Technical Note

Arthroscopic Acromioclavicular Joint Reconstruction With TightRope and FiberTape Loop

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Abstract: High-grade acromioclavicular (AC) injuries are frequent in the active population, and their treatment in the acute setting has reduced sequelae such as chronic pain, functional impairment, and inability to return to sports. Multiple techniques have been described to achieve reduction and fixation of the AC joint, but still there is no consensus. The objective of this Technical Note is to describe the reduction and internal fixation under arthroscopic assistance of the AC joint with the use of a double button implant plus high-strength tape in the acute setting.

Acromioclavicular (AC) dislocations correspond to more than 40% of shoulder injuries in contact athletes.[1] Associated injuries have been described with rates from 18% to 39.3%, highlighting rotator cuff injuries (32.3%), chondral defects (30.6%), and SLAP lesions (22.6%) with 8.6% of additional reconstructive surgery.[2,3] With arthroscopic advances, there is currently a trend to manage this type of injury in a minimally invasive manner through arthroscopic assistance. Advantages of arthroscopy includes smaller approaches, less soft tissue dissection, direct visualization of anatomical landmarks, and intra-articular differential diagnosis that allows us to treat associated injuries immediately.[4]

Multiple implants have been developed with the aim of maintaining reduction and fixation to allow coracoclavicular (CC) and AC ligaments to heal within their physiological term.[5-7] However, these constructs still present complications such as loss of reduction of up to 26.8% and residual pain between 25% and 39%, making a case for active research into strong and stable constructs.[4]

The primary objective of this Technical Note is to describe the treatment of acute high-grade AC joint dislocations with an arthroscopic AC joint reconstruction with TightRope and FiberTape (Arthrex, Naples, FL). The advantages and disadvantages of the technique are outlined in Table 1.

Surgical Technique

Anesthesia and Patient Position

We use general anesthesia plus an interscalene block for pain management. A 45° beach chair position is used, which allows glenohumeral arthroscopy and switch to open surgery if necessary. The radiograph C-arch is set to come in from the contralateral side of the injured shoulder when necessary. We do not use an arm holder, and the arm is let free to rest on the patient's belly (Video 1).

Table 1. Advantages and Disadvantages

Advantages	Disadvantages
Minimally invasive	Risk of neurologic injuries: musculocutaneous and suprascapular nerve
Allows direct evaluation and treatment of intra-articular injuries	Risk of conjoint tendon detachment
Direct visualization of the coracoid's base	Risk of clavicle or coracoid fracture
	Cannot be used if coracoid fracture is present

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Fig 1. Direct view of left shoulder with patient in beach chair position. Posterior (P), anterolateral (AL), and anterior (A) portals are marked. Mini open incision on clavicle marked with red line.

Diagnostic Arthroscopy and Coracoid Exposure

Three portals are used for this surgery: a standard posterior portal, an anterolateral working portal, and an anterior portal (Fig 1). We start with a diagnostic arthroscopy, looking for associated injuries. With a spinal needle, the anterior portal is located, always trying to respect the rotator cuff interval and middle glenohumeral ligament as much as possible. In this case, we went medial to the thick middle glenohumeral ligament and opened the rotator cuff interval just near the coracoid. With the shaver, the coracoid is carefully located. Then the anterolateral portal is created with the help of a spinal needle, going anterior to the joint capsule. The scope is switched to the anterolateral portal for better vision, and the debridement is continued from the anterior portal until the base of the coracoid is reached. Then the scope is switched to the anterior portal to have a clear vision of the base of the coracoid.

Reduction and Fixation of the AC Joint

The CC guide is introduced through the anterolateral portal, and the exit point of the guide is held under the center of the coracoid's base (Fig 2A). At this point, with the help of the guide pin sleeve on the skin, we make a small incision over the clavicle and find the center spot on the superior cortex to drill through the clavicle and, at the same time, the exit point under the center of the coracoid's base. Using a power drill, a 2.4-mm drill guide pin is inserted into the guide pin sleeve and advanced through the clavicle and coracoid. The tip of the guide pin should be captured by the drill stop at the base of the coracoid under direct visualization (Fig 2B). Remember that the base is like a circle that flattens lateral, so it always seems that you may be too medial from the inferior surface. Using a power drill, the 4-mm cannulated drill is advanced over the pin through the clavicle and coracoid. The reamer is left in position, but the inner guide pin must be removed. Cannulated drilling beyond the coracoid must be avoided under direct arthroscopic visualization. A Nitinol suture wire is passed through the cannulated drill, leaving the loop superiorly, and the tip is grabbed with the grasper through the anterolateral portal. One white traction suture from the oblong button of the TightRope is inserted through the wire loop of the Nitinol suture-passing wire. The suture-passing wire is pulled to retrieve the white traction suture. The oblong button is advanced through the clavicle and the coracoid under direct visualization until it exits the

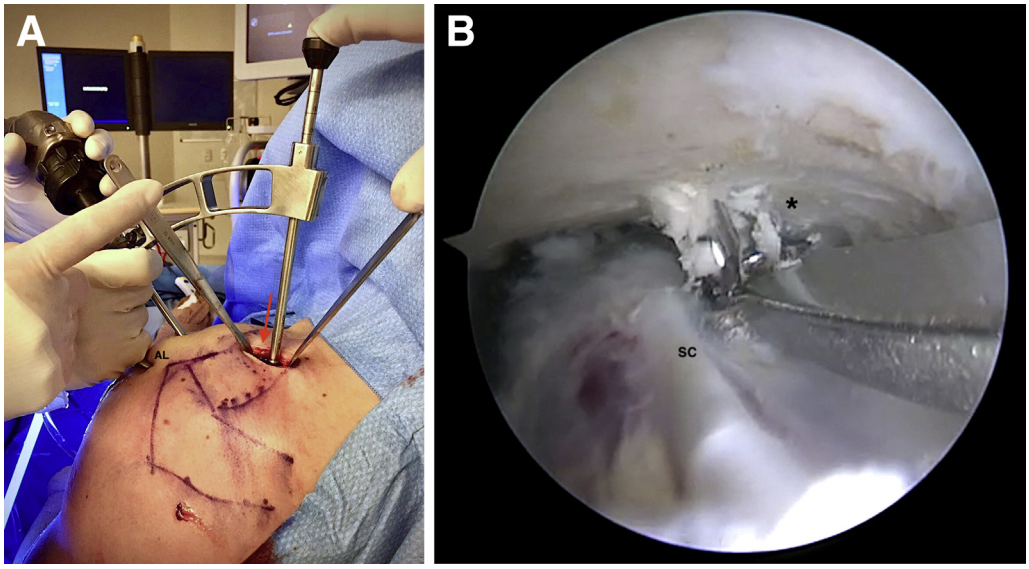

Fig 2. Left shoulder in beach chair position. (A) The coracoclavicular guide is inserted through the anterolateral (AL) portal reaching the center of the clavicle on top (red arrow) and the center of the coracoid's base on the bottom. (B) View from the anterior portal. The guide drill pin should reach the center of the coracoid's base (*) and should be stopped by the coracoclavicular guide under direct vision over the subscapularis (SC).

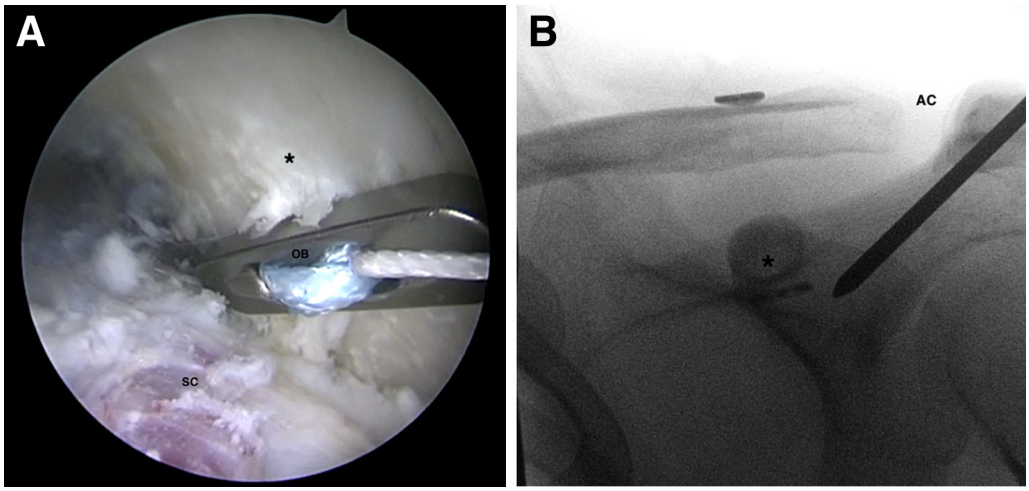

Fig 3. Left shoulder in beach chair position. (A) Arthroscopic anterior portal view. The oblong button (OB) of the TightRope is positioned under direct vision at the base of the coracoid (*). (B) After reduction of the acromioclavicular (AC) joint, AC reduction and TightRope position is confirmed under fluoroscopy. TightRope buttons should be parallel and the clavicular tunnel should reach the center of the coracoid's base (*). (SC, subscapularis.)

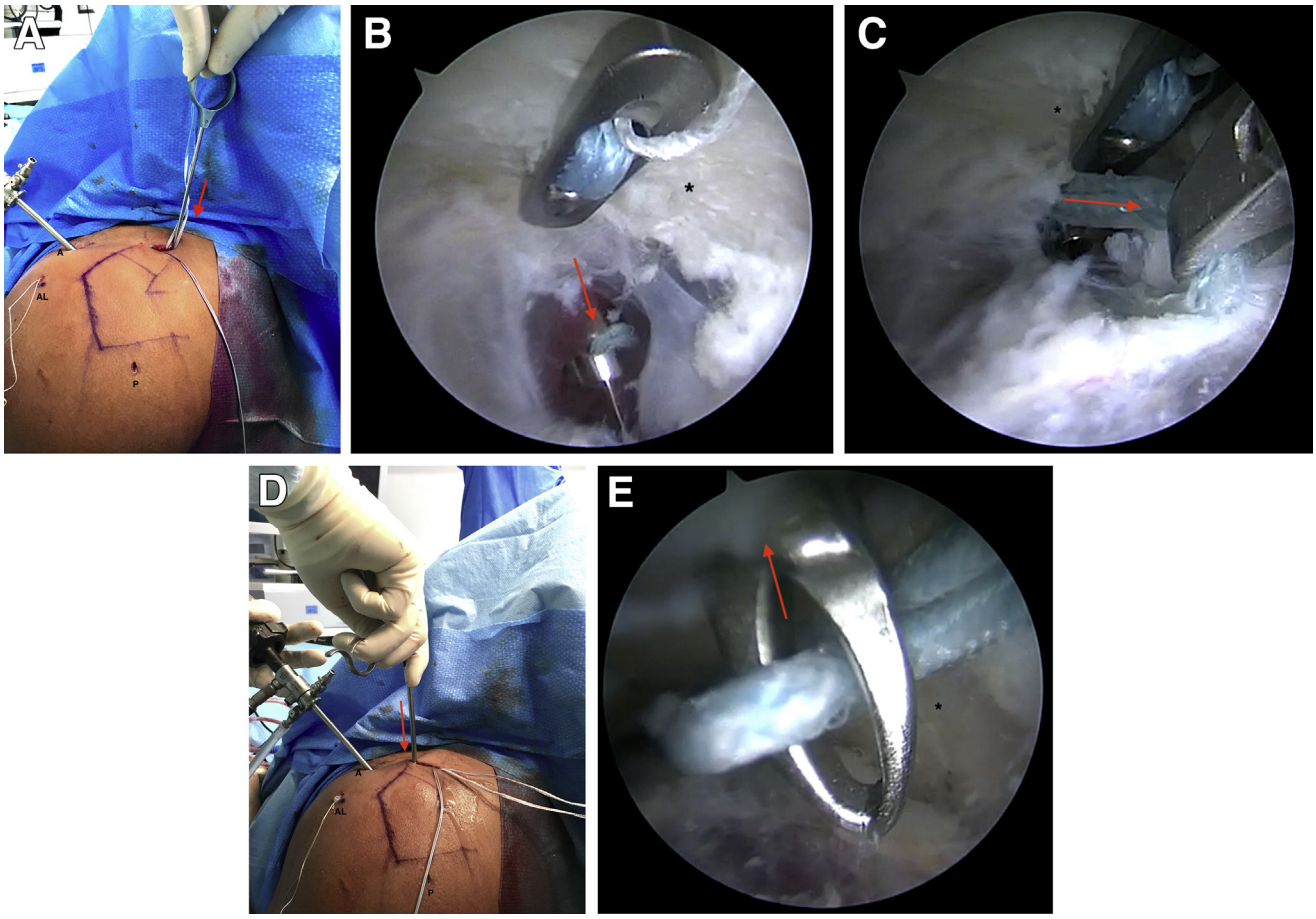

Fig 4. Left shoulder in beach chair position. (A) The knot pusher with the FiberTape loop is advanced from the posterior (P) edge of the clavicle to reach the medial border of the coracoid. (B) Arthroscopic anterior (A) portal view. The knot pusher and the FiberTape loop (red arrow) reaching the medial border of the coracoid (*). (C) From the anterolateral (AL) portal, the FiberTape loop is pulled with a grasper (red arrow). (D) From the anterior edge of the clavicle, a grasper is advanced toward the lateral edge of the coracoid (red arrow). (E) The FiberTape loop is grabbed with a grasper and pulled upward (red arrow) anterior to the clavicle.

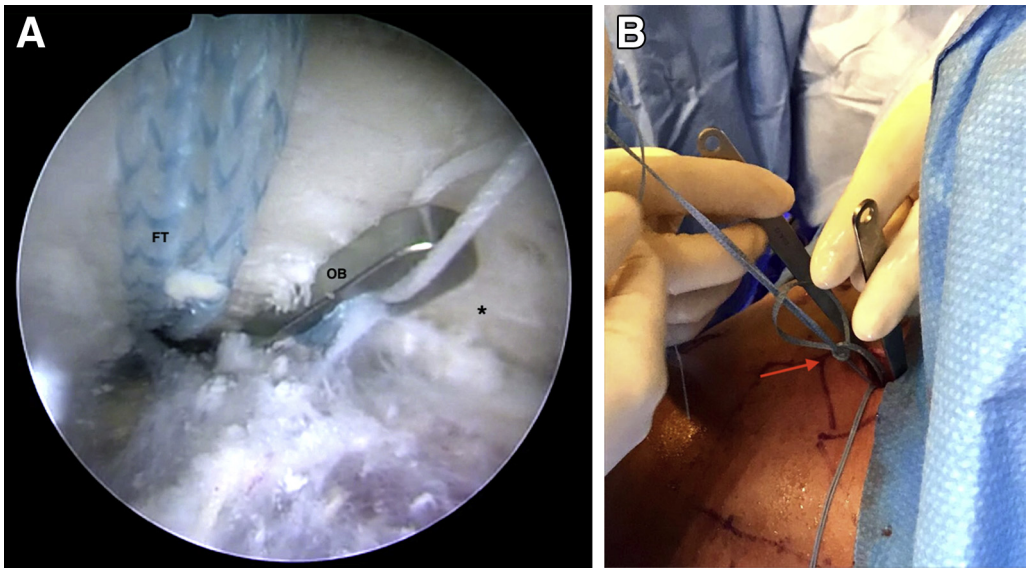

Fig 5. Left shoulder in beach chair position. (A) Arthroscopic anterior portal view. The FiberTape (FT) should be anterior of the oblong coracoid button (OB) of the TightRope. (B) A Nice knot is done to secure the FiberTape (red arrow).

coracoid's base with the help of a grasper (Fig 3A). Once the security of the oblong button is confirmed, the clavicle is reduced under fluoroscopy (Fig 3B). Both blue TightRope suture tails are pulled to advance the round button down to the surface of the clavicle. Then the sutures are tied over the top of the TightRope. We add a FiberTape loop around the clavicle and under the coracoid to enhance the stability of the repair. First we do a blunt dissection medial to the coracoid's base. From the posterior border of the clavicle, a knot pusher is advanced with the FiberTape loop to the medial border of the coracoid (Fig 4 A and B). The FiberTape loop is grabbed (Fig 4C), and the knot pusher is removed. From the anterior border of the clavicle, a grasper is advanced to the lateral border of the coracoid to grab the FiberTape loop (Fig 4 D and E). The FiberTape should be anterior to the oblong subcoracoid button of the TightRope, to prevent posterior sliding of the FiberTape and the clavicle in relationship to the acromion. Then the FiberTape is secured on top of the clavicle with a Nice knot (Fig 5). A final diagram of the construct can be seen in Figure 6. Pearls and pitfalls of the procedure are outlined in Table 2.

Rehabilitation

All patients use a standard shoulder immobilization for 6 weeks. Immediate postoperative active range of motion is encouraged for the hand. Active motion of the elbow and passive external rotation of the shoulder are also encouraged immediately, but with elbow support to neutralize gravity force on the construct. Passive glenohumeral elevation up to 90° is allowed

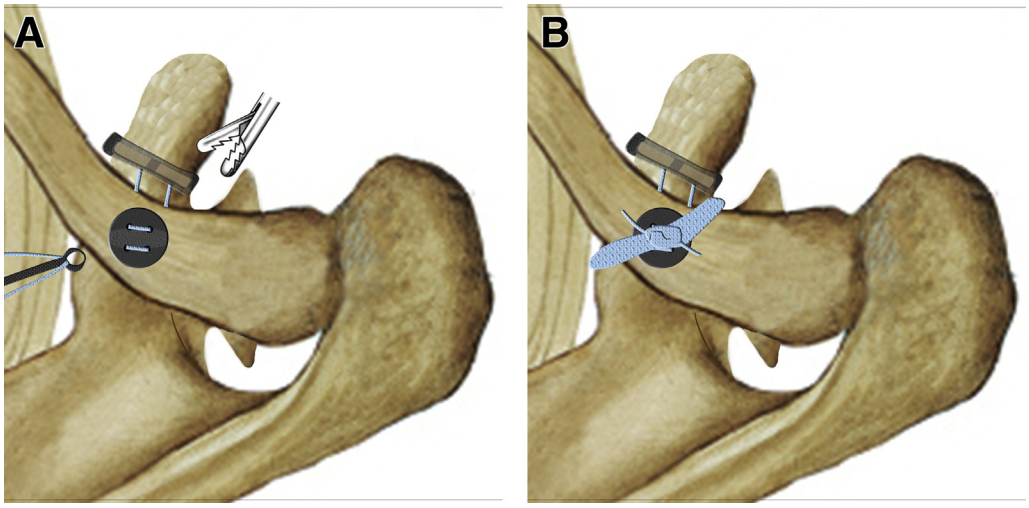

Fig 6. Illustration of the relationship between the TightRope and FiberTape loop. Top view of the acromioclavicular joint and coracoid. (A) Space where the knot pusher is advanced and the space where it is pulled up by a grasper to make the loop under the coracoid. (B) FiberTape crossing over the clavicle in an anterior to posterior direction. The TightRope is positioned in the center of the coracoid.

Table 2. Pearls and Pitfalls of the Surgical Technique

Pearls	Pitfalls
Use of arthroscopic assistance for 3 portals: posterior to allow intra-articular diagnosis; anterior to identify and visualize the coracoid; and anterolateral as a working portal.	An anterolateral portal very close to the anterior portal that may hinder the use of instruments.
Achieve an adequate visualization of the base of the coracoid, bluntly debriding the more medial adhesions of the base that come from the subscapularis muscle.	Excessive soft tissues on the medial border of the coracoid do not allow visualization of the FiberTape on the knot pusher medial to the coracoid.
Correct knowledge of the coracoid's base anatomy to identify the center from an inferior view and achieve the right positioning of the guidewire. This step can be assisted with fluoroscopy.	A guidewire outside the center of the base, usually more lateral, can be a risk factor for failure owing to a fracture of the base of the coracoid.
Achieve direct vision of the anterior and posterior border of the clavicle to position the guidewire at the center.	A clavicular tunnel near the bony rim can cause a fracture and failure of the fixation.

under supervision from week 4, and unrestrictive active motion is started after week 6. Strengthening is allowed between weeks 8 and 12.

Discussion

In this surgical technique, we described how to increase the TightRope stability by adding a FiberTape loop around the coracoid and clavicle for the acute setting. In recent years, there have been a significant number of publications describing a variety of implants with similar goals, with the TightRope being one of the most studied. Vulliet et al.[5] retrospectively compared the use of TightRope versus Dog Bone (Arthrex) in 40 patients at 1 year of follow-up. Functional results were similar between both groups, however, loss of reduction (displacement $\geq$ 5 mm) was higher in the Dog Bone group (55% vs 22%; $P < .0001$).[5] Zhang et al.[7] reviewed the clinical and radiological results of 24 patients treated only with TightRope; 25% presented radiological failure associated with worse functional results at 2 years of follow-up, suggesting that it still needs to be modified. Hann et al.[6] retrospectively evaluated 59 patients with double TightRope associated with a percutaneous AC cerclage for type V lesions, with 2 years of follow-up. The average Constant score was 90 points with a subjective shoulder value score of 90%. The modified Alexander radiological evaluation showed a partial dynamic posterior translation in 41.1% of cases and a complete posterior translation at the end of follow-up in 5.8% of cases. Although the revision rate was 11.7%, only 1 patient required revision owing to recurrent instability.

In a recent systematic review, suspensory devices showed the postoperative Constant score ranged from 82.6 to 97.8 at a minimum 2 years follow-up with the lowest rates of complications, compared with hook plates and K-wires.[8]

Concern about proximity of neurovascular structures during arthroscopically assisted AC joint surgery has been raised. Banaszek et al.[9] showed that the neurovascular structures of closest proximity to the implanted materials with a similar arthroscopic technique were the suprascapular nerve and the suprascapular artery. The location of closest proximity occurred adjacent to the medial border of the coracoid, anterior to the suprascapular notch. The suprascapular nerve was measured to pass as close as 2.2 mm to the tape, with a mean of 8.2 mm. The nerve was closer than 5.0 mm to implanted material in 1 of 6 specimens. The suprascapular artery appeared to be in contact with the tape in 1 specimen (no damage to artery), with a mean of 5.6 mm.[9]

In general, we believe that isolated use of TightRope for high-grade AC joint dislocations has been insufficient for this type of injuries and the use of an augmentation method is necessary to increase the stability. Adding a FiberTape loop according to our described technique could be a valid and reproducible method to increase the stability of the AC joint allowing adequate healing of AC and CC ligaments in the acute setting. Acquiring the ability to arthroscopically pass a loop around the coracoid and the clavicle gives the advantage of adding a tendon graft in the same manner in chronic cases without changing the technique.[10] This has been validated in a large retrospective cohort study comparing different surgical techniques for chronic AC reconstruction, which found CC ligament reconstruction with cortical button combined with loop fixation of allograft around the coracoid to have the lowest radiographic failure and rates of reoperation.[11]

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References

1. Pallis M, Cameron KL, Svoboda SJ, Owens BD. Epidemiology of acromioclavicular joint injury in young athletes. *Am J Sports Med* 2012;40:2072-2077.
2. Pauly S, Gerhardt C, Haas NP, Scheibel M. Prevalence of concomitant intraarticular lesions in patients treated operatively for high-grade acromioclavicular joint

separations. *Knee Surg Sports Traumatol Arthrosc* 2009;17:513-517.
3. Markel J, Schwarting T, Malcherczyk D, Peterlein C-D, Ruchholtz S, El-Zayat BF. Concomitant glenohumeral pathologies in high-grade acromioclavicular separation (type III-V). *BMC Musculoskelet Disord* 2017;18:439.
4. Nelson A, Woodmass J, Esposito J, et al. Complications following arthroscopic fixation of acromioclavicular separations: A systematic review of the literature. *Open Access J Sports Med* 2015;6:97-107.
5. Vulliet P, Le Hanneur M, Cladiere V, Loriaut P, Boyer P. A comparison between two double-button endoscopically assisted surgical techniques for the treatment acute acromioclavicular dislocations. *Musculoskelet Surg* 2018;102:73-79.
6. Hann C, Kraus N, Minkus M, Maziak N, Scheibel M. Combined arthroscopically assisted coraco- and acromioclavicular stabilization of acute high-grade acromioclavicular joint separations. *Knee Surg Sports Traumatol Arthrosc* 2018;26:212-220.
7. Zhang L-F, Yin B, Hou S, Han B, Huang D. Arthroscopic fixation of acute acromioclavicular joint disruption with TightRope™: Outcome and complications after minimum 2 (2-5) years follow-up. *J Orthop Surg* 2017;25. 230949901668449.
8. Moatshe G, Kruckeberg BM, Chahla J, et al. Acromioclavicular and coracoclavicular ligament reconstruction for acromioclavicular joint instability: A systematic review of clinical and radiographic outcomes. *Arthroscopy* 2018;34:1979-1995.e8.
9. Banaszek D, Pickell M, Wilson E, et al. Anatomical evaluation of the proximity of neurovascular structures during arthroscopically assisted acromioclavicular joint reconstruction: A cadaveric pilot study. *Arthroscopy* 2017;33:75-81.
10. Menge TJ, Tahal DS, Katthagen JC, Millett PJ. Arthroscopic acromioclavicular joint reconstruction using knotless coracoclavicular fixation and soft-tissue anatomic coracoclavicular ligament reconstruction. *Arthrosc Tech* 2017;6:e37-e42.
11. Spencer HT, Hsu L, Sodl J, Arianjam A, Yian EH. Radiographic failure and rates of re-operation after acromioclavicular joint reconstruction: A comparison of surgical techniques. *Bone Joint J* 2016;98-B:512-518.