SHOULDER

Arthroscopic treatment of acute acromioclavicular joint dislocation with double flip button

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Abstract The ideal treatment for acute acromioclavicular joint dislocation is still controversial, both in terms of indications and surgical technique. The clinical and radiographic outcomes of 16 patients affected by acute AC joint dislocation (type III–V) and arthroscopically treated with a coracoclavicular double flip button are presented. Despite the excellent clinical results both in terms of Constant score (mean 97 points) and patient satisfaction, at a mean follow-up of 31 months the radiographs showed partial loss of reduction due to distal migration of the flip button within the upper third of the clavicle in one-fourth of the cases. The technique presented here proved to be safe and minimally invasive while delivering good aesthetic results and allowing for the treatment of associated lesions. Furthermore, the technique could benefit from more advanced retention devices, which ought to reduce or avoid migration of the flip buttons.

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Introduction

The ideal treatment for acromioclavicular (AC) joint dislocation is currently controversial, both in terms of indications and surgical technique [3].

The literature reports several arthroscopic and open reconstructive techniques for the treatment of acute lesions. Some techniques, as the coracoid apex and the conjoined tendon transfer, are no longer recommended [7]. Some others stabilize the AC joint with metal wires, screws or hook plates and may be associated with high complication rates, mainly related to the implant itself [1, 15, 23, 26, 27, 29, 30, 34].

Some authors use either open or arthroscopic AC ligament transposition techniques to treat acute lesions [18]. However, ligament transfer alone may not be sufficient to guarantee a good primary stabilization [14, 19]. The lack of additional coracoclavicular reinforcement systems may determine residual laxity upon healing [9]. Moreover, sacrificing the coracoacromial ligament may lead to the upward dislocation of the humeral head, and also seems to be associated with glenohumeral laxity [11, 12, 20].

In 1941, Bosworth described the first open coracoclavicular stabilization technique with screws, made popular by Rockwood in the 1990s [4, 5, 31, 32]. The results reported for this technique are satisfactory, but include complications like screw mobilization due to coracoid cut-out, screw rupture and partial loss of the reduction upon screw removal [6, 13, 16, 25]. Biomechanical cadaver studies by Harris assessed stiffness and strength of different coracoclavicular fixation systems in comparison to intact

ligaments. A monocortical coracoid implantation of the coracoclavicular screw presents stiffness similar to ligaments, but more than 50% resistance loss. In contrast, bicortical coracoid implantation of the screw confers greater resistance (80%) with respect to intact ligaments but significantly superior stiffness [14]. The higher rigidity, interfering with physiological rotational movements of the clavicle, seems to be related to some of the previously described complications of this treatment, such as pull out of the screw and fracture of the coracoid.

Coracoclavicular suture loop augmentations have been described: major problems with these techniques are the invasive preparation of the coracoid base and the anterior subluxation of the clavicle responsible for postoperative malreduction of the AC joint [2, 16]. Suture cerclage has been shown to dig into the lateral clavicle and the coracoid as a result of rotational motion of the clavicle [17].

More recently published techniques employ coracoclavicular fixation devices like flip buttons on intertwined sutures for acute AC dislocations, in order to reduce complications associated with suture cerclage [37, 38].

The aim of the present study is to evaluate the clinical and radiological outcomes at a minimum follow-up of 2 years in a group of patients with acute AC dislocation treated arthroscopically.

Materials and methods

Between August 2004 and September 2006 we treated 16 patients affected by acute AC joint dislocation. There were 15 men and 1 woman with a mean age of 33.3 years (range, 20–54 years). According to the Rockwood classification 10 (62.5%) patients had type III lesions, 4 (25%) had type IV lesions and 2 (12.5%) had type V lesions. The mean time between trauma and surgery was 4.3 days (range, 2–10 days). The dominant shoulder was involved in six (37.5%) patients. Eight (50%) patients practiced high-demanding physical activities and three (18.8%) were heavy manual workers.

All the lesions were diagnosed at clinical and radiographic evaluation in anteroposterior and axillary views of the affected shoulder. The lesions were classified according to preoperative radiographs.

The surgery is performed in the beach-chair position without any arm traction. Sterile preparation and draping are used as for common arthroscopic procedures. The AC joint is manually reduced and temporarily stabilized with a 1.8 mm diameter K-wire. The AC joint reduction is performed prior to arthroscopy to correctly identify bony landmarks. A 30° angle arthroscope is then inserted in the glenohumeral joint through a standard posterior portal. A 7 mm soft plastic cannula is positioned through an anterior

mid-glenoid portal with an outside-in technique. This portal must allow the instruments to reach the anteroinferior aspect of the coracoid base, passing between the superior and middle glenohumeral ligaments and following the superior edge of the subscapularis tendon from lateral to medial. A standard anterosuperior portal is created, to switch the scope and aim it medially to show the base of the coracoid. The complete exposure of the anteroinferior surface of the base of the coracoid is obtained with a radiofrequency ablator. The tip of a posterior cruciate ligament-reconstruction femoral guide is inserted through the anterior portal and maintained at the center of the coracoid base. A 6 mm skin incision is made over the clavicle, 3 cm medial to the AC joint, and the pin-sleeve of the PCL-guide is positioned between the anterior third and middle third of the clavicle to avoid an anterior displacement of the bone at the end of the procedure.

A 2.4 mm K-wire is inserted through the clavicle and coracoid. The arthroscopic visualization of the tip of the K-wire at the base of the coracoid confirms its correct positioning in the center of the bony process where the tip of the guide has been carefully held in place, in order to prevent any malpositioning. The femoral guide is removed and the 4.5 mm Endobutton cannulated drill bit (Smith & Nephew INC, Largo, FL) used to make the bony tunnels. The guide wire is then removed, leaving the cannulated drill bit on site, and a No. 1 PDS thread is inserted through it and retrieved through the anterior mid-glenoid portal.

A # 5 Fiberwire suture and a # 2 Fiberwire suture (Arthrex, Naples, FL) are looped around the internal eyelets of the two Endobuttons. The implantation on the coracoid is obtained by sliding the first Endobutton through the bony tunnels in the clavicle and coracoid, using two additional Ethibond No. 2 (Ethicon Endo-Surgery, Inc., Cincinnati, OH) transport sutures. These sutures are inserted in the lateral eyelets of the inferior flip button and retrieved out of the anterior mid-glenoid portal, via the PDS thread. Once the first Endobutton has been flipped and safely anchored at the base of the coracoid, the Fiberwire sutures are tied to the second Endobutton at the superior aspect of the clavicle. This passage is monitored arthroscopically. The transport sutures are finally removed.

The mean follow-up was 31 months (range, 24–48 months). At final follow-up patients were assessed using the Constant score (the mean score was rounded to the nearest figure) and were asked to express global satisfaction on the procedure by responding either "satisfied" or "not satisfied". AC joint comparative radiographic evaluations were also obtained at rest and under stress [8]. Anteroposterior stress views were obtained with 5 kg weights hung at each wrist. The images were analyzed to assess coracoclavicular distance (height in millimeters

between the upper border of the coracoid process and the inferior cortex of the clavicle) bilaterally, reduction with respect to the contralateral shoulder (reduction, subdislocation and dislocation, respectively, with coracoclavicular heights greater than less than one-fourth, between more than one-fourth and double, and more than double as compared to the uninjured shoulder), and development of degenerative changes of the AC joint. Stress joint stability also was assessed by calculating the difference of the coracoclavicular distance measured at rest and under stress on radiographs (elongation distance). All measurements were performed with a digital calliper and rounded to the nearest figure.

Statistical analysis

One-sample Kolmogorov-Smirnov excluded normality of the tested variables, thus non-parametric tests were performed. The coracoclavicular distance difference between the operated and non-operated groups was tested with Wilcoxon Mann–Whitney test. The coracoclavicular distance difference between rest and stress views of the operated shoulder was analyzed with the Wilcoxon signed ranks test.

The level of significance was set at $P < 0.05$. Computerized statistical analysis was performed using SPSS software (version 11.0; SPSS Inc., Chicago, IL).

Results

The mean Constant score at final follow-up was 97 points (range, 82–100), with full recovery of the shoulder range of motion in all the patients. All the patients returned to all daily activities at mean 3.2 months postoperatively (range, 3–4 months). All the patients were satisfied with the treatment.

Immediate postoperative radiographic imaging reported successful acromion-clavicular reduction in all cases. The radiographs at final follow-up showed a mean coracoclavicular distance of 10 mm (range, 6–16 mm) at the operated shoulder and 9 mm (range, 6–11 mm) at the non-operated shoulder. This difference was not statistically significant. At the final follow-up, 12 shoulders (75%) maintained a complete reduction and 4 shoulders (25%) showed a partial loss of reduction, with a mean coracoclavicular distance of 150% (range, 136–172%) as compared to the uninjured shoulder. Nevertheless, the functional outcomes of all these four patients were excellent, with a mean Constant score of 99 points (range, 97–100) and complete range of motion. With reference to stress joint stability, stress views showed a mean coracoclavicular distance of 10 mm (range, 6–16 mm). There was no

statistical significant difference between the mean coracoclavicular distance under stress and the mean coracoclavicular distance at rest. No patient presented with AC joint degenerative changes at the last radiographic evaluation.

The only observed complication was a superficial infection of the skin incision above the clavicle in two patients (12.5%), solved with a 2 week antibiotic therapy.

Concomitant lesions observed at arthroscopy included three (18.75%) type 2 SLAP lesions repaired with one TwinFix Ti 3.5 suture anchor (Smith and Nephew, Andover, MA) and one (6.25%) Bankart lesion from 7 to 9 o'clock repaired with one TwinFix Ti 2.8 suture anchor.

Discussion

The most important finding of the present study was that the presented technique produced good clinical results at the 3 year follow-up despite a slight migration of the superior flip button into the clavicle without affecting the outcome. Indeed, the clinical results of the presented arthroscopic technique at an average follow-up of 2 years were excellent in terms of the mean Constant score; all the patients showed global satisfaction with the procedure. The mean time of 3.2 months for return to all daily activities was comparable to that previously reported in the literature [21, 22, 33].

From a radiological point of view one-fourth of the patients without any history of postoperative trauma presented with a partial loss of reduction. It was associated with the migration of the superior flip button into the clavicle secondary to the penetration of the superior cortex that never progressed beyond the upper third of the collarbone. Nevertheless, all of these patients reported excellent functional outcome and were satisfied with the procedure despite a slight prominence of the lateral profile of the clavicle. Although the cut-through of suture cerclage in the clavicle has been previously described [17], to our knowledge the distal migration of the flip button in the clavicle has not yet been reported. It occurred in a substantial proportion of patients and is therefore worthy of consideration. Unfortunately, the lack of serial radiographic controls over time does not allow us to establish the beginning and progression of this process. The rest and stress views of the AC joint showed no significant difference in the coracoclavicular distance, confirming good joint stability in all the patients. At a mean follow-up of 31 months, the articular surface degenerative changes were not observed at radiological evaluation of the AC joint, but further evaluation is recommended to confirm this result in the long-term.

As of yet the treatment of type III AC joint dislocations is controversial. Young and active patients with higher

activity levels are candidates for surgery in order to achieve anatomic restoration and better clinical results, but the gold standard for the surgical technique has not been defined. The main objective is the anatomic reduction of the dislocation and the repair or reconstruction of the coracoclavicular ligaments. In addition, to protect the repaired or reconstructed ligaments during healing, the achieved reduction should be maintained with reinforcement systems [10]. Actually, clavicle stabilization in acute dislocations is associated with the formation of a bridging scar tissue even in case of non-suturable coracoclavicular ligaments. An undesirable aspect of all temporary stabilization devices such as screws is the second surgery needed for their removal [28].

Petersen et al. obtained AC joint stabilization with two flip buttons and polydioxanone (PDS) thread looped around them using an open minimally invasive approach. The drill guide for the coracoid tunnel was introduced through the medial coracoid aspect and the coracoid flip button was inserted with a custom-made button pusher. When compared to other coracoclavicular stabilization systems using suture cerclage, this technique prevented significant anterior displacement of the clavicle and reduced the abrasive wear that leads to clavicular erosion [37].

The retention system used in the present study benefits from the same mechanical principles of the one described by Petersen et al., but did not require any custom-made device. Moreover, a superior strength braided double polyethylene thread (Fiberwire) was used in view of the data reported by Motamedi et al. [28] where no significant difference in terms of strength and rigidity was demonstrated between intact coracoclavicular ligaments, polydioxanone (PDS) sutures and braided polyethylene-sutures.

A downside of the fiberwire sutures may be related to their higher price that, however, did not significantly influence the cost of the global procedure.

Arthroscopic visualization allowed a very precise positioning of the Endobutton at the coracoid base through the rotator interval, keeping more distant from the nervous structures with respect to the minimally invasive medial open approach. Indeed, in an anatomic study, Lo et al. [24] demonstrated the presence of the axillary nerve at mean 29.3 mm medially from the anteromedial margin of the coracoid process base.

Another remarkable advantage of the arthroscopic technique is the ability to diagnose and treat associated lesions. In this series of patients concomitant lesions were identified in 25% of the cases. Comparable percentages were reported by Imhoff et al. in acromioclavicular joints dislocations type III through V [35]. If untreated, these lesions may be responsible for the persistence of shoulder pain after recovery from an AC joint injury.

Conclusion

The presented technique is minimally invasive and proved to be safe. Furthermore, it delivers good clinical and aesthetic results in the treatment of acute AC joint lesions. Nonetheless, given the distal migration of the flip button with partial loss of reduction of the AC joint observed in some cases, the use of a double TightRope device could be considered. As recently described by Walz et al. [36], this technique seems to re-establish a more anatomical reconstruction of both coracoclavicular ligaments and the two buttons on the superior cortex of the clavicle, should reduce or avoid migration of the flip button into the bone by decreasing pressure at the implant-bone interface.

References

1. Bakalim G, Wilppula E (1975) Surgical or conservative treatment of total dislocation of the acromioclavicular joint. Acta Chir Scand 141:43–47
2. Baker JE, Nicandri GT, Young DC et al (2003) A cadaveric study examining acromioclavicular joint congruity after different methods of coracoclavicular loop repair. J Shoulder Elbow Surg 12:595–598
3. Bjerneld H, Hovelius L, Thorling J (1983) Acromioclavicular separations treated conservatively. A 5-year follow-up study. Acta Orthop Scand 54:743–745
4. Bosworth BM (1941) Acromioclavicular separation: a new method of repair. Surg Gynecol Obstet 73:866–871
5. Bosworth BM (1948) Acromioclavicular dislocation: end result of screw suspension treatment. Ann Surg Gynecol Obstet 127:98–111
6. Broos P, Stoffelen D, Van de Sijpe K et al (1997) Operative Versorgung der vollstandingen AC-Luxation TossY III mit der Bosworth-Schraube oder der Wolter-Platte. Eine Kritische Bethachtung. Unfallchirurgie 23:153–160
7. Brunelli G, Brunelli F (1988) The treatment of acromioclavicular dislocation by transfer of the short head of the biceps. Int Orthop 12:105–108
8. Constant CR, Murly AH (1987) A clinical method of functional assessment of the shoulder. Clin Orthop Relat Res 214:160–164
9. Deshmukh AV, Wilson DR, Zilberfarb JL et al (2004) Stability of acromioclavicular joint reconstruction: biomechanical testing of various surgical techniques in a cadaveric model. Am J Sports Med 32:1492–1498
10. Dias JJ, Steingold RF, Richardson RA et al (1987) The conservative treatment of acromioclavicular dislocation. Review after five years. J Bone Joint Surg Br 69:719–722
11. Diederichsen LP, Norregaard J, Krogsgaard M et al (2004) Reflexes in the shoulder muscles elicited from the human coracoacromial ligament. J Orthop Res 22:976–983
12. Field LD, Dines DM, Zabinski SJ (1997) Hemiarthroplasty of the shoulder for rotator cuff arthropathy. J Shoulder Elbow Surg 6:18–23
13. Fredenschuss B, Boszotta H, Helperstorfer W (1991) Ergebnisse nach operativer Stabilisierung des zerrissenen Schultergelenkes. Kombinationsverfahren versus Bosworth-Schraube. Unfallchirurg 94:95–98

14. Harris RI, Wallace AL, Harper GD et al (2000) Structural properties of the intact end the reconstructed coracoclavicular ligament complex. Am J Sports Med 28:103–108
15. Hellmich A, Sievers U (1988) Operative repair of acromioclavicular separation via transcutaneous Kirschner wire fixation: results of follow-up examinations in 45 patients. Aktuelle Traumatol 18:9–13
16. Jerosch J, Filler T, Peuker E, Greig M et al (1999) Which stabilization technique corrects anatomy best in patients with AC-separation? An experimental study. Knee Surg Sports Traumatol Arthrosc 7:365–372
17. Kippe MA, Demetropoulos CK, Jurist KA et al (2006) Modes of failure in acromioclavicular joint reconstruction: a biomechanical analysis of clavicular motion and its role in construct failure. Presented at the 52nd annual meeting of the Orthopaedic Research Society, Chicago, IL, 19–22 March 2006
18. Lafosse L, Bayer GP, Leuzzinger J (2005) Arthroscopic treatment of acute and chronic acromioclavicular joint dislocation. Arthroscopy 21:1117e1–1117e8
19. Lee SJ, Nikolas SJ, Akizuki KH et al (2003) Reconstruction of the coracoclavicular ligaments with tendon grafts. A comparative biomechanical study. Am J Sports Med 31:648–654
20. Lee TQ, Black AD, Tibone JE et al (2001) Release of the coracoacromial ligament can lead to glenohumeral laxity: a biomechanical study. J Shoulder Elbow Surg 10:68–72
21. Lim YW, Sood A, Van Riet RP (2007) Acromioclavicular joint reduction, repair and reconstruction using metallic buttons-early results and complications. Tech Shoulder Elbow Surg 8:213–221
22. Lim YW (2008) Triple endobutton technique in acromioclavicular joint reduction and reconstruction. Ann Acad Med Singap 37:294–299
23. Lindsey RW, Gutowski WT (1986) The migration of a broken pin following fixation of the acromioclavicular joint: a case report and review of the literature. Orthopedics 9:413–416
24. Lo IK, Burkhart SS, Parten PM (2004) Surgery about the coracoid: neurovascular structures at risk. Arthroscopy 20:591–595
25. Lowe GP, Fogarty MJ (1977) Acute acromioclavicular joint dislocation: result of operative treatment with the Bosworth screw. Aust NZ J Surg 47:664–667
26. Mayr E, Braun W, Eber W et al (1999) Treatment of acromioclavicular joint separations: central Kirschner-wire and PDS-augmentation. Unfallchirurg 102:278–286
27. Mlasowsky B, Brenner P, Duben W et al (1988) Repair of complete acromioclavicular dislocation (Tossy stage III) using Balser's hook plate combined with ligament sutures. Injury 19:227–232
28. Motamedi AR, Blevins FT, Willis MC et al (2000) Biomechanics of the coracoclavicular ligament complex and augmentations used in its repair and reconstruction. Am J Sports Med 28:380–384
29. Norrell H Jr, Llewellyn RC (1965) Migration of a threaded Steinmann pin from an acromioclavicular joint into the spinal canal: a case report. J Bone Joint Surg Am 47:1024–1026
30. Paavolainen P, Bjorkenheim JM, Paukku P et al (1983) Surgical treatment of acromioclavicular dislocation: a review of 39 patients. Injury 14:415–420
31. Rockwood CA Jr, Williams GR Jr, Young DC (1988) Disorder of the acromioclavicular joint. In: Rockwood CA Jr, Matsen FAIII (eds) The shoulder, 2nd edn. WB Saunders, Philadelphia, pp 483–553
32. Rockwood CA Jr (1984) Injuries to the acromioclavicular joint. In: Rockwood CA Jr, Green DP (eds) Fractures in adults, 2nd edn. JB Lippincott, Philadelphia, pp 860–910
33. Shin SJ, Yun YH, Yoo JD (2008) Coracoclavicular ligament reconstruction for acromioclavicular dislocation using 2 suture anchors and coracoacromial ligament transfer. Am J Sports Med 37:346–351
34. Sim E, Schwarz N, Hocker K et al (1995) Repair of complete acromioclavicular separations using the acromioclavicular-hook plate. Clin Orthop Relat Res 314:134–142
35. Tischer T, Salzmann GM, El-Azab H et al (2009) Incidence of associated injuries with acute acromioclavicular joint dislocations types III through V. Am J Sports Med 37:136–139
36. Walz L, Salzmann GM, Fabbro T et al (2008) The anatomic reconstruction of acromioclavicular joint dislocations using 2 TightRope devices. Am J Sports Med 36:2398–2406
37. Wellmann M, Zantop T, Petersen W (2007) Minimally invasive coracoclavicular ligament augmentation with a flip button/polydioxanone repair for treatment of total acromioclavicular joint dislocation. Arthroscopy 23:1132.e1–1132.e5
38. Wellmann M, Zantop T, Weimann A et al (2007) Biomechanical evaluation of minimally invasive repairs for complete AC joint dislocation. Am J Sports Med 35:955–961