

Arthroscopic Acromioclavicular Fixation With Suture Tape Augmentation After Coracoclavicular Fixation With Dog Bone Button: Surgical Technique



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Abstract: An arthroscopic technique for the surgical treatment of acute acromioclavicular (AC) joint injuries is presented in this study. This procedure aims to achieve both vertical and horizontal stability through the healing of both coracoclavicular (CC) and AC ligaments. As a routine maneuver, arthroscopic CC stabilization was applied using the dog bone button to obtain only vertical stability. Additional arthroscopic AC joint fixation with suture tape augmentation is simple and easy and provides a safe technique to achieve horizontal stability of the joint and to increase the vertical stability to minimize the complications of standard CC reconstruction techniques.

Acromioclavicular (AC) joint injuries are common shoulder injuries in young men, especially in contact sports.^{1,2} The overall incidence rate is 9.2 per 1,000 people per year. Among AC joint injuries, Rockwood classification type III injuries still remain controversial with respect to surgical treatment. For high-grade injuries, most surgeons prefer a surgical treatment that allows for a high level of activity for young patients and athletes.^{1,2}

There are more than 60 surgical techniques described for the treatment of AC joint injuries.³⁻⁵ Currently, to treat acute AC joint dislocations, many surgeons use the arthroscopic coracoclavicular (CC) suture button fixation by various methods.^{3,4} However, in both clinical and biomechanical studies, CC stabilization alone without AC stabilization was not enough to provide horizontal stability.^{6,7} In a recent preliminary

biomechanics study using finite element analysis, the CC fixation and augmented AC fixation with sutures showed the potential to provide excellent horizontal stability.⁸

Furthermore, in suture button techniques, the incidence of clavicle and coracoid fractures is reported to range from 27.1% to 44%.^{9,10} The additional AC fixation could reduce stress to the suture button, which makes complications less likely to occur, including fractures, clavicular osteolysis, and buttons removed from clavicle.⁸

The suture tape augmentation, a ligament repair bridging concept using braided ultra-high-molecular-weight polyethylene/polyester suture tape and knotless anchors, provides reinforcement of ligament strength and more resistance to gap formation under fatigue loading.^{11,12} Arthroscopic AC joint fixation with suture tape augmentation is an easy and simple method that can improve horizontal stability after arthroscopic CC fixation using a suture button.

In this Technical Note, our preferred technique for arthroscopic augmented AC joint fixation with suture tape augmentation after CC fixation using a single suture button is described. A summary of key steps is provided in [Table 1](#), and a summary of the techniques is provided in [Video 1](#).

Operative Technique

The patient is placed in the beach chair position with a mechanical arm holder. The patient is draped, being sure to retain sufficient access to the clavicle for the

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The authors report that they have no conflicts of interest in the authorship and publication of this article. Full ICMJE author disclosure forms are available for this article online, as [supplementary material](#).

Received June 1, 2018; accepted August 2, 2018.

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2212-6287/18677

<https://doi.org/10.1016/j.eats.2018.08.005>

Table 1. Order of Steps With Pitfalls and Pearls

Surgical Steps	Pitfalls	Pearls
Finding the anterior aspect of AC joint at the subacromial space.	Injury of deltoid muscle and remnant AC joint ligament.	Percutaneous spinal needle insertion at the AC joint is useful to find the anterior surface of AC joint. Lateral viewing portal is good for obtaining sufficient visualization of the anterior surface of AC joint at the subacromial space.
Creation of anterior AC joint portal.	Improper positioning of anterior AC joint portal can be caused by malposition of anchor, subacromial violation, acromion fracture, and clavicle fracture.	It is hard to practice drilling and tapping parallel to the joint undersurface via conventional anterior portal. Percutaneous spinal needle insertion at the anterior surface of the AC joint is useful to determine proper portal location.
Minimal detachment of deltoid muscle around anchor insertion point.	Injury of deltoid muscle.	From the anterior surface of AC joint, at least about 5 mm of detachment of the deltoid muscle is inevitable to obtain proper working space for anchor insertion. Measuring the thickness of acromion and clavicle with simple a radiograph preoperatively is helpful to decide anchor position at the center of the acromion and clavicle.
Insertion of 3.5-mm SwiveLock anchor at the acromion.	Subacromial impingement could be induced by violation of anchor and acromion fracture.	Parallel drilling and tapping to the undersurface of the acromion should be performed. Double checking with the arthroscope is useful to avoid subacromial violation with anchor. Especially for Asian, female, or small stature patients, a 3.5-mm SwiveLock anchor is better than a 4.75-mm SwiveLock anchor to avoid acromion fracture.
Insertion of 3.5-mm SwiveLock anchor at the clavicle.	Remnant horizontal instability, malreduction of horizontal alignment, and clavicle fracture.	Fixation as tight as possible using FiberTape is good for accurate reduction and restoration of horizontal stability, because the limited range of motion of the AC joint is not critical as it is with the other joints. Checking with fluoroscopy or axial view simple radiograph is helpful for determining accurate AC joint reduction. Parallel drilling and tapping to the undersurface of the acromion and clavicle should be performed. Especially for Asian, female, or small stature patients, 3.5-mm SwiveLock anchor is better than 4.75-mm SwiveLock anchor to avoid clavicle fracture.

AC, acromioclavicular.

clavicular bone tunnel. The C-arm should be prepared on the contralateral side to analyze anatomical reduction. Anatomic landmarks are identified and drawn on the skin (Fig 1).

Before the arthroscopic procedure, a 2-cm incision is made parallel to the skin crease, oblique to the clavicle shaft, and about 3.5 cm (depending on the body size) medial to the AC joint. A partial monocortical pilot hole is created in the center of the superior cortex and about 3.5 cm medial to the lateral end of the clavicle.

In a standard fashion, 2 arthroscopic portals, posterior and anterior, are placed. Diagnostic glenohumeral arthroscopy is performed using a 40-mm 30° arthroscope through the posterior portal. Concomitant pathologic intra-articular lesions, including labral lesions, chondral lesions, and so on, were addressed as needed.

An anterior portal is routinely established in a standard fashion as a working portal. Preparation of the coracoid base is performed via a transinterval approach. The rotator interval is opened using an electrothermal

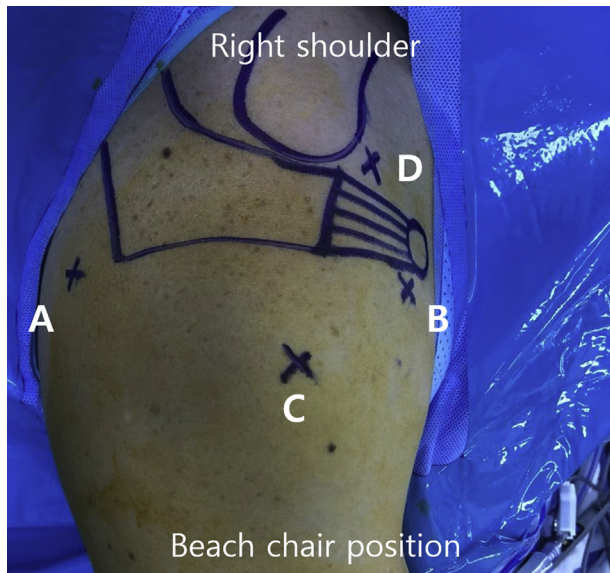


Fig 1. Right shoulder of patient in the beach chair position. Portals are skin incisions marked preoperatively: posterior portal (A) as a viewing portal, anterior portal (B) as a working portal, lateral portal (C) as a viewing portal, and anterior acromioclavicular joint portal (D) as a working portal for acromioclavicular fixation.

device and a soft tissue shaver. The coracoid base is clearly visualized in a medial-to-lateral margin to assess the base center. Before drilling, to prevent a windshield wiper phenomenon between the bone tunnels, the AC joint is reduced using intraoperative imaging with the fluoroscopy. An AC guide (Arthrex, Naples, FL) is placed on the center of the coracoid base through the anterior portal (Fig 2A). Transclavicular-coracoid drilling (4.0 mm) is performed by using the AC guide; the

clavicular part of the guide tip is placed into the pilot hole to prevent displacement. To guarantee the placement of the bone tunnel, drilling is performed under fluoroscopic and arthroscopic control. A shuttle suture (SutureLasso; Arthrex) or triclosan-coated polydioxanone sutures (PDS Plus Antibacterial Suture; Ethicon, Somerville, NJ) are passed through the cannulated drill bit and retrieved through the anterior portal after the guide pin is removed, before removing the drill bit. The ends of the 2 FiberTapes or 1 FiberTape with 2 FiberWires (Arthrex) loaded with the dog bone button (Arthrex) are shuttled through the coracoid and clavicular bone tunnel (Fig 2B). Subsequently, a second dog bone button is loaded onto the suture. Both FiberWires and FiberTapes are firmly tied superior to the dog bone button. It is important to check the correct positioning of the AC joint and implants with fluoroscopy before the suture is tied.

The next step in the procedure consists of arthroscopic AC joint stabilization with suture tape augmentation. In this procedure, the authors prefer using the lateral portal as a viewing portal, and an additional portal is established just anterior to the AC joint, named the anterior acromioclavicular joint portal (Fig 1). The portal is used as a working portal for all procedures of AC joint stabilization with a suture tape augmentation.

To identify the AC joint in the arthroscopic view, percutaneous spinal needle insertion to the anterior aspect of AC joint is useful (Fig 3A). Using an electrothermal device and a debrider, the deltoid muscle from the undersurface of the AC joint is minimally detached (Fig 3B). The width of the deltoid detachment is about 5 mm medial and lateral to the AC joint, and the length from the inferior border of the medial acromion and

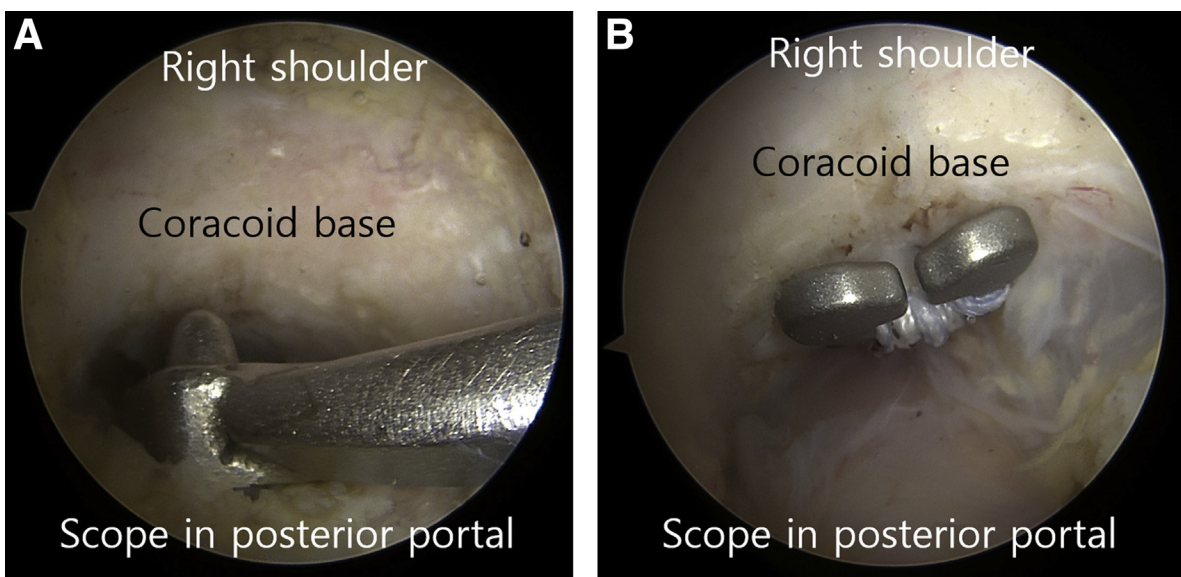


Fig 2. Arthroscopic views of a right shoulder. (A) An acromioclavicular guide is placed on the center of the coracoid base through the anterior portal (B). Vertical stabilization is established with dog bone buttons.

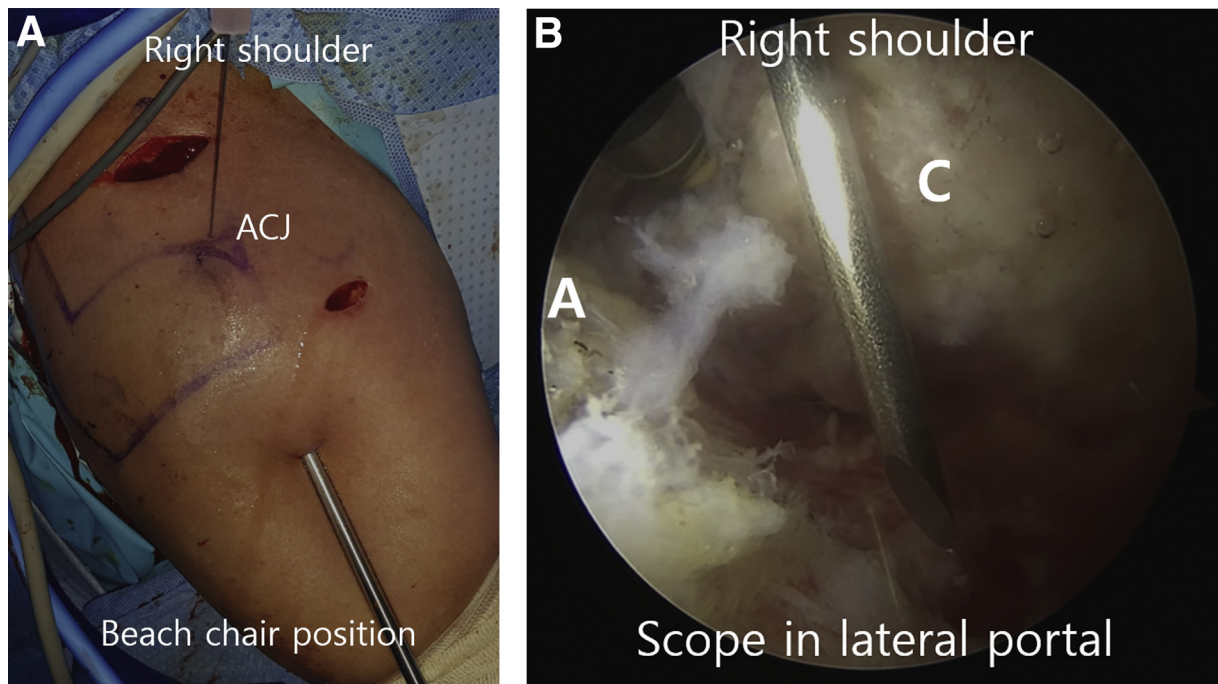


Fig 3. (A) Percutaneous spinal needle insertion into the anterior aspect of the acromioclavicular joint of a right shoulder. (B) Arthroscopic view of a right shoulder showing the anterior acromioclavicular joint. (A, acromion; ACJ, acromioclavicular joint; C, clavicle.)

distal clavicle is half of the height of the acromion measured on preoperative anteroposterior radiographs. After detachment, the ruptured AC joint ligament (Fig 4) and its horizontal instability (Video 1) can be checked by pushing the distal clavicle anterior to posterior in the horizontal axis.

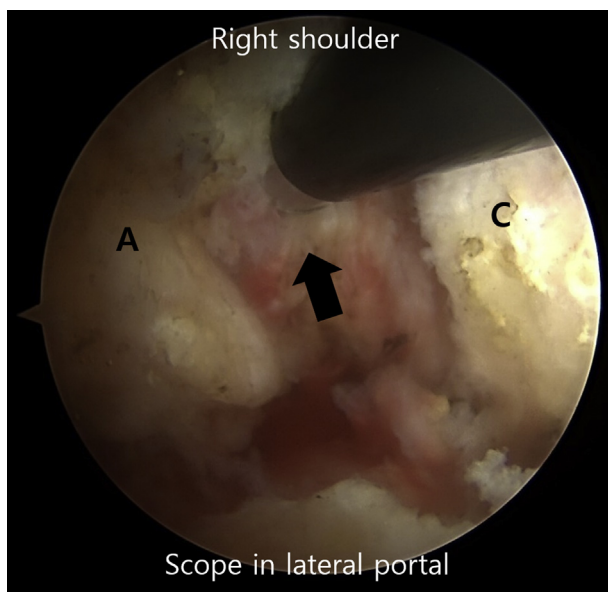


Fig 4. Arthroscopic view of a right shoulder showing the ruptured acromioclavicular joint ligament (arrow). (A, acromion; C, clavicle.)

Next, the 2.7-mm tunnel is created in the acromion through the anterior acromioclavicular portal in the arthroscopic view using a drill guide followed by a 3.5-mm tap (Arthrex). The acromial tunnel is placed anterior to the cortex, just lateral to the AC joint, and at the center of the acromial height in the upper portion of the deltoid detachment. A FiberTape loaded 3.5-mm BioComposite SwiveLock (Arthrex) is inserted into the acromion (Fig 5A). Another 2.7-mm tunnel is created in the distal clavicle in the same fashion as the acromial tunnel, just medial to the AC joint and at the same level as the acromial tunnel. A second 3.5-mm anchor loaded with the opposite end of the FiberTape is then inserted into the distal clavicle (Fig 5B). After AC joint fixation, the restoration of horizontal stability is evaluated by using a probe (Video 1). The inferior cortex of the bones by suture anchor can be checked through the arthroscopic view. Finally, the wound is closed with absorbable sutures (Fig 6). Table 1 summarizes the technical pitfalls and pearls of the operative technique.

Postoperative Rehabilitation

The patient's arm is placed in a sling for 6 weeks postoperatively. Passive and active-assisted abduction/forward elevation is limited to 30° for 2 weeks, limited to 45° for another 2 weeks (weeks 2-4), and limited to 60° for another 2 weeks (weeks 4-6). Active and unlimited motion is initiated 6 weeks postoperatively. Strength exercises are started after 3 months. Patients

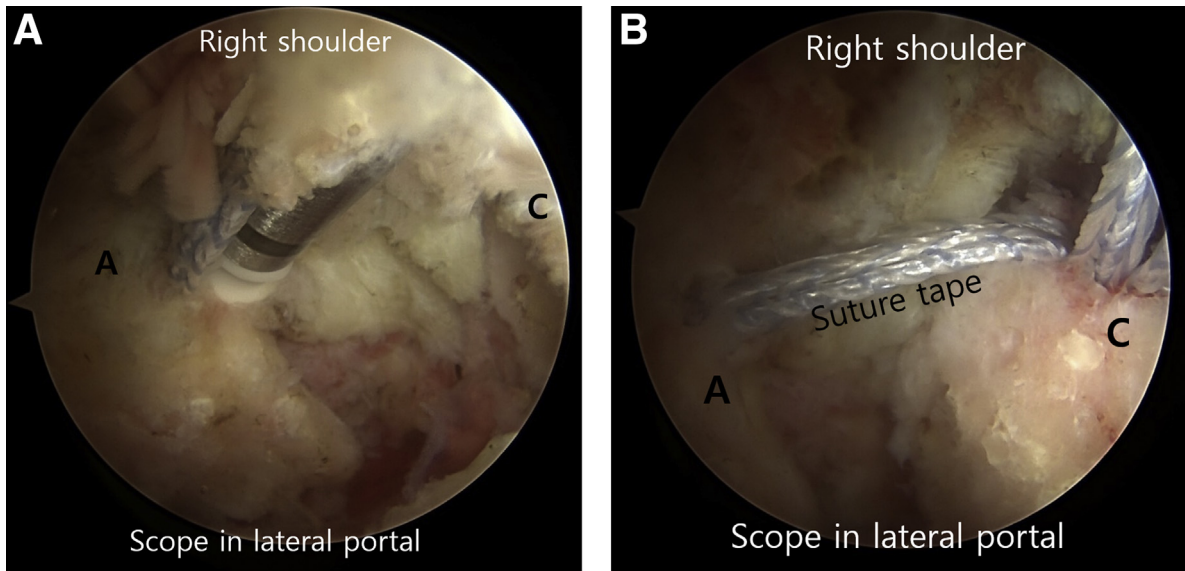


Fig 5. Arthroscopic views of a right shoulder. (A) FiberTape-loaded 3.5-mm BioComposite SwiveLock is inserted into the acromion. (B) A second 3.5-mm anchor loaded with the opposite end of the FiberTape is then inserted into the distal clavicle. (A, acromion; C, clavicle.)

are allowed to return to full-contact athletics after 4 to 5 months.

Discussion

Currently, no overall gold standard for the surgical management of AC joint dislocation has been discovered. In acute dislocation, many surgeons have treated AC joint dislocation with suture button devices to reduce the joint; theoretically, these treatments are enough to heal native CC ligaments.^{4,7,13}

In surgeries using a suture button device for CC reconstruction, arthroscopic techniques show improvements similar to their open counterparts, according to the literature.¹⁴ In grade 3 AC joint dislocations, Arrigoni et al.¹⁵ showed that 42% of the patients were diagnosed with additional pathologic lesions and 29% required additional treatments. Arthroscopic techniques have several advantages, including the ability to find and treat these concomitant pathologic lesions.¹⁵

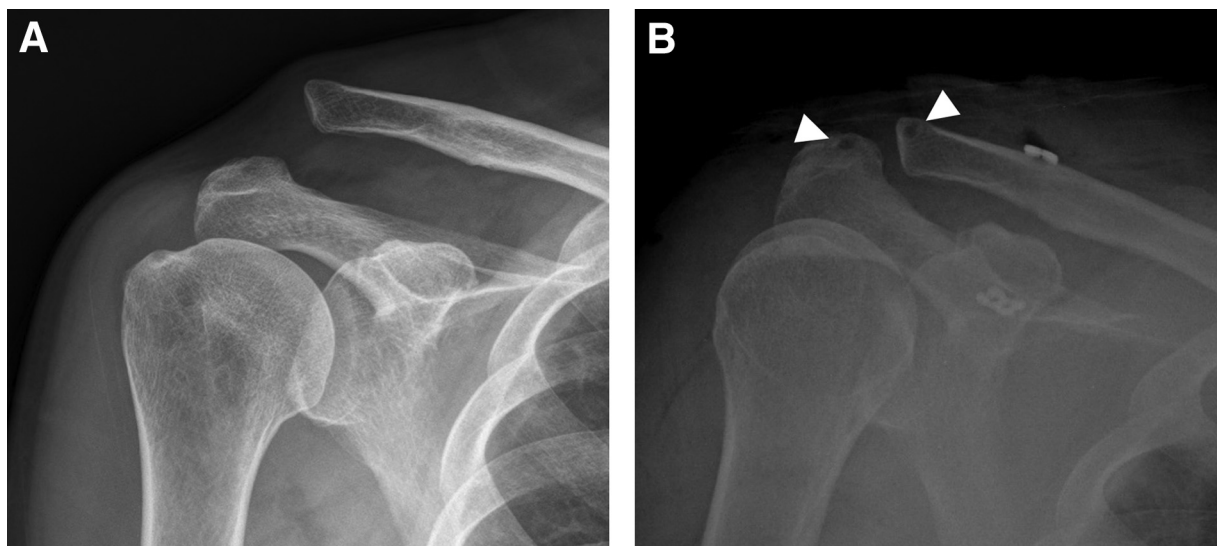


Fig 6. (A) Preoperative simple radiography shows Rockwood classification type V acromioclavicular joint injury. (B) Postoperative simple radiography shows reduction with dog bone button and suture tape augmentation. The arrowhead indicates that anchors were inserted in the center of bones.

Table 2. Advantages and Disadvantages of Arthroscopic Acromioclavicular (AC) Joint Fixation With Internal Bracing

Advantages	Disadvantages
<ol style="list-style-type: none"> 1. Minimizing the deltoid muscle injury around the anterior AC joint through the subacromial approach with an arthroscope. Minimal injury of deltoid muscle may be healed with scarring. 2. Avoidance of subacromial violation by anchor through observation with the arthroscope. 3. Simple and easy method with only 1 additional portal (anterior AC joint portal). 4. Additional fixation of AC joint is helpful to prevent clavicle or coracoid fractures. 5. Restoration of AC joint horizontal stability can prevent the scapular dyskinesis and chronic shoulder pain induced by remnant horizontal instability. 	<ol style="list-style-type: none"> 1. Complete avoidance of deltoid muscle injury is impossible. 2. Large diameter anchor could be a cause of acromion and clavicle fractures. 3. Anterior fixation only of the AC joint with internal bracing could be insufficient to achieve rotational stability of the AC joint, although anterior structure is the most important for rotational stability.

However, In 2001, Debski et al.¹⁶ showed a transection of the AC joint capsule with intact CC ligaments that resulted in a significant increase in horizontal translation. Recently, both biomechanical and clinical studies showed insufficient horizontal stability by CC reconstruction alone in treating AC joint dislocation. Carbone et al.¹⁷ described patients with a history of chronic AC joint instability (grade III), of which 100% had scapular dyskinesis and 58.33% had the grouping of conditions collectively known as SICK syndrome (scapular malposition, inferior medial scapular winging, coracoid tenderness, and scapular dyskinesis). Unsolved horizontal instability can be a cause of SICK and chronic shoulder pain.^{5,17} Moreover, Shin and Kim⁹ reported that suture button devices provide only vertical stability; however, unsolved horizontal instability can induce excessive stress of the suture button on the bone and cause clavicle and coracoid fractures.

As a result, emphasis is placed on the additional direct AC ligament reconstruction to control optimal physiological function recovery, including horizontal stability.^{6,18} In a recent preliminary biomechanics study using finite element analysis, additional AC fixation not only increased horizontal stability but also reduced stress to the suture button.⁸ Like this load-sharing concept, additional AC joint fixation will reduce the complications in CC fixation compared with a suture button alone.

To establish AC joint stability directly, many techniques incorporate suture cord cerclage, temporary pin fixation, and direct AC ligament reconstruction.¹⁹⁻²¹ However, no clinical literature exists that indicates an improved procedure. In 2018, Dyrna et al.²² showed that anterior segments of the capsule are of the highest importance in providing the joint's stability under rotational loading. To ensure simple, safe, and effective reconstruction of the AC ligament, the authors prefer using suture tape augmentation techniques only in the anterior segment of the joint under arthroscopy.

Arthroscopy-assisted techniques have several advantages in comparison with the open procedure. With

arthroscopic subacromial space visualization, subacromial impingement induced by violation of anchor can be checked. Although deltoid muscle injury is inevitable, this arthroscopic technique is good for minimizing the deltoid injury in comparison with open technique. To minimize the violation of the deltoid muscle, the thickness of the acromion and clavicle at the level of the tunnel was checked preoperatively using simple radiography; intraoperatively, the deltoid muscle was detached from the undersurface of the bones to the center of the acromion and clavicle bones. Gerber et al.²³ presented deltoid scarring after lateral acromioplasty without cases of dehiscence and increase in fatty infiltration, which significantly atrophied the deltoid. In this approach, we expect minimal detachment of the deltoid from the origin, so that it can heal with minimal scarring (Table 2).

In summary, additional arthroscopic AC joint fixation with suture tape augmentation is simple and easy and provides a safe technique to achieve horizontal stability of the joint and to increase the vertical stability to minimize the complications of standard CC reconstruction techniques.

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