of AC arthrodesis related to the hyper-rigid assembly, with known harmful effects on shoulder mobility [8].

Another phenomenon may explain the loss in postoperative reduction: intraclavicular migration of the superior button that results in relaxation with negative effects on ligament healing. The small diameter (6.5 mm) of the superior button of the first version of the synthetic ligament was probably poorly adapted to the stresses exerted by the clavicle. This button tended to migrate through the clavicle, as can be seen on Figs. 5 and 6. This transclavicular migration of the button has already been described. Four patients out of 16 in the series reported by Murena et al. showed loss of reduction at a mean follow-up of 31 months, although this did not affect the clinical results [10]. In this series of arthroscopic stabilization of acute dislocations, two double-button synthetic ligaments were used, similar to those used in the present study, to reproduce more anatomical trajectories for the conoid and trapezoid ligaments. The clavicular button was modified in a new version with a wider button (10 mm). This adaptation, used for nine of our patients, has shown no clavicular button migration phenomena or loss of correction. However, the low number of patients and the insufficiently long follow-up do not allow us to draw reliable conclusions.

Several limits to this study and the endoscopic technique must be mentioned. First of all, in more than 30% of the cases, the technique was found to be flawed because of the onset of recurrences (2) and loss of correction (3). This underscores the need to improve the endoscopic technique and the implants. These poor radiological results
on reduction, however, altered the clinical results on pain and mobility only very little or not at all. These secondary displacements were more moderate than the initial sprain. Therefore, we consider these correction losses not as treatment failure and a complication, but rather as a technical defect related to the material. This surgery is very technically demanding and requires a certain learning period. Our series included several operators, which could be a source of bias in the interpretation of the results. Arthroscopy reduces the morbidity of this procedure, but it also includes certain risks. One must not go beyond the coracoid so as not to compromise the neurovascular structures, particularly the branches of the brachial plexus. Time from injury to surgery is also an essential factor to take into account. It is recommended to operate within 3 weeks so as to obtain favorable ligament healing. Our series included a small number of nonrandomized patients. It was impossible to more precisely define the indications and results between Rockwood type III and IV AC dislocations and to compare this technique with conservative treatment.

Conclusion

The endoscopic technique reduces morbidity of synthetic ligament augmentation known for its complications. It is a promising technique in the treatment of Rockwood type III and IV AC dislocations. Reduction losses (3) and recurrence (2) are an incentive to improve the technique and the implants. Randomized series including greater numbers of subjects and a longer follow-up period are necessary to more precisely assess the indications and results of endoscopic techniques by comparing them to functional treatment.

Conflict of interest statement


References
