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ORIGINAL STUDY

Functional and radiological outcome after arthroscopic and open acromioclavicular stabilization using a double-button fixation system

Saartje DEFOORT, Olivier VERBORGT

From AZ St. Lucas, Brugge, Belgium

The aim of this study was to determine the functional outcome and radiological results after open and arthroscopic stabilization of the acromioclavicular joint using a double-button fixation system.

We reviewed 16 patients that were surgically treated for acromioclavicular dislocation using a double-button fixation system. An arthroscopic technique was used in 9 patients for acute injuries and an open technique in 7 patients for subacute or chronic lesions. Mean follow-up was 17 months (range : 6-26 months). The mean DASH score post-operatively was 2.29 (range : 0-5.83), VAS score was 0.82 (range : 0-2) and SSV averaged 90.5 % (range : 80-95%). Radiologically the reduction of the acromioclavicular joint was complete in 10 patients. A clinically stable residual subluxation was present in 5 patients. Only one patient experienced a redislocation after new trauma and needed revision surgery.

Operative treatment of grade 3 and 4 acromioclavicular dislocations, using a double button coracoclavicular fixation system, yielded good functional results with full return to work and recreational activities. Arthroscopic coracoclavicular fixation without CA ligament transfer should be reserved for acute injuries within 2 weeks after the trauma.

Keywords : acromioclavicular joint ; stabilisation ; double button fixation system.

INTRODUCTION

Acromioclavicular (AC) joint dislocation is a common shoulder injury that often occurs by a direct force after falling on the point of the shoulder with the arm adducted or with an extended and adducted arm, mostly during sports activities. Grade III in athletic patients and unstable grade IV AC dislocations are often surgically treated, but the surgical technique remains a topic of debate. Open (*3,4,6,14,19, 21,22,25,27,29-31,35,39*) and arthroscopic (*2,5,7,9,18,20, 26,28,32-37,43*) techniques using various types of fixation have been described with variable success rates. Hardware failure and/or need for removal, loss of reduction or impaired functional outcome have been reported for both open and arthroscopic techniques (*4-7,13,14,18,19,21,22,25-31,39,41*). Although promising surgical techniques and fixation devices have been developed, outcome reports (*5,7,26*) remain scarce. The aim of this study was to determine the functional outcome and radiological results after arthroscopic and mini-open repair of grade III and IV AC dislocation, using a double-button system.

MATERIALS AND METHODS

We prospectively followed 16 consecutive patients who underwent surgical stabilization (between 2006 and 2008) for a traumatic AC dis-

■ Saartje Defoort, MD, resident.
■ Olivier Verborgt, MD, PhD, orthopaedic surgeon.
Orthopaedic department , AZ St. Lucas, Brugge, Belgium.
Correspondence : O. Verborgt, AZ St. Lucas, St-Lucas-laan 29, 8310 Brugge, Belgium.
E-mail : olivier.verborgt@telenet.be
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location grade III (6 cases) or grade IV (10 cases) according to the Rockwood classification. Patients with a history of previous shoulder complaints or those with associated injuries were excluded. The mean follow-up was 17 months (range : 6-26 months). The mean age was 39.6 years (range : 20-54.9), 14 were male and 2 were female. There were 11 right and 5 left shoulders. There were different types of trauma : 11 cases were sports related (4 skiing accidents, 4 bicycle accidents, 1 soccer injury and 2 falls from a horse), 2 traffic accidents, 2 domestic accidents and 1 occupational accident.

Assessment

Functional outcome was assessed with the DASH (Disability of Arm, Shoulder and Hand) scoring system (*8*), Visual analogue scale (VAS) score and subjective shoulder value (SSV) (*12*), by an independent observer (SD). A standard radiograph was assessed immediately after surgery and at the time of the last follow-up. The AP view of the AC joint was evaluated for reduction of the AC joint and hardware position.

Statistical analysis

The Wilcoxon signed-rank test was used to compare the clinical outcome of the arthroscopic group with the mini-open group, with a p-value of < 0.05 considered as significant.

Operative procedure

All surgeries were performed by the same surgeon (OVB) using a double-button coraco-clavicular fixation system (TightRope, Arthrex, Naples, USA). This system is composed of an upper round button and a lower oblong button joined by a continuous loop of n°5 Fiber Wire (Arthrex, Naples, USA). The oblong button has preloaded traction sutures to aid for traction and correct positioning of the button underneath the coracoid. An arthroscopic technique was used in 9 patients with an acute injury (< 2 weeks after trauma) ; open reconstruction was performed in 7 patients with subacute (> 2 weeks, < 3 months) or chronic lesions (> 3 months). The arthroscopic procedure consisted of closed reduction of the AC joint and arthroscopic coraco-clavicular fixation using the double-button device. In the open procedure, an open reduction and coraco-clavicular fixation using the same device was performed in conjunction with distal clavicle excision and coracoacromial ligament transfer, according to Weaver and Dunn (*38*).

Arthroscopic technique

The patient was positioned in the beach chair position with the arm resting on an arm holder. Two classical portals were used : the posterolateral as viewing portal and an anterior portal through the rotator interval as a working portal. First the rotator interval was opened using a radiofrequency device (VAPR, Depuy Mitek), until visualization of the coracoid and attached conjoined tendon. The antero-inferior undersurface of the coracoid process was freed of all soft tissues. Through the anterior portal, a specific aiming device was inserted underneath the coracoid. The tip was placed in the middle of the undersurface of the coracoid. A small skin incision was created over the lateral end of the clavicle, and the proximal part of the aiming guide was positioned at approximately 2 cm medial to the AC joint. The AC joint was then manually reduced and a smooth K-wire was drilled through the aiming device, going from proximal through the clavicle to distal through the coracoid. Once the K-wire was visualized underneath the coracoid, the guide was removed. The K-wire was overdrilled with a 4.0 mm cannulated drill bit to create the bony tunnels in the clavicle and coracoid. With the use of a flexible guide wire, the double-button was passed first with the oblong metal button through the clavicle and through the coracoid. Once past the coracoid, the button was flipped to the horizontal position by pulling one of two traction sutures. The second round button was advanced until contact with the upper surface of the clavicle. In the reduced position the suture tails were tensioned and ends were secured with a non-sliding knot.

Mini-Open procedure

A straight 4 cm skin incision was made extending from the distal end of the clavicle towards the coracoid process. Meticulous dissection and identification of the torn AC joint capsule was done and a resection of 5-10 mm of the lateral portion of the clavicle was performed using an oscillating saw. Limited opening of the delto-pectoral interval further down distally exposed the coraco-acromial ligament which was released sharply from the acromial side at its maximal length. The ligament was then prepared with a Krakow stitch at the free end and tagged. Small transosseous 1.6mm holes were drilled at 3 mm from the cut end of the lateral clavicle, exiting into the medullary canal, important for fixation of the CA ligament. Under direct visualization, the bony tunnels through clavicle and coracoid were drilled in separate steps. This was done using a smooth K wire and subsequent overdrilling of the K wire with a 4.0 mm cannulated drill. Using a nitinol passing wire, the double-button device was passed first with the oblong metal button through the clavicle and through the coracoid. Once past the coracoid the button was flipped to the horizontal position by pulling one of two traction sutures. The second round button was advanced until contact with the upper surface of the clavicle. Before tensioning the double button device, the prepared CA ligament was transferred to the distal end of the clavicle and the sutures were passed trans-osseous through the upper side of the distal clavicle. Firmly holding the AC joint reduced, now the double button device was tensioned and the ends were secured with a locking knot. Then the trans-osseous sutures of the transferred CA ligament were tied to each other and additionally tied to the sutures of the double button device, laying the knot as flat as possible. Finally the AC joint capsule was repaired with non-absorbable sutures and the delto-trapezial fascia was repaired with absorbable sutures using mattress stitches.

Postoperative management

All patients used an adduction sling for a period of 4 weeks for comfort. Immediate passive and actively assisted range of motion exercises were allowed. Strengthening exercises were only allowed from three months postoperatively.

Table I. — Clinical results

	All (n = 16)	Arthroscopic (n = 9)	Mini-open (n = 7)	p
Grade III	6	2	4	
Grade IV	10	7	3	
DASH	2.29 (0-5.83)	1.11	3.95	0.02*
VAS	0.8 (0-2)	0.6	1.5	0.01*
SSV	90 (80-95%)	92	86	0.03*
Return to work	16	9	7	

RESULTS

Clinical Results (table I)

The mean DASH score at final follow-up was 2.29 (range : 0-5.83). The mean VAS score was 0.8 (range : 0-2). The subjective shoulder value (SSV) averaged 90% (range : 80-95%). Patient satisfaction was very high and all would go through the same operation again if needed. All but one AC joints were clinically stable and these patients returned to preoperative levels of work and recreational activities. One patient from the arthroscopic group had recurrent instability after a new trauma 4 months after the index operation and needed revision surgery.

The clinical outcome, when comparing Dash score ($p = 0.02$), VAS score ($p = 0.01$) and SSV ($p = 0.03$), was significantly better for the arthroscopic group than for the mini-open group.

Radiological Results (table II)

Radiological assessment in the immediate postoperative period showed in all cases complete reduction of the AC joint in both groups. The double-button device was positioned correctly in all

Table II. — Radiological results

	All (n = 16)	Arthroscopic (n = 9)	Mini-open (n = 7)
Complete reduction	10	4	6
Recurrent subluxation (< 1 cm)	5	4	1
Redislocation (> 1 cm)	1	1	0

Fig. 1. — (a) Post-operative radiograph after arthroscopic AC stabilisation of a left shoulder showing anatomical reduction of the AC joint and correct position of the double-button system. (b) Post-operative radiograph after arthroscopic AC stabilisation of a right shoulder showing recurrent subluxation of the AC joint and intracortical migration of the upper (small) button.

patients. At final follow-up, 10 patients showed complete reduction of the AC joint (fig 1a). In 5 patients there was a recurrent subluxation (< 1 cm) (fig 1b). This subluxation occurred in 4 cases from the arthroscopic group and 1 case from the mini-open group. In 4 of these patients, the proximal button had slightly eroded into the upper border of the clavicle. The patient that had a recurrent instability showed a complete redislocation (> 1cm) after a new trauma , with the proximal button that had migrated into the clavicular tunnel.

Complications

There were no infections or nerve injuries. No revisions were needed due to hardware related problems. There were no signs of periarticular calcifications or AC joint degenerative changes.

DISCUSSION

Surgical treatment of AC dislocations grade III and IV remains challenging and many different techniques using different types of fixation have been described (*3,13,17,19,21,22,27,35,36,39*). Both AC joint fixation and coracoclavicular fixation techniques belong to the treatment strategy and depend on the timing of the surgery after the injury and on the surgeon's preference.

Biomechanical studies have shown that the coraco-clavicular ligaments contribute approximately two thirds of the restraining force to superior displacement (*11,13,15,23,24,27*). In particular, the conoid ligament has a primary role in restraining anterior and superior translation and displacement of the clavicle, especially under high loads, whereas the function of the trapezoid ligament is less important. These findings support surgeons' attention to coracoclavicular fixation in the treatment of unstable AC dislocations. In acute cases, primary healing of the native coraco-clavicular ligaments may occur and simple AC joint or coraco-clavicular fixation may be sufficient. Open procedures with AC joint fixation using transarticular pinning and hook plates, or coracoclavicular fixation using screws, synthetic loop bands, cerclage wires, and braided nonabsorbable large sutures have been reported with variable results in acute AC dislocations (*4,6,14,19,21,22,25,27,29-31,39*). The need for hardware removal, hardware failure due to Gigli saw effect of sutures and loop bands with secondary loss of fixation have been described as possible complications (*42*). Recently, arthroscopic techniques have been developed to improve these results with better cosmesis and earlier return to normal function (*2,5,7,9,18,20,26,28,32-36,43*). Advantages of an arthroscopic technique are better visualization of the coracoid for optimal fixation and less damage to the soft tissues surrounding the CC ligaments and therefore less interference with the primary ligament healing. The theoretical advantage of having the possibility to diagnose and treat associated glenohumeral pathology, as sug-

gested by Murena *et al* (*26*), remains controversial and could not be confirmed by our experience and other reports in the literature. The arthroscopic technique of coracoclavicular fixation using a double button device has been reported by a few authors (*5,17,33,41,44*). We now report excellent functional outcome and patient satisfaction after this procedure in acute, grade III and IV AC dislocations. However, the first generation of this device consisted of a smaller, round proximal button that could erode the clavicle and therefore lead to loss of reduction (*4,18,26*). Since a bigger proximal button was developed, no erosion or failure occurred in our series. The titanium buttons, positioned centrally on top of the clavicle and under the coracoid, connected with a continuous loop of n°5 Fiberwire sutures makes the construct stronger than the native CC ligament and AC joint complex and provides strong maintenance of reduction with homogeneous distribution of load on the bone surface, which protects against the sawing effect of the sutures, that has been described as the mechanism of failure in other techniques using anchors and sutures (*36,42*). Accurate positioning of the bony tunnels and buttons centrally on the clavicle and under the coracoid process are cardinal for solid fixation. Malpositioning of the clavicular (too anterior) or the coracoid button (too lateral) may lead to asymmetric loading and cutout of the fixation device. Recently, Lim *et al* (*44*) and Wellmann *et al* (*40*) have recommended the use of a double bundle reconstruction system, in order to better reconstruct normal CC ligament complex, consisting of conoid (posteromedial) and trapezoid (anterolateral) ligament. Cost-effectiveness of this technique needs to be further investigated.

In subacute or chronic cases, primary healing of the CC ligaments is insufficient and ligament replacement is necessary. Also, the AC joint is often severely damaged and an additional distal clavicle resection is advisable to avoid further AC arthritis pain. This has been treated for a long time using the Weaver Dunn technique, with transfer of the coracoacromial (CA) ligaments to the distal end of the clavicle combined with a resection of the lateral clavicle as described by Mumford. In order to protect the CA ligament transfer, a strong coracoclavicular fixation is advisable, since the load to failure of the native AC joint complex has been reported to be 815 N, whereas it is only 483 N for the Weaver-Dunn procedure. Bhattacharya *et al* reported encouraging preliminary results in chronic cases using a strong, artificial ligament that serves as a loop fixation between clavicle and coracoid (*3*). Similarly, the use of the double-button device provides a strong construct that protects the CA ligament transfer and allows early range of motion and early rehabilitation. At this moment, we prefer to do this using a mini-open technique since it is technically easier and faster and it allows to repair the delto-trapezial fascia at the end of the procedure, which has been shown to be an important secondary stabilizer of the AC joint. However, arthroscopic techniques of CA ligament transfer or ligament grafting using tendon grafts (*2,9,23,35*) are promising and further development may lead to better results and reproducible procedures. In our study, the clinical outcome (DASH score, VAS score and SSV) of the patients that were treated in an acute phase using the arthroscopic technique was better than the outcome of the patients that were treated in a chronic stage using the mini-open technique. This may suggest that AC dislocations needing surgical treatment are better treated acutely, since an arthroscopic technique without distal clavicle excision and CA ligament transfer may be used in that stage. Limitations of this study are the relative small number of included patients, absence of controls and of pre-operative clinical assessment. However, we have prospectively followed a homogeneous group of patients that were assessed by an independent observer and the results have shown consistent good functional and radiological outcome and have led us to use this double-button fixation technique as the gold standard.

In this study, coracoclavicular fixation using a double-button device yielded good clinical results after AC dislocations grade III and IV. In an acute setting this can be performed arthroscopically, while for subacute and chronic cases a mini-open technique with additional CA ligament transfer and distal clavicle resection is our preferred procedure.

REFERENCES

1. **Barber FA, Herbert MA, Richards DP**. Sutures and suture anchors: Update 2003. *Arthroscopy* 2003 ; 19 : 985-990.
2. **Baumgarten KM, Altech DW, Cordasco FA.** Arthroscopically assisted acromioclavicular joint reconstruction. *Arthroscop*y.2006 ; 22 : 228.e1-228.e6.
3. **Bhattacharya R, Goodchild L, Rangan A.** Acromioclavicular joint reconstruction using the Nottingham Surgilig : A preliminary report. *Acta Orthop Belg* 2008 ; 74 : 167-172.
4. **Bishop JY, Kaeding C**. Treatment of the acute traumatic acromioclavicular separation. *Sports Med Arthrosc Rev* 2006 ; 14 : 237-244.
5. **Boileau P, Old J, Gastaud O, Brassart N, Roussanne Y.** All-arthroscopic Weaver-Dunn-Chuinard procedure with double-button fixation for chronic acromioclavicular joint dislocation. *Arthroscopy* 2010 ; 26 : 149-160.
6. **Carofino BC, Mazzocca AD.** The anatomic coracoclavicular ligament reconstruction : Surgical technique and indications. *J Shoulder Elbow Surg* 2010 ; 19 : 37-46.
7. **Chernchujit B, Tischer T, Imhoff AB.** Arthroscopic reconstruction of the acromioclavicular joint disruption : surgical technique and preliminary results. *Arch Orthop Trauma Surg* 2006 ; 126 : 575-581.
8. **De Smet L.** The DASH questionnaire and score in the evaluation of hand and wrist disorders. *Acta Orhop Belg* 2008 ; 74 : 575-581.
9. **DeBerardino Th, Pensak MJ, Ferreira J, Mazzocca AD.** Arthroscopic stabilization of acromioclavicular joint dislocation using the AC graftrope system. *J Shoulder Elbow Surg* 2010 ; 19 : 47-52.
10. **Fraser-Moodie JA, Shortt NL, Robinson CM**. Injuries to the acromioclavicular joint, aspects of current management. *J Bone Joint Surg* 2008 ; 90-B : 697-707.
11. **Fukuda K, Craig EV, An KN, Cofield RH, Chao EY.** Biomechanical study of the ligamentous system of the acromioclavicular joint. *J Bone Joint Surg* 1986 ; 68-A : 434-440.
12. **Gilbart MK, Gerber C.** Comparison of the subjective shoulder value and the Constant score. *J Shoulder Elbow Surg* 2007 ; 16 : 717-721.
13. **Grutter PW, Petersen SA.** Anatomical acromioclavicular ligament reconstruction : a biomechanical comparison of reconstructive techniques of the acromioclavicular joint. *Am J Sports Med* 2005 ; 33 : 1723-1728.
14. **Gstettner C, Tauber M, Hitzl W, Resch H.** Rockwood type III acromioclavicular dislocation : Surgical versus conservative treatment. *J Shoulder Elbow Surg* 2008 ; 17 : 220-225.
15. **Harris RI, Wallace AL, Harper GD**. Structural properties of the intact and the reconstructed coracoclavicular ligament complex. *Am J Sports Med* 2000 ; 28 : 103-108.
16. **Harvey A, Thomas NP, Amis AA**. Fixation of the graft in reconstruction of the anterior cruciate ligament. *J Bone Joint Surg* 2005 ; 87-B : 593-603.
17. **Hernegger GS, Kadletz R.** TightRope. The revolutionary anatomical fixation in acromioclavicular joint dislocation. A case report. *Tech Shoulder Elbow Surg* 2006 ; 7 : 86-88.
18. **Hosseini H, Friedmann S, Tröger M, Lobenhoffer P, Agneskirchner JD.** Arthroscopic reconstruction of chronic AC joint dislocations by transposition of the coraco-acromial ligament augmented by the Tight Rope device : a technical note. *Knee Surg Sports Traumatol Arthrosc* 2009 ; 17 : 92-97
19. **Kwon YW, Iannotti JP.** Operative treatment of acromioclavicular joint injuries and results. *Clin Sports Med* 2003 ; 22 : 291-300.
20. **Lafosse L, Baier GP, Leuzinger J.** Arthroscopic treatment of acute and chronic acromioclavicular joint dislocation. *Arthroscopy* 2005 ; 21 : 1017.e1-1017.e8.
21. **Lancaster S, Horowitz M, Alonso J.** Complete acromioclavicular separation : A comparison of operative methods. *Clin Orthop Relat Res* 1987 ; 216 : 80-88.
22. **Law K, Yung S, Ho P, Chang HT, Chan KM.** Coracoclavicular ligament reconstruction using a gracilis tendon graft for acute type III acromioclavicular dislocation. *J Orthop Surg* 2007 ; 15 : 315-318.
23. **Lee SJ, Nicholas SJ, Akizuki KH *et al*.** Reconstruction of the coracoclavicular ligaments with tendon grafts : A comparative biomechanical study. *Am J Sports Med* 2003 ; 31 : 648-655.
24. **Mazzocca AD, Santangelo SA, Johnson ST *et al***. A biomechanical evaluation of an anatomical coracoclavicular ligament reconstruction. *Am J Sports Med* 2006 ; 34 : 236-246.
25. **Millet PJ, Braun S, Gobezie R Pacheco, IH..** Acromioclavicular joint reconstruction with coracoacromial ligament transfer using the docking technique. *BMC Musculoskeletal Disorders* 2009 ; 10 : 6.
26. **Murena L, Vulcano E, Ratti C *et al***. Arthroscopic treatment of acute acromioclavicular joint dislocation with double flip button. *Knee Surg Sports Traumatol Arthrosc* 2009 ; 17 : 1511-1515.
27. **Nicholas SJ, Lee SJ, Mullaney MJ, Tyler TF, McHugh MP.** Clinical outcomes of coracoclavicular ligament reconstructions using tendon grafts. *Am J Sports Med* 2007 ; 35 : 1912-1917.
28. **Nuber GW, Bowen MK.** Arthroscopic treatment of acromioclavicular joint injuries and results. *Clin Sports Med* 2003 ; 22 : 301-317.
29. **Payvandi S, Jeong J, Seitz WH**. Treatment of complete acromioclavicular separations with a modified Weaver and Dunn Technique. *Techn Hand & Upper Extr Surg* 2008 ; 12 : 59-64.
30. **Press J, Zuckerman JD, Gallagher M, Cuomo F.** Treatment of grade III acromioclavicular separations : operative versus nonoperative management. *Bull Hosp Jt Dis* 1997 ; 56 : 77-83.

31. **Rolf O, Von Weyhern AH, Ewers A, Boehm TD, Gohlke F.** Acromioclavicular dislocation Rockwood III-V : results of early versus delayed surgical treatment. *Arch Orthop Trauma Surg* 2008 ; 128 : 1153-1157.
32. **Rolla PR, Surace MF, Murena L**. Arthroscopic treatment of acute acromioclavicular joint dislocation. *Arthroscopy* 2004 ; 20 : 662-668.
33. **Salzmann GM, Walz L, Schoettle PB, Imhoff AB**. Arthroscopic anatomical reconstruction of the acromioclavicular joint. *Acta Orthop Belg* 2008 ; 74 : 397-400.
34. **Scheibel M, Ifesanya A, Pauly S, Haas NP.** Arthroscopically assisted coracoclavicular ligament reconstruction for chronic acromioclavicular joint instability. *Arch Orthop Traum Surg* 2008 ; 128 : 1327-1333.
35. **Shetty NS, Yoo YS, Kim DY, Lee SS, Jeong US.** Open anatomical coracoclavicular ligament reconstruction using a tendon graft with an Endobutton loop. *Acta Orthop Belg* 2009 ; 75 : 828-831.
36. **Somers JF, Van der Linden D**. Arthroscopic fixation of type III acromioclavicular dislocations. *Acta Orthop Belg* 2007 ; 73 : 566-570.
37. **Trikha SP, Acton D, Wilson AJ, Curtis MJ.** A new method of arthroscopic reconstruction of the dislocated acromio-clavicular joint. *Ann R Coll Surg Engl* 2004 ; 86 : 161-164.
38. **Weaver JK, Dunn HK**. Treatment of acromioclavicular injuries, especially complete acromioclavicular separation. *J Bone Joint Surg* 1972 ; 54-A : 1187-1194
39. **Weinstein DM, McCann PD, McIlveen SJ, Flatow EL, Bigliani LU.** Surgical treatment of complete acromioclavicular dislocations. *Am J Sports Med* 1995 ; 23 : 324-331.
40. **Wellmann M, Kempka JP, Schanz S *et al*.** Coracoclavicular ligament reconstruction : biomechanical comparison of tendon graft repairs to a synthetic double bundle augmentation. *Knee Surg Sports Traumatol Arthrosc* 2009 : 17 : 521-528.
41. **Wellmann M, Zantop T, Petersen W**. Minimally invasive coracoclavicular ligament augmentation with a flip button/polydioxanone repair for treatment of total acromioclavicular joint dislocation. *Arthroscopy* 2007 ; 23 : 1132.e1-1132.e5.
42. **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 : 955-61.
43. **Wolf EM, Pennington WT.** Arthroscopic reconstruction for acromioclavicular joint dislocation. *Arthroscopy* 2001 ; 17 : 558-563.
44. **Yeow Wai Lim.** Triple endobutton technique in acromioclavicular joint reduction and reconstruction. *Ann Acad Med Singapore* 2008 ; 37 : 294-299.