



Coracoclavicular ligament repair and screw fixation in acromioclavicular dislocations

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Objectives: We evaluated the long-term results of acromioclavicular dislocations treated with coracoclavicular fixation using a cancellous screw.

Methods: Coracoclavicular fixation was performed using the modified Bosworth technique in 32 patients (24 males, 8 females; mean age 35 years; range 19 to 58 years) with acromioclavicular dislocations. According to the Rockwood classification, seven patients had type III, nine patients had type IV, 13 patients had type V, and three patients had type VI dislocations. Following repair of the coracoclavicular ligament, fixation was performed with a cancellous screw in all but two patients in whom a cortical screw was used. These two patients developed redislocation due to screw cut out and underwent reoperation with cancellous screw fixation and were not included in the final assessments. The screws were removed under local anesthesia after eight weeks postoperatively. The patients were evaluated for cosmetic appearance, functional status, pain, localized tenderness, articular range of motion, and with the functional Constant scoring system. The mean follow up was 3.1 years (range 1 to 8 years).

Results: The mean Constant score was 98 (range 92 to 100). The results were excellent in 26 patients (86.7%) and good in four patients (13.3%). There was subluxation of the acromioclavicular joint in one patient (3.3%). The alignment of the acromioclavicular joint was normal in the remaining patients. None of the patients showed joint degeneration. All patients were pain-free and achieved full range of motion.

Conclusion: With ease of application, low complication rate, and low rate of acromioclavicular joint arthrosis, the modified Bosworth technique is an effective surgical method in providing satisfactory shoulder function in acromioclavicular dislocations.

Key words: Acromioclavicular joint/injuries/surgery; bone screws; dislocations/surgery; ligaments/injuries.

The acromioclavicular joint is stabilized by two ligaments: the acromioclavicular ligaments control horizontal stability, and coracoclavicular ligaments provide vertical stability.^[1,2] Acromioclavicular joint dislocations account for 12% of all dislocations about the shoulder and are five times more common in males than in females. In 1960s, Tossy and Allman classified acromioclavicular dislocations into three types (I, II and III).^[3,4] This classification was modified in 1984 by Rockwood with addition of types IV,

V, and VI.^[5] In type I dislocations, the acromioclavicular and coracoclavicular ligaments are intact. In type II dislocations, the acromioclavicular ligaments are completely ruptured, whereas the coracoclavicular ligaments are intact. Type I and II dislocations are treated conservatively.^[6] In type III dislocations, the coracoclavicular ligaments are also ruptured. Although there is no established treatment method for type III injuries, surgical treatment is preferred particularly in younger, active patients with physically

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demanding work.^[6-9] Type IV dislocations are rare injuries, where the distal end of the clavicle is displaced posteriorly into the trapezius muscle. Type V injuries are more severe than type III and IV injuries. The lateral clavicle is detached from the muscles. Pain is the prominent symptom. Loss of support to the arm may lead to tension in the brachial plexus and neurogenic pain. Type VI injuries are also rare. The distal end of the clavicle is displaced inferiorly towards the subacromial space. Surgery is the treatment of choice for type IV, V, and VI injuries.^[6] Although more than 60 procedures have been described for surgical treatment of acromioclavicular joint dislocations, there is no gold standard for management of these dislocations.^[10-15] These procedures can be grouped in five main categories: (1) fixation of the acromioclavicular joint with a K-wire or hook plate, (2) dynamic muscle transfer, (3) fixation between the clavicle and the coracoid (with the use of a Bosworth screw or synthetic augmentation), (4) ligament reconstruction, and (5) distal clavicle resection.

Literature review shows that it is unclear what type of treatment is recommended for a specific type of dislocation, indicating that there is still no established method. In this study, we evaluated the long-term results of patients whose acromioclavicular dislocations were treated with coracoclavicular fixation using a cancellous screw.

Patients and methods

Thirty-two patients (24 males, 8 females; mean age 35 years; range 19 to 58 years) underwent surgery for acromioclavicular joint dislocations. According to the Rockwood classification, seven patients had type III, nine patients had type IV, 13 patients had type V, and three patients had type VI dislocations. One patient also had a glenoid neck fracture. The injury was on the right side in 21 patients, on the left side in 11 patients, and in the dominant arm in 23 patients. The dislocations resulted from falls in 16 patients, sports injuries in eight patients, and traffic accidents in eight patients.

Surgical procedure

A parallel incision was made through the skin folds under general anaesthesia with the patient in the beach-chair position. The disrupted coracoclavicular ligaments were identified and marked with a No 2 Ethibond suture (Ethicon). After placing the clavicle to its anatomic position, the clavicle and the coracoid

were drilled with a 3.2 mm drill, and the place of the screw was prepared with a taper. Then, only the clavicle was drilled at the same place with a 4.5 mm drill. The fixation was made with a short-threaded cancellous screw (Bosworth screw) of appropriate size and a scale (Fig. 1a, b). A cortical fixation screw



Fig. 1. (a) Radiograph showing a type III acromioclavicular dislocation. Radiographs obtained (b) following screw fixation and (c) screw removal after eight weeks. Complete reduction is seen.

was used in the first two patients due to unavailability of a Bosworth screw. Subsequently, the Ethibond sutures which were previously inserted through the coracoclavicular ligaments were tied. Following surgery, the patients were allowed to use their operated upper extremities for daily requirements. A shoulder sling was used in obese and portly patients for three weeks. For each patient, any shoulder flexion and abduction beyond 90 degrees were restricted for eight weeks (until the removal of screw). The screw was removed under local anesthesia in the operation room after eight weeks (Fig. 1c).

The patients were evaluated for cosmetic appearance, functional status, pain, localized tenderness, articular range of motion, and with the Constant functional scoring system. The mean follow-up was 3.1 years (range 1 to 8 years).

Results

Postoperative recurrence of dislocation was observed in two patients (6.3%). Both patients were treated with a cortical fixation screw, which resulted in screw cut out. One of the patients was reoperated and the fixation was made with a cancellous screw. The shoulder was held in a shoulder sling for four weeks after surgery. The patient developed a 3-mm loss of reduction during follow-up; there was no sign of acromioclavicular joint arthrosis and the patient had pain-free and full range of motion. The other patient underwent ligament repair using the palmaris longus tendon. Fixation was made with a cancellous screw and reinforced by suture hooks. The results of these two patients were excluded in the final examinations.

Although no elevations above the shoulder level were allowed for the first eight weeks, none of the patients had any restriction in shoulder movements, and all achieved full range of motion within a short period of time. All patients were pain-free. The mean Constant score was 98 (range 92 to 100). The results were excellent in 26 patients (86.7%) and good in four patients (13.3%). None had a poor result.

A reduction loss of 3 mm occurred in one patient (3.3%). Although the fixation was made with a cancellous screw, this patient had an almost osteoporotic bone structure. No shoulder complication or pain were observed in this patient despite acromioclavicular joint subluxation.

Radiographically, the alignment of the acromioclavicular joint was normal in all but one patient with subluxation. None of the patients showed joint degeneration or notable ossification. Cosmetically, no patient had a poor scar tissue and the acromioclavicular joint was barely visible. Each patient had pain-free and full shoulder movements. All the patients returned to preinjury jobs or sports activities.

Discussion

Although there are more than 60 procedures described for surgical treatment of acromioclavicular joint dislocations, there is still no gold standard.^[6,16-19] When overall surgical options are considered, there are two groups of surgical treatment: primary repair or reconstruction of the coracoclavicular ligament.^[16]

Acromioclavicular joint fixation has been made with the use of a screw, K-wire, or plate. However, these techniques are associated with the development of infection, acromioclavicular joint arthritis, implant failure or migration, resulting in high rates of failure.^[12,20-22] Another technique is the dynamic muscle transfer; however, static stability cannot be assured in dynamic muscle transfers, and it is associated with risks for nonunion and nerve damage.^[2,23,24] Coracoclavicular stabilization can also be performed with the use of screws, synthetic material, or cerclage wires. The stability of anatomical acromioclavicular joint reconstructions with the use of graft implantation is highly associated with the graft used.^[17] Coracoclavicular stabilization with a lag screw was described by Bosworth in 1940s. No repair or reconstruction of the ligament were described in the original technique. In 1990s, Rockwood and Young recommended repair of the ligament in acute cases, and reconstruction of the ligament in chronic cases, along with the use of a Bosworth screw.^[6] Arthroscopy-aided fixation with a coracoclavicular screw described by Rolla et al.^[25] in 2004 improved this treatment method one step further, minimizing surgical trauma.

Biomechanical studies on the coracoacromial ligament have shown that the strength and stiffness of the coracoacromial ligament are only about half of the coracoclavicular ligament. Repair by polyester slings and suture hooks has similar strength, but 30% less stiffness.^[26] Despite satisfactory clinical outcomes, coracoid and clavicular erosions and infections have been reported following surgeries using nonabsorb-

able materials.^[27,28] The mechanical performance of the coracoclavicular screw is closest to that of the original ligament. The strength of the coracoclavicular screw is 80% greater than that of the original ligament when it is placed bicortically, compared to only half in unicortical placement,^[26] which indicates the critical importance of correct screw placement. In our cases, the screws were placed bicortically and efficiency of the fixation was always verified by fluoroscopy following the procedure. Since no original Bosworth screw was available, cortical screws were used in the first two patients. However, as both cases developed screw cut out, subsequent fixation procedures were carried out with cancellous screws. Only one of the patients treated with a cancellous screw developed subluxation. Loosening of the screw and recurrence of dislocation are among the most common complications of this treatment.^[29] Bektaşer et al.^[30] reported a recurrence rate of 8.8% in patients treated with the Bosworth technique. In addition, loss of coracoacromial fixation has been reported to be 16%.^[18,31,32] Only 60-87% of the cases with recurrent dislocations had satisfactory results.^[33] In cases with subluxation, no relationship has not been reported between the amount of subluxation and the outcome. Although some patients with subluxation may have complaints of mild pain and discomfort during follow-up,^[9] most patients have been reported to have good results without any adverse effect of subluxation.^[9,21,22] Similarly, no pain and restriction in movements were observed during the follow-up of our patients with subluxation.

Drilling the clavicle and the coracoid through the disrupted coracoclavicular ligaments enhances the biological response, i.e. biological fixation. It has been reported that residual bone dust which is produced during drilling of the clavicle and deposits between the clavicle and the coracoid during the placement of the screw contributes to bone healing. Furthermore, approximation of the ends of ruptured acromioclavicular ligaments enhances healing of these ligaments.^[34,35] Clayer et al.^[36] demonstrated the development of fibrosis in the coracoclavicular distance by magnetic resonance studies. In our cases, we inserted the screws after repair of the ruptured coracoclavicular ligaments with nonabsorbable sutures. The sutures were then tied following reduction of the acromioclavicular joint and fixation with a screw.

Despite biomechanical advantages, screw cut out, infection, and irritation under the head of the screw

have been reported with coracoclavicular screw fixation.^[18] However, no infection and irritation were observed in our series.

One limitation of the modified Bosworth technique is the need for a second surgical procedure for screw removal. Early removal of the screw to avoid breakage and the risk for recurrent deformity due to early removal should be very well balanced; otherwise, deformity may recur, which has been reported as high as 35%. Recommended screw removal is at eight weeks.^[15] In our series, all screws were removed at postoperative eight weeks under local anesthesia and no screw breakage was observed.

In conclusion, fixation with a cancellous screw in the surgical treatment of acromioclavicular joint dislocations is an effective method in achieving satisfactory shoulder functions, with ease of use, lower complication rate, and lower rate of acromioclavicular joint arthritis. The following recommendations can be put forward: (1) the disrupted ends of the ligaments should be identified and fixed with nonabsorbable sutures; (2) a cancellous screw should be used and it must be placed bicortically in the coracoid; (3) the screw should be removed at week 8; (4) a shoulder sling should be used in overweight and portly patients for a period of three weeks, while slim patients can be allowed to move their arms up to the shoulder level.

References

1. Bjerneld H, Hovelius L, Thorling J. Acromio-clavicular separations treated conservatively. A 5-year follow-up study. *Acta Orthop Scand* 1983;54:743-5.
2. Fukuda K, Craig EV, An KN, Cofield RH, Chao EY. Biomechanical study of the ligamentous system of the acromioclavicular joint. *J Bone Joint Surg [Am]* 1986;68:434-40.
3. Tossy JD, Mead NC, Sigmond HM. Acromioclavicular separations: useful and practical classification for treatment. *Clin Orthop Relat Res* 1963;(28):111-9.
4. Allman FL Jr. Fractures and ligamentous injuries of the clavicle and its articulation. *J Bone Joint Surg [Am]* 1967;49:774-84.
5. Rockwood CA Jr. Injuries to the acromioclavicular joint. In: Rockwood CA Jr, Green DP, editors. *Fractures in adults*. Vol. 1, 2nd ed. Philadelphia: JB Lippincott; 1984. p. 860-910, 974-82.
6. Collins DN. Disorders of the acromioclavicular joint. In: Rockwood CA Jr, Matsen FA III, Wirth MA, Lippitt SB, Fehring EV, Sperling JW, editors. *The shoulder*. Vol. 4, 4th ed. Philadelphia: Saunders Elsevier; 2009. p. 453-526.

7. Dias JJ, Steingold RF, Richardson RA, Tesfayohannes B, Gregg PJ. The conservative treatment of acromioclavicular dislocation. Review after five years. *J Bone Joint Surg [Br]* 1987;69:719-22.
8. Roper BA, Levack B. The surgical treatment of acromioclavicular dislocations. *J Bone Joint Surg [Br]* 1982;64:597-9.
9. Law KY, Yung SH, Ho PY, Chang HT, Chan KM. Coracoclavicular ligament reconstruction using a gracilis tendon graft for acute type-III acromioclavicular dislocation. *J Orthop Surg* 2007;15:315-8.
10. Berg EE. A preliminary report of acromioclavicular joint reconstruction with clavicular corticotomy. *J Shoulder Elbow Surg* 1995;4:135-40.
11. Fleming RE, Tornberg DN, Kiernan H. An operative repair of acromioclavicular separation. *J Trauma* 1978;18:709-12.
12. Lancaster S, Horowitz M, Alonso J. Complete acromioclavicular separations. A comparison of operative methods. *Clin Orthop Relat Res* 1987;(216):80-8.
13. Verhaven E, DeBoeck H, Haentjens P, Handelberg F, Casteleyn PP, Opdecam P. Surgical treatment of acute type-V acromioclavicular injuries in athletes. *Arch Orthop Trauma Surg* 1993;112:189-92.
14. Weinstein DM, McCann PD, McIlveen SJ, Flatow EL, Bigliani LU. Surgical treatment of complete acromioclavicular dislocations. *Am J Sports Med* 1995;23:324-31.
15. Bannister GC, Wallace WA, Stableforth PG, Hutson MA. The management of acute acromioclavicular dislocation. A randomised prospective controlled trial. *J Bone Joint Surg [Br]* 1989;71:848-50.
16. Rockwood CA Jr, Williams GR, Young DC. Injuries to the acromioclavicular joint. In: Rockwood CA Jr, Green DP, Buchholz RW, Heckmen JD, editors. *Rockwood and Green's fractures in adults*. Vol. 2, 4th ed. Philadelphia: JB Lippincott-Raven; 1996. p. 1341-413.
17. Grutter PW, Petersen SA. Anatomical acromioclavicular ligament reconstruction: a biomechanical comparison of reconstructive techniques of the acromioclavicular joint. *Am J Sports Med* 2005;33:1723-8.
18. Galpin RD, Hawkins RJ, Grainger RW. A comparative analysis of operative versus nonoperative treatment of grade III acromioclavicular separations. *Clin Orthop Relat Res* 1985;(193):150-5.
19. Bhattacharya R, Goodchild L, Rangan A. Acromioclavicular joint reconstruction using the Nottingham Surgilig: a preliminary report. *Acta Orthop Belg* 2008;74:167-72.
20. Bargren JH, Erlanger S, Dick HM. Biomechanics and comparison of two operative methods of treatment of complete acromioclavicular separation. *Clin Orthop Relat Res* 1978;(130):267-72.
21. Ejam S, Lind T, Falkenberg B. Surgical treatment of acute and chronic acromioclavicular dislocation Tossy type III and V using the Hook plate. *Acta Orthop Belg* 2008;74:441-5.
22. Salem KH, Schmelz A. Treatment of Tossy III acromioclavicular joint injuries using hook plates and ligament suture. *J Orthop Trauma* 2009;23:565-9.
23. Deshmukh AV, Wilson DR, Zilberfarb JL, Perlmutter GS. Stability of acromioclavicular joint reconstruction: biomechanical testing of various surgical techniques in a cadaveric model. *Am J Sports Med* 2004;32:1492-8.
24. Miller CA, Ong BC, Jazrawi LM, Joseph T, Heywood CS, Rosen J, et al. Assessment of clavicular translation after arthroscopic Mumford procedure: direct versus indirect resection-a cadaveric study. *Arthroscopy* 2005;21:64-8.
25. Rolla PR, Surace MF, Murena L. Arthroscopic treatment of acute acromioclavicular joint dislocation. *Arthroscopy* 2004;20:662-8.
26. Harris RI, Wallace AL, Harper GD, Goldberg JA, Sonnabend DH, Walsh WR. Structural properties of the intact and the reconstructed coracoclavicular ligament complex. *Am J Sports Med* 2000;28:103-8.
27. Neault MA, Nuber GW, Marymont JV. Infections after surgical repair of acromioclavicular separations with nonabsorbable tape or suture. *J Shoulder Elbow Surg* 1996;5:477-8.
28. Takagishi K, Yonemoto K, Tsukamoto Y. A cautionary note to treatment of complete acromioclavicular separation using artificial materials. *Orthop Int* 1996;4:343-7.
29. Pavlik A, Csépai D, Hidas P. Surgical treatment of chronic acromioclavicular joint dislocation by modified Weaver-Dunn procedure. *Knee Surg Sports Traumatol Arthrosc* 2001;9:307-12.
30. Bektaşer B, Bozkurt M, Öçgüder A, Solak Ş, Oğuz T. Tip III akromiyoklaviküler eklem çıkıklarının modifiye Bosworth tekniği ile cerrahi tedavisi. *Ulus Travma Acil Cerrahi Derg* 2004;10:245-9.
31. Pfahler M, Krödel A, Refior HJ. Surgical treatment of acromioclavicular dislocation. *Arch Orthop Trauma Surg* 1994;113:308-11.
32. Taft TN, Wilson FC, Oglesby JW. Dislocation of the acromioclavicular joint. An end-result study. *J Bone Joint Surg [Am]* 1987;69:1045-51.
33. Graupe F, Dauer U, Eyssel M. Late results of surgical treatment of Tossy III acromioclavicular joint separation with the Balsler plate. *Unfallchirurg* 1995;98:422-6. [Abstract]
34. Kennedy JC. Complete dislocation of the acromioclavicular joint: 14 years later. *J Trauma* 1968;8:311-8.
35. Kennedy JC, Cameron H. Complete dislocation of the acromioclavicular joint. *J Bone Joint Surg [Br]* 1954;36:202-8.
36. Clayer M, Slavotinek J, Krishnan J. The results of coracoclavicular slings for acromioclavicular dislocation. *Aust N Z J Surg* 1997;67:343-6.