

(41)

COPYRIGHT 2016 © BY THE ARCHIVES OF BONE AND JOINT SURGERY

**RESEARCH ARTICLE**

# Double-button Fixation System for Management of Acute Acromioclavicular Joint Dislocation

Ali Torkaman, MD; Abolfazl Bagherifard, MD; Tahmineh Mokhatri, PhD Student; Mohammad Hossein Shabanpour Haghighi, MD; Siamak Monshizadeh, MD; Hamid Taraz, MD; Amin Hasanvand, PhD Student

Research performed at Firouzgar Hospital, University of Medical Sciences, Tehran, Iran

Received: 6 August 2015

Accepted: 8 October 2015

**Abstract**

**Background:** Surgical treatments for acromioclavicular (AC) joint dislocation present with some complications. The present study was designed to evaluate the double-button fixation system in the management of acute acromioclavicular joint dislocation.

**Methods:** This cross sectional study, done between February 2011 to June 2014, consisted of 28 patients who underwent surgical management by the double-button fixation system for acute AC joint dislocation. Age, sex, injury mechanism, dominant hand, side with injury, length of follow up, time before surgery, shoulder and hand (DASH), constant and visual analogue scale (VAS) scores, and all complications of the cases during the follow up were recorded.

**Results:** The mean age of patients was 33.23±6.7 years. Twenty four patients (85.71%) were male and four (14.28%) were female. The significant differences were observed between pre-operation VAS, constant shoulder scores and post-operation measurements. There were not any significant differences between right and left coracoclavicular, but two cases of heterotrophic ossifications were recorded. The mean follow-up time was 16.17±4.38 months.

**Conclusion:** According to the results, the double-button fixation system for management of acute acromioclavicular joint dislocation has suitable results and minimal damage to the soft tissues surrounding the coracoclavicular ligaments.

**Keywords:** Acromioclavicular joint, Dislocation, Double-button fixation

**Introduction**

Acromioclavicular (AC) joint dislocation involves 12% of shoulder joint injuries and is usually caused by direct or indirect force (1). This type of injury can involve individuals of all age groups and is a common injury as a result of accidents related to traffic, sports (especially falls during skiing and in contact sports with an incidence of 41% among football players), military training, and falls (2-4).

Rockwood's classification (grades I to VI) is commonly used for grading the AC joint and is based on the degree of injuries (5, 6). Treatment of grade I and II AC joint

dislocations can be performed conservatively. However, surgical intervention is required for patients with grades III (especially individuals who are workers with heavy manual occupations, overhead throwing athletes, and so on) and IV-VI (because of their common characteristics including instability in the horizontal and vertical direction of both due to AC ligament and coracoclavicular (CC) ligament disruption (7, 8).

Numerous surgical techniques have been suggested to treat AC joint dislocation. These surgical techniques are described based on two goals: the ligament healing and ligament reconstruction. Ligament healing methods

**Corresponding Author:** Mohammadhossein Shabanpour Haghighi, Firuzgar Hospital, Iran University of Medical Sciences, Tehran, Iran  
Email: [dr.mh.shabanpour34@gmail.com](mailto:dr.mh.shabanpour34@gmail.com)



THE ONLINE VERSION OF THIS ARTICLE  
[ABJS.MUMS.AC.IR](http://abjs.mums.ac.ir)

endeavor to reduce the distance between the clavicle and coracoid, which leads to primary healing of the CC ligament. However, these methods are not suitable for chronic dislocations. In the second type of surgeries, CC ligament is reconstructed and is indicated in chronic dislocations (9, 10). Nevertheless, a gold standard has not been described for this injury, yet. According to the studies, the fixation of this type of injury is associated with non-anatomical restoration, trauma during surgery, and many complications resulting from the surgery (11-17). Although non-operative treatments are recommended for type III AC joint dislocations (18), results from recent studies have shown better functional outcomes for surgical treatments of this type of injury (19).

In this study, reconstruction of the normal anatomy of

the AC joint with the double-button fixation system in acute acromioclavicular joint dislocation was evaluated.

## Materials and Methods

### *Patients and inclusion criteria*

Patients who have undergone surgical management with the double-button fixation system for acute AC joint dislocation were evaluated in a cross sectional study done between February 2011 to June 2014, in Firouzgar Hospital (University of Medical Sciences, Tehran, Iran). Twenty-eight patients including 24 men and four women (age range: 22 to 48) were enrolled into the study.

To determination injury type three radiographic views were used: AP view (with 10 degrees cranial tilt

**Table 1.** characteristics of patients with acromioclavicular dislocation undergone

No	Age	Sex	Injury side	Injury mechanism	Dislocation grade	Period before the surgery (day)	follow up duration (month)
1	32	Male	Right	Accident	III	2	24
2	26	Male	Right	Accident	III	1	22
3	37	Male	Right	Falling	V	3	22
4	40	Male	Right	Falling	V	5	21
5	33	Male	left	Accident	III	2	20
6	28	Male	Right	Accident	V	3	20
7	41	Male	Right	Falling	V	4	19
8	35	Male	Right	Accident	IV	5	19
9	29	Male	Left	Accident	III	3	19
10	31	Male	Right	Accident	V	2	19
11	31	Female	Left	Accident	III	4	17
12	48	Male	Right	Accident	V	2	17
13	31	Male	Right	Accident	IV	3	17
14	27	Male	Right	Falling	III	5	16
15	26	Male	Left	Falling	III	4	15
16	33	Female	Left	Accident	III	2	15
17	35	Female	Right	Accident	V	3	14
18	48	Female	Right	Accident	V	3	22
19	44	Male	Right	Accident	III	2	18
20	31	Male	Left	Accident	III	2	10
21	25	Male	Right	Accident	V	1	12
22	28	Male	Right	Falling	IV	3	12
23	22	Male	Right	Accident	III	2	12
24	35	Male	Left	Falling	III	1	11
25	26	Male	Right	Falling	V	2	11
26	30	Male	Right	Accident	III	3	10
27	30	Male	Right	Accident	III	3	10
28	27	Male	Right	Accident	V	2	10

of the beam or Zanca view), true axillary view in the supine position and stress view of both sides of the AC joint and CC ligament). Inclusion criteria were: 1) all cases of acute AC joint and type III, IV or V dislocation according to the Rockwood classification (20), 2) no history of shoulder injuries and related operations, 3) follow up time more than 10 months. Type III cases were enrolled into the study if the distal end of the clavicle was located more or equal to 75 to 100% of its articular surface width in the radiographs and if painful palpation and protuberance shape of the clavicle during shoulder anterior raising in clinical diagnosis existed. All surgeries were performed by a senior surgeon and all subjects were operated on by the same double endobutton technique.

### **Surgical technique**

The stability of the shoulder and AC joint reduction was evaluated when the patient was placed in the beach chair position. All examinations were performed under local or general anesthesia. For controlling the infection, three doses of cephalosporin (second-generation) were administered for all patients. At first, the injured upper limb of the subject was prepped and draped in the normal sterile condition. For this purpose, the anatomical landmarks such as anterior portion of the acromion, distal clavicle, and coracoid process were used to determine the skin incision. A 4-6 cm skin incision was made after palpation of the coracoid process tip, and from the distance between the base of the coracoid process and 2.5 cm posterior to the AC joint was opened. Then the incision line was expanded on the subcutaneous tissue. Next, 2.5 cm to the AC joint the anterior deltoid muscle was split to ease the exposure of the coracoid process base.

Then the distance between coracoid process and distal part of the clavicle was split. The tissue was dissected medially and laterally by a curved soft tissue elevator. Lateral flap was continued to exposure the AC joint. In the first step, a 2.4 mm guide pin was placed in the central point of the base of the coracoid process. Then, the guide pin was carefully overdrilled by a 4.5 mm drill. In the next step, the center of the

distance between the anterior and posterior borders from the superior surface of the clavicle was drilled in the same condition and then the guide pin and drill were removed. At first, the Tight Rope device (Arthrex, Naples, FL) was inserted into the hole on the clavicle and then through the coracoid hole by a button inserter. Then, the first button was flipped and fixed under the base of the coracoid process by pulling one of the traction sutures. In this step, AC joint reduction was performed in the anatomical position under pressure using the fluoroscopic visualization. In this position, the second button was placed and fixed on the superior surface of the clavicle and finally, while an assistant held the reduction, the button was secured by about five knots. According to post-operative protocol, shoulder mobilization was checked.

### **Follow up**

For all cases, all information such as age, sex, mechanism of injury, dominant hand, side with injury, length of follow up and time before surgery were recorded. Shoulder and hand (DASH) (21), constant (22) and visual analogue scale (VAS) scores were recorded in pre-operation and post operation times and used for functional evaluations in follow up time. In addition, vertical distance between the superior border of the coracoid process and anterior-inferior border of the clavicle were calculated on the standard view of the anteroposterior radiographs (CC) on both sides in the last follow up. All complications from cases were recorded during the follow up period.

### **Statistical analysis**

Data were entered into the SPSS-16 software. For qualitative data, frequency, frequency percentage, mean and standard deviation (SD) were used. For comparing the pre- and post-operative quantitative data, the t-test was used.  $P$ -value $\leq$ 0.05 was considered the significance level.

### **Results**

In this study, 28 patients with acromioclavicular dislocation were enrolled into the study. Table 1

**Table 2.** Dash, VAS and constant shoulder scores of pre-operation and post-operation and CC of both sides

	Mean	SD*	Maximum	Minimum	P-value
Pre-Operation VAS	6.82	1.85	10.00	4.00	0.001
Post-Operation VAS	0.82	0.94	3.00	0.00	
Pre-Operation Constant Score	33.54	3.99	38.00	25.00	<0.001
Post-Operation Constant Score	89.36	7.59	100.00	72.00	
Pre-Operation DASH	20.79	5.03	30.00	13.23	<0.001
Post-Operation DASH	1.43	1.37	4.16	0.00	
CC** of injured limb (mm)	10.53	1.78	12.47	9.28	0.238
CC of normal limb (mm)	10.16	1.67	11.22	8.35	

\*SD: Standard deviation

\*\*CC: Vertical distance between superior border of coracoid process and anterior-inferior border of clavicle

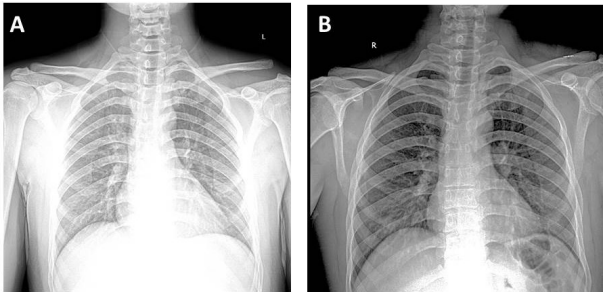


Figure 1. Anteroposterior view of the shoulder. A: pre-operation radiography, B: post-operation radiography in a patient with the double-button fixation system.

shows the characteristics of each patient. The mean age of patients was  $33.23 \pm 6.7$  years (range: 22 to 48 years). Twenty-four patients (85.71%) were male and four (14.28%) were female. The injury side was on the right side of 21 patients (75%) and on the left side of seven patients (25%). The mechanisms of injury were accident in 20 cases (71.42%) and falling in eight cases (28.57%). Dislocation was grade III for 14 cases (58.33%), grade IV for three cases (10.71%) and grade V for 11 cases (39.28%). The mean time of hospitalization before the surgery was  $2.7 \pm 1.4$  days (range: 1 to 5 days) and the mean time of follow-up was  $16.17 \pm 4.38$  months (range: 10 to 24 months). In Table 2, the mean and SD for pre- and post-operation VAS, Dash, constant shoulder scores and CC of both sides are shown. Mean pre-operative VAS was  $6.82 \pm 1.85$  and mean post-operative VAS was  $0.82 \pm 0.94$ . There was a significant difference in the pre- and post-operative VAS scores ( $P=0.001$ , Table 2). In addition, the mean pre- and post-operative constant scores were  $33.54 \pm 3.99$  and  $89.36 \pm 7.59$ , respectively. There was a significant difference in the pre- and post-operative constant scores ( $P<0.001$ , Table 2). Mean pre- and post-operative Dash were  $20.79 \pm 5.03$  and  $1.43 \pm 1.37$ , respectively and there was a significant difference in these scores ( $P<0.001$ , Table 2). However, there were not any significant differences between the right and left CC ( $P=0.238$ , Table 2). The pre- and post-operative radiographic results of a patient with double-button fixation system are shown in Figure 1. During the follow-up, two cases with heterotrophic ossifications were recorded.

## Discussion

Different methods were suggested to manage acute AC joint dislocation. More than 70 methods have been suggested for management of complete AC joint separation (23). However, according to the literature the rate of complications is high with these methods. Other techniques such as Kirschner wires, pins, screws or hook plates are also used to manage AC joint dislocation (24-27). Restoring the normal physiology of the AC joint by reducing the dislocation and stabilizing the distal part of the clavicle and making an environment for tissue reconstruction is the most important goal for all methods. But ineffectiveness has

been shown for these methods. Because using the pin or cerclage as a temporary fixation has a high incidence of degenerative changes, breaking of the pins, and instrument migration into the thorax and bony lesions, so these methods have not been suggested for long term treatment (28-30).

Nowadays, older methods such as the coracoid process transfer with conjoined tendon attachment or Bosworth CC screw fixation are rarely used. According to studies, the coracoid process transfer technique cannot provide stability to the AC joint and is with some risks such as musculocutaneous nerve injury, screw breakdown or loss of fixation and nonunion of the coracoid. Bosworth technique with repairing CC ligament for management of the acute AC joint dislocation was popularized by Rockwood et al. In this method, screw removal was suggested eight to 10 weeks after surgery for CC ligament healing. Complications such as ossification, osteolysis, and screw loosening or breakage were recorded for the Bosworth technique in the follow up of the patients (31).

The CC ligament plays an important role in restraining force to the vertical translation and horizontal limitation is applied by the joint capsule and AC ligament. The biomechanics of CC ligament complex has been studied in previous researches and their results have shown the unique role of this complex in the anterior and superior displacement of the clavicle (32, 33). In some techniques sutures were used to reduce the distance between AC joint dislocations. However, sutures can have sawing effects and lead to failure of these techniques (23, 34). For AC joint reconstruction, Ponce et al. (2004) used nine NO. 1 absorbable sutures wrapped in a tension cable cord fashion and tendon autograft was performed for athletics and revision cases for augmentation fixation (35).

In the present study, 28 patients with AC joint dislocation who underwent surgical treatment by the double endobutton technique were evaluated. In this technique, two titanium buttons with sutures were used on the superior and inferior sides. Subsequently, the load on the joint was disturbed equally; therefore, preventing the sawing effects of the sutures.

According to the Dash, VAS, and constant shoulder score results, this technique has suitable results for patients with AC joint dislocation. Post-operative Dash and VAS scores were lower and constant shoulder score was higher than pre-operation results. This showed the patients were satisfied with this technique. During the follow-up, two cases of heterotrophic ossification were recorded.

In a similar study, Beris et al. (2013) used a double-button fixation system to manage acute acromioclavicular joint dislocation. They studied 12 patients and DASH, Constant and the VAS scores and CC distance was used for their evaluations. AC joint osteoarthritis, CC calcification or osteolysis of the distal clavicle or the coracoid process was not recorded. The mean constant score was higher than the mean pre-operative value of 34.4 and the mean DASH score decreased at the last follow-up. The mean VAS



score decreased and the mean CC distance from the operated shoulder was similar to the CC distance from the normal side (36). Their results confirm the result of the present study.

Shin et al. (2015) studied the post-operative complications from arthroscopic CC reconstruction using a single adjustable-loop length suspensory fixation device in 18 patients with acute AC joint dislocation. Their results showed satisfactory clinical outcomes after surgery. In radiological examinations, CC fixation failure of greater than 50% of the unaffected side was recorded for 33% of the patients within three months after the surgery. Surgical technical problems and complications associated with the adjustable-loop-length suspensory fixation device were reported in eight patients (44%) (37).

According to the results of the present study, the double-button fixation system does minimal damage to the soft tissues surrounding the CC ligaments and is a suitable technique for the management of acute acromioclavicular joint dislocation.

Ali Torkaman MD  
Mohammad Hossein Shabanpour Haghighi MD  
Siamak Monshizadeh MD  
Hamid Taraz MD  
Firuzgar Hospital, Iran University of Medical Sciences,  
Tehran, Iran

Abolfazl Bagherifard MD  
Shafa Orthopedic Hospital, Iran University of Medical  
Sciences, Tehran, Iran

Tahmineh Mokhatri PhD Student  
Department of Anatomy, School of Medicine, Tehran  
University of Medical Sciences, Tehran, Iran

Amin Hasanvand PhD Student  
Department of Pharmacology, School of Medicine,  
International Campus, Tehran University of Medical Sciences  
(IC-TUMS), Tehran, Iran  
Departments of Pharmacology, School of Medicine, Tehran  
University of Medical Sciences, Tehran, Iran

## References

- Collins DN. Disorders of the acromioclavicular joint. In: Rockwood Jr CA, editor. The shoulder. 4th ed. Philadelphia: Elsevier Health Sciences; 2009. P. 453-526.
- Mazzocca AD, Arciero RA, Bicos J. Evaluation and treatment of acromioclavicular joint injuries. *Am J Sports Med.* 2007; 35(2):316-29.
- Babhulkar A, Pawaskar A. Acromioclavicular joint dislocations. *Cur Rev Musculoskeletal Med.* 2014; 7(1):33-9.
- Verdano M, Pellegrini A, Zanelli M, Paterlini M, Ceccarelli F. Modified Phemister procedure for the surgical treatment of Rockwood types III, IV, V acute acromioclavicular joint dislocation. *Musculoskeletal Surg.* 2012; 96(3):213-22.
- Rockwood CA, Williams GR, Young D. Disorders of the acromioclavicular joint. In: Rockwood CA, Matsen FA, editors. The shoulder. 2th ed. Philadelphia: WB Saunders; 1998. P. 483-553.
- MacDonald PB, Lapointe P. Acromioclavicular and sternoclavicular joint injuries. *Orthop Clin North Am.* 2008; 39(4):535-45.
- Pan Z, Zhang H, Sun C, Qu L, Cui Y. Arthroscopy-assisted reconstruction of coracoclavicular ligament by Endobutton fixation for treatment of acromioclavicular joint dislocation. *Arch Orthop Trauma Surg.* 2015; 135(1):9-16.
- Iannotti JP, Williams GR. Disorders of the shoulder: diagnosis and management. 2th ed. Philadelphia: Lippincott Williams & Wilkins; 2007. P. 979-1006.9.
- Mazzocca AD, Santangelo SA, Johnson ST, Rios CG, Dumonski ML, Arciero RA. A biomechanical evaluation of an anatomical coracoclavicular ligament reconstruction. *Am J Sports Med.* 2006; 34(2):236-46.
- Virtanen KJ, Remes VM, Tulikoura IT, Pajarinen JT, Savolainen VT, Björkenheim JM, et al. Surgical treatment of Rockwood grade-V acromioclavicular joint dislocations: 50 patients followed for 15-22 years. *Acta Orthop.* 2013; 84(2):191-5.
- Di Francesco A, Zoccali C, Colafarina O, Pizzoferrato R, Flamini S. The use of hook plate in type III and V acromio-clavicular Rockwood dislocations: clinical and radiological midterm results and MRI evaluation in 42 patients. *Injury.* 2012; 43(2):147-52.
- Leidel BA, Braunstein V, Kirchhoff C, Pilotto S, Mutschler W, Biberthaler P. Consistency of long-term outcome of acute Rockwood grade III acromioclavicular joint separations after K-wire transfixation. *J Trauma.* 2009; 66(6):1666-71.
- Huang TW, Hsieh PH, Huang KC, Huang KC. Suspension suture augmentation for repair of coracoclavicular ligament disruptions. *Clin Orthop Relat Res.* 2009; 467(8):2142-8.
- Kim SH, Lee YH, Shin SH, Lee YH, Baek GH. Outcome of conjoined tendon and coracoacromial ligament transfer for the treatment of chronic type V acromioclavicular joint separation. *Injury.* 2012; 43(2):213-8.
- Karlsson J, Arnarson H, Sigurjonsson K. Acromioclavicular dislocations treated by coracoacromial ligament transfer. *Arch Orthop Traum Surg.* 1986; 106(1):8-11.
- De Baets T, Truijen J, Driesen R, Pittevels T. The

- treatment of acromioclavicular joint dislocation Tossy grade III with a clavicle hook plate. *Acta Orthop Belg.* 2004; 70(6):515-9.
17. Habernek H, Weinstabl R, Schmid L, Fialka C. A crook plate for treatment of acromioclavicular joint separation: indication, technique, and results after one year. *J Trauma.* 1993; 35(6):893-901.
  18. Phillips AM, Smart C, Groom AF. Acromioclavicular dislocation: Conservative or surgical therapy. *Clin Orthop Relat Res.* 1998; 353(2):10-7.
  19. Gstettner C, Tauber M, Hitzl W, Resch H. Rockwood type III acromioclavicular dislocation: surgical versus conservative treatment. *J Shoulder Elbow Surg.* 2008; 17(2):220-5.
  20. Swanik KA, Lephart SM, Swanik CB, Lephart SP, Stone DA, Fu FH. The effects of shoulder plyometric training on proprioception and selected muscle performance characteristics. *J Shoulder Elbow Surg.* 2002; 11(6):579-86.
  21. De Smet L. The DASH questionnaire and score in the evaluation of hand and wrist disorders. *Acta Orthop Belg.* 2008; 74(5):575-81.
  22. Constant CR, Murley AH. A clinical method of functional assessment of the shoulder. *Clin Orthop Relat Res.* 1987; 214(12):160-4.
  23. Dimakopoulos P, Panagopoulos A, Syggelos SA, Panagiotopoulos E, Lambiris E. Double-loop suture repair for acute acromioclavicular joint disruption. *Am J Sports Med.* 2006; 34(7):1112-9.
  24. Koukakis A, Manouras A, Apostolou CD, Lagoudianakis E, Papadima A, Triantafillou C, et al. Results using the AO hook plate for dislocations of the acromioclavicular joint. *Expert Rev Med Devices.* 2008; 5(5):567-72.
  25. Mlasowsky B, Brenner P, Düben W, Heymann H. Repair of complete acromioclavicular dislocation (Tossy stage III) using Balser's hook plate combined with ligament sutures. *Injury.* 1988; 19(4):227-32.
  26. Paavolainen P, Björkenheim JM, Paukku P, Slätis P. Surgical treatment of acromioclavicular dislocation: a review of 39 patients. *Injury.* 1983; 14(5):415-20.
  27. Hellmich A, Sievers U. Operative repair of acromioclavicular separation via transcutaneous Kirschner wire fixation: results of follow-up examinations in 45 patients. *Aktuelle Traumatol.* 1988; 18(3):9-13.
  28. Mazet R. Migration of a Kirschner wire from the shoulder region into the lung. *J Bone Joint Surg.* 1943; 25(2):477-83.
  29. Norrell H Jr, Llewellyn RC. Migration of a threaded Steinmann pin from an acromioclavicular joint into the spinal canal. *J Bone Joint Surg Am.* 1965; 47(5):1024-6.
  30. Lindsey RW, Gutowski WT. The migration of a broken pin following fixation of the acromioclavicular joint. A case report and review of the literature. *Orthopedics.* 1986; 9(3):413-6.
  31. Bosworth BM. Acromioclavicular separation. New method of repair. *Surg Gynecol Obstet.* 1941; 73(1):866-71.
  32. Costic RS, Labriola JE, Rodosky MW, Debski RE. Biomechanical rationale for development of anatomical reconstructions of coracoclavicular ligaments after complete acromioclavicular joint dislocations. *Am J Sports Med.* 2004; 32(8):1929-36.
  33. Harris RI, Vu DH, Sonnabend DH, Goldberg JA, Walsh WR. Anatomic variance of the coracoclavicular ligaments. *J Shoulder Elbow Surg.* 2001; 10(6):585-8.
  34. Wellmann M, Zantop T, Weimann A, Raschke MJ, Petersen W. Biomechanical evaluation of minimally invasive repairs for complete acromioclavicular joint dislocation. *Am J Sports Med.* 2007; 35(6):955-61.
  35. Ponce BA, Millett PJ, Warner JJ. Acromioclavicular joint instability—reconstruction indications and techniques. *Oper Tech Sports Med.* 2004; 12(1):35-42.
  36. Beris A, Lykissas M, Kostas-Agnantis I, Vekris M, Mitsionis G, Korompilias A. Management of acute acromioclavicular joint dislocation with a double-button fixation system. *Injury.* 2013; 44(3):288-92.
  37. Shin SJ, Kim NK. Complications after arthroscopic coracoclavicular reconstruction using a single adjustable-loop-length suspensory fixation device in acute acromioclavicular joint dislocation. *Arthroscopy.* 2015; 31(5):816-24.