

Arthroscopically Assisted Double-Loop Suture Repair for Acute Acromioclavicular Joint Disruption



Emmanouil M. Fandridis, M.D., Ph.D., Frantzeska Zampeli, M.D., Ph.D., and Panagiotis Dimakopoulos, M.D., Ph.D.

Abstract: The surgical management of acute high-grade acromioclavicular (AC) joint (ACJ) injuries has evolved during the last decades. Numerous surgical techniques exist and recently arthroscopically assisted or all endoscopic techniques have gained popularity due to certain advantages. The goals of the new anatomic coracoclavicular ligament reconstruction techniques are to achieve anatomic reduction of the ACJ to allow and facilitate primary healing of AC and coracoclavicular (CC) ligaments, and also to minimize the risk of associated complications. We regularly use the open repair with double-loop sutures for the acute ACJ disruption, as described by Dimakopoulos et al. at 2006. In this surgical technique article, we present the arthroscopically assisted technique for the double-loop suture repair.

Introduction

Acromioclavicular (AC) joint (ACJ) injuries are injuries usually present in young, active, and athletic population, with reported incidence of 9.2 injuries per 1,000 person-years in young athletes and represent about 12% of all traumatic shoulder girdle injuries.^{1,2} They occur most commonly during sports participation, road traffic accidents, and fall from a height or a fall on the adducted shoulder. Conservative treatment is recommended for type I and II injuries, and surgical management is recommended for patients with high-grade type IV and V injury, according to Rockwood classification.³ For the controversial type III injuries, consensus has arisen more recently giving emphasis to the component of horizontal instability that differentiates between subtypes IIIA and IIIB, and authors advocate early surgical reconstruction for type

IIIB especially in select high-functioning patients, such as manual laborers and overhead-throwing athletes.^{4,5}

The optimal surgical management of high-grade ACJ injuries has changed over time from the Weaver Dunn procedure,⁶ to its modifications^{7,8} and more recently to the anatomic coracoclavicular (CC) ligament reconstruction techniques. Several modifications of the anatomic CC reconstruction techniques exist with no universally accepted “gold standard”; however, all have as a common principle to use an internal bracing that provides reduction of the ACJ during the acute phase, thus allowing for primary healing of the CC and AC ligaments. Biomechanical and clinical studies have confirmed that good to excellent results are expected with these techniques.⁹⁻¹⁵ A skillful arthroscopic surgeon can take advantage of recent advances in implant designs and perform arthroscopically assisted or fully endoscopically assisted procedures such the anatomic ACJ stabilization procedure. These arthroscopic techniques have the advantage of a minimally invasive approach, facilitate management of associated intraarticular lesions, and offer adequate visualization of the coracoid.¹²⁻²⁰ However, these new methods have resulted in some new complications such as tunnel widening, coracoid or clavicle fractures, and implant failure additionally to the already known complications of loss of reduction and redislocation.²

In our upper-limb dedicated department, we use the double-loop suture repair technique that has been described since 2006, and its efficacy in the long-term has been proven when used as an open

From the Hand-Upper Limb-Microsurgery Department, General Hospital KAT, Athens, Greece (E.M.F., F.Z.); and Orthopaedic Department, University of Patras, Patras, Greece (P.D.)

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 November 13, 2021; accepted January 14, 2022.

Address correspondence to Frantzeska Zampeli, M.D., Ph.D., KAT General Hospital, Nikis 2, Kifisia, Postal code 145 61, Greece. E-mail: fzampeli@gmail.com

© 2022 THE AUTHORS. Published by Elsevier Inc. on behalf of the Arthroscopy Association of North America. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>). 2212-6287/211628

<https://doi.org/10.1016/j.eats.2022.01.013>

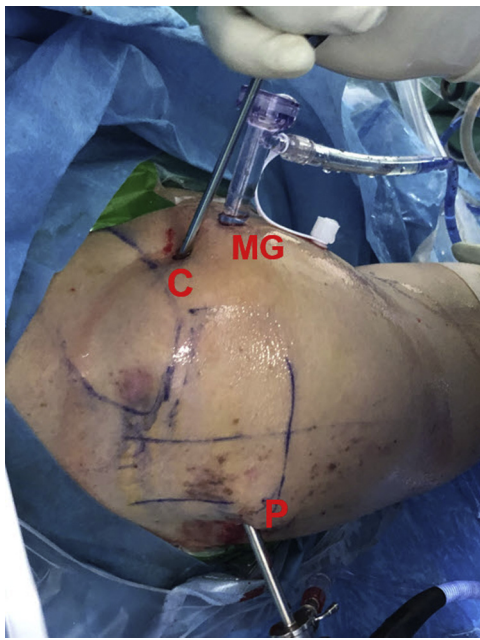


Fig 1. Beach chair position, right shoulder, outside view of arthroscopic portals. C, coracoid portal; MG, midglenoid portal; P, posterior standard portal.

procedure.^{13,21-22} This technique does not use hardware and implants, but is a suture-based technique, which does not deteriorate the efficacy of the technique.²³ In this Technical Note, we present our arthroscopically assisted technique of the double-loop suture repair for acute high-grade ACJ injuries.

Surgical Technique

Patient's Evaluation and Indications

After physical examination and imaging evaluation with radiographs (true anteroposterior, lateral, bilateral Zanca view without weight, and Alexander view), patients with Rockwood types IIIB, IV, and V in the acute phase (<3 weeks) are the best candidates for this technique. For the controversial type IIIB injury, clavicle overriding in the cross-body adduction, Alexander view, the activity level, and demands of the patient are

taken in consideration to suggest operative treatment.^{4,5}

Surgical Technique

Under general anesthesia, the patient was positioned on a beach chair position with the arm in forward flexion around 30° with traction 2 kg. Four standard portals (posterior standard portal, midglenoid portal, anterolateral (AL) portal, and lateral portal) and two accessory portals (coracoid and anterosuperior portal) are usually required for the procedure (Fig 1).

The operation (video 1 can be described in three main parts. Part 1 consists of intra-articular glenohumeral arthroscopy and dissection of the coracoid in order to place the sutures around its base (steps 1-3). Part 2 includes the subacromial arthroscopy, the dissection of the AC joint and lateral clavicle, and the retrieval of the previously placed sutures. At the end of this part, the coracoclavicular space should also be dissected (steps 4-6). The third part includes the drilling of the clavicular tunnel and the reduction and stabilization of the AC joint (steps 7 and 8). The steps of the technique, the pearls and pitfalls (Table 1), and the advantages and disadvantages (Table 2) are discussed.

Step 1. Glenohumeral Arthroscopy

The glenohumeral joint is approached through the standard posterior portal (soft point portal). Any concomitant intra-articular lesions that need to be treated are repaired first. The midglenoid portal is created as the first working portal with an outside-in needle technique. The rotator interval is opened, and the coracoid process is dissected as much as the view from the posterior portal allows, especially its lateral and inferior surface using a radio frequency ablation device (Fig 2).

Step 2. Coracoid Dissection

With the scope through posterior portal and using the midglenoid as a working portal, the coracoid process is further dissected on its inferior, superior, and medial

Table 1. Advantages and Disadvantages of Arthroscopically Assisted Double-Loop Suture Repair for Acute Acromioclavicular Joint Disruption

Advantages	Disadvantages
1. Evaluation/treatment of all intra-articular and subacromial lesions	1. No direct tunnel from the clavicle to coracoid as other techniques
2. No coracoid tunnel. No coracoid fracture or tunnel widening	2. Need to prepare the coracoid process and separately the subacromial anterior space in order to retrieve the sutures
3. No hardware	3. Partial detachment of pectoralis minor tendon from the coracoid
4. Low-cost of Ethibond sutures compared with other materials	4. Risk with careless suture management
5. No rigid construction. Permits slight clavicular rotation	5. No dedicated instruments yet
6. Suture configuration offers vertical and horizontal stability in acute cases	6. Not an all-arthroscopic technique
7. No special arthroscopic instruments needed	
8. No difficult procedure for shoulder arthroscopists	

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
<ol style="list-style-type: none"> 1. The coracoid portal is safe and easy with the outside-inside needle technique. 2. The lateral transtendinous portal gives an extra adequate view to the medial side of the coracoid. 3. The scope in the subacromial space checks with safety the gradual drilling to the inferior side of the clavicle 	<ol style="list-style-type: none"> 1. The anterior subacromial debridement is essential in order to retrieve the sutures from both sides of the coracoid to the subacromial space. 2. The clavicular tunnel should be checked through the mini-open approach of the superior aspect of the clavicle. The goal is to be in the middle of the antero-posterior diameter of the clavicle and vertical to the coracoid base. This is ~2.5-3 cm medial to the AC joint line. Any divergent course of the sutures will compromise the anatomic reduction.

surface (Fig 3A). The coracoid portal is then created with the outside-in needle technique just over the coracoid process (Fig 3B). This portal facilitates the dissection of the medial side (Fig 3C), superior surface, and undersurface of the coracoid process. At the medial side of the coracoid process, careful detachment of the pectoralis minor fascia, as needed, is performed close to the bone. At the superior aspect of the coracoid toward its base, remnants of the torn coracoclavicular (CC) ligaments are identified and preserved when possible (Fig 3D). The anterolateral portal (AL) is created with the outside-in needle technique through the rotator interval. The AL portal can be used as working portal in this step to further facilitate the coracoid dissection.

Step 3. Passage of the Sutures Around Coracoid Base

A suture is brought via the coracoid portal to the medial side of the coracoid process and then is retrieved from the midglenoid portal (Fig 4A). This shuttle relay suture is replaced by four Ethibond no. 5 sutures (Ethicon, Inc., Somerville, NJ) from the coracoid portal to the midglenoid portal, thus passing them around

coracoid base (Fig 4B). In this way, four limbs of the sutures are placed medially through the coracoid portal, and four limbs are placed laterally through the midglenoid portal (Fig 4B).

Step 4. Subacromial Arthroscopy

The scope is switched subacromially through the standard posterior portal, and the lateral portal is created as a working portal in order to debride the subacromial space (Fig 5). Then the scope is moved to the lateral portal, and the debridement of the coracoid process can be completed in all sides using the midglenoid as a working portal.

Step 5. Dissection of AC Joint and Lateral Clavicle

Next step is to inspect the ACJ disruption and debride the coracoclavicular space cautiously in order to preserve the remnants of CC ligaments. With the scope through lateral portal, the inferior part of the ACJ is debrided and exposed as much as necessary (Fig 6A). An accessory anterosuperior portal (AS) parallel to ACJ facilitates preparation of the joint, as well as the more medial aspect of the clavicle to allow for a more medial

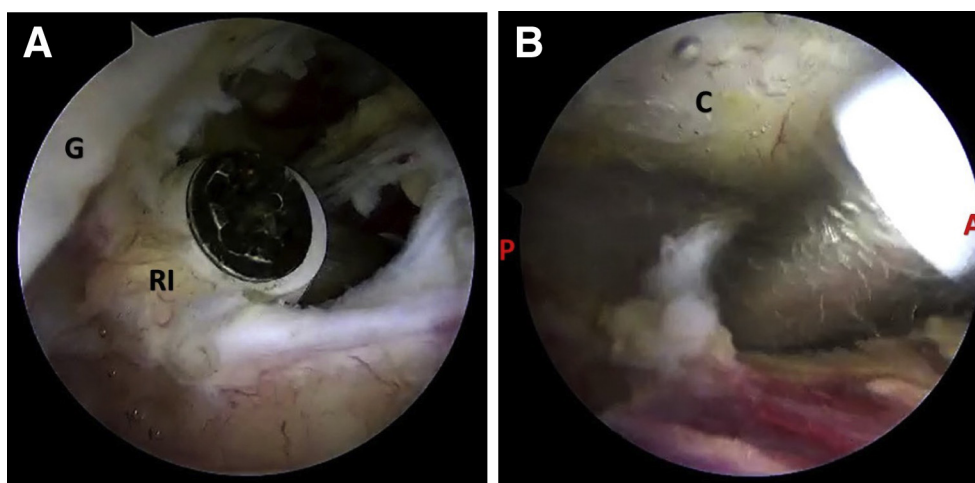


Fig 2. Glenohumeral arthroscopy. Beach chair position, right shoulder, arthroscopic view from the posterior portal. Through the midglenoid portal as working portal, the rotator interval is opened (A) and the coracoid is dissected as much as the viewing from posterior portal allows (B), especially the lateral, superior, and inferior surface using a radiofrequency ablation device (Apollo RF MP90, Arthrex). A, anteriorly; C, coracoid; G, glenoid labrum; P, posteriorly; RI, rotator interval.

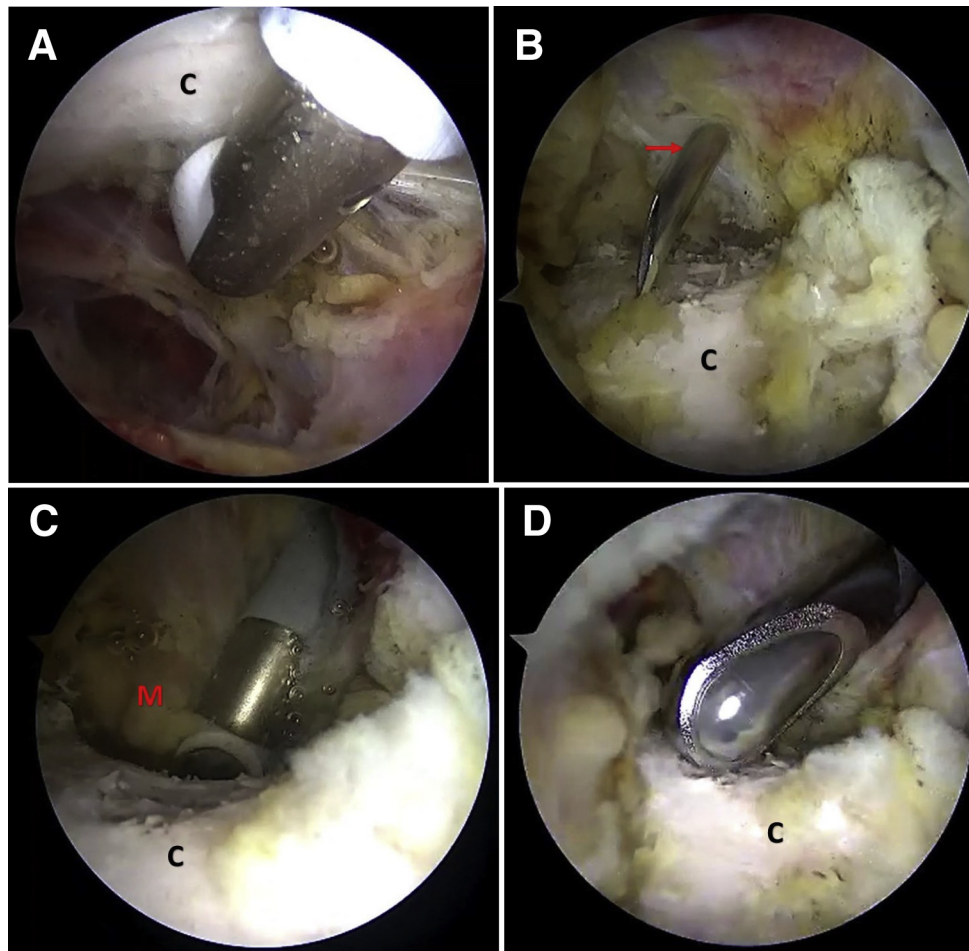


Fig 3. Coracoid dissection. Beach chair position, right shoulder, arthroscopic view from the posterior portal. (A) Through the midglenoid as working portal, the coracoid is further dissected on its inferior surface. (B) The coracoid portal is created with the outside-in needle technique just over the coracoid (red arrow). (C) The dissection of the medial side of the coracoid process is facilitated through the coracoid portal. (D) At the superior aspect of the coracoid towards its base, remnants of the torn coracoclavicular (CC) ligaments are identified and preserved when possible. C, coracoid, M, medially.

and more anatomic tunnel placement (Fig 6B). The debridement proceeds cautiously medially in order to expose the undersurface of the clavicle and its anterior and posterior borders, and concomitantly to preserve the remnants of the CC ligaments, as well as any hematoma tissue formation (Fig 6, C and D). For cases in which the clavicle is incarcerated in the deltotrapezial fascia, dissection from the medial to lateral part enables extraction of the clavicle, as its lateral part may not be easily identified. Two working portals can be used concomitantly: a probe or switching stick may facilitate the visualization by pushing down the underlying soft tissue, and the dissection of the clavicle more medially can be, thus, further facilitated through the AS portal.

Step 6. Suture Retrieval and Dissection of Coracoclavicular Space

During this step, the anterior subacromial space and coracoclavicular fascia are dissected so that the

Ethibond sutures that were previously placed around the coracoid base can be retrieved. The opening of the rotator interval that was performed during glenohumeral arthroscopy facilitates this step. By the end of this step, the coracoclavicular (CC) space should be clear enough so that the Ethibond sutures that were previously placed under the base of the coracoid are now visible and accessible and had an unhindered route free from soft tissue from coracoid to the clavicle. We switch the scope to the AL portal to ensure the CC space is opened and the lateral limbs of the sutures are accessible (Fig 7).

Step 7. Clavicular Bone Tunnel

A 2-cm incision in line with the clavicle is made at its superior aspect at 2.5-3-cm distance from the ACJ line (Fig 8). The deltotrapezial fascia is recognized and prepared in order to be repaired at the end of the procedure. This is sometimes already torn, while other

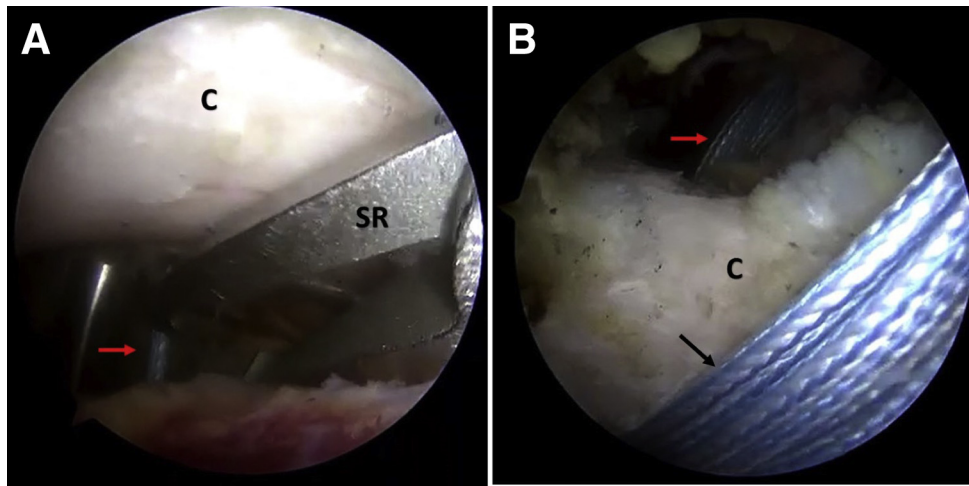


Fig 4. Passage of the sutures around coracoid base. Beach chair position, right shoulder, arthroscopic view from the anterolateral portal. (A) A suture is brought via coracoid portal to the medial side of the coracoid process (red arrow) and then is retrieved from midglenoid portal. (B) This shuttle relay suture brings four Ethibond No 5 sutures (Ethicon, Inc, Somerville, NJ) from the coracoid portal, around the base of the coracoid process, out to the midglenoid portal. In this way four limbs of the sutures are placed medially through the coracoid portal (red arrow) and four limbs laterally through the midglenoid portal (black arrow). C, coracoid; SR, suture retriever through midglenoid portal.

times it seems intact, and once incised, it is obvious that its deep part was torn as a result of the injury. Through this incision, a K-wire is placed through the distal clavicle at the middle of its anteroposterior width, at the level between the conoid and trapezoid ligament insertion directed toward the coracoid base. Except from the distance from the ACJ that determines the anatomic position of the clavicular bone tunnel, another technical tip is that the clavicular bone tunnel

should be just over the coracoid. In this way, this vertical shortest distance avoids any angulation of the sutures between coracoid process and clavicle. The optimal position of the K-wire can be controlled arthroscopically, and once achieved, one drill hole is made using cannulated drill gradually up to the 4.5-mm drill bit. Using a wire and a shuttle suture, the surgeon passes the lateral four limbs of the Ethibond sutures through the clavicle hole. Then we use the suture retriever to bring two of the medial limbs of sutures just anteriorly to the clavicle, and the other two limbs of the medial sutures are passed directly posteriorly to the clavicle (Fig 9).

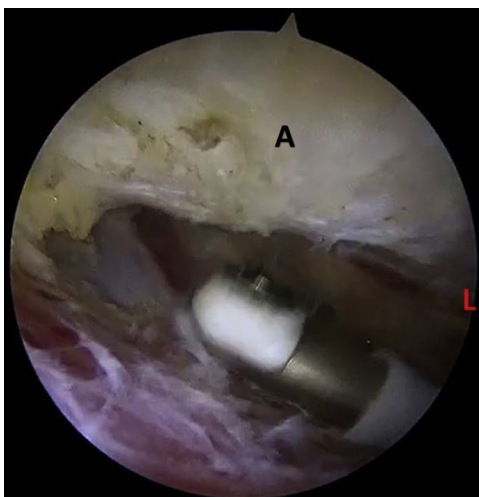


Fig 5. Subacromial arthroscopy. Beach chair position, right shoulder, arthroscopic view from the standard posterior portal. The RF ablation device (Apollo RF MP90, Arthrex) is used through the lateral portal to debride the subacromial space. A, acromion; L, laterally.

Step 8. Coracoclavicular Fixation

The ACJ is reduced by applying downward and slight anterior pressure to the clavicle and by counteracting through the elbow to push the scapula upward. An alternative and more direct way of reduction is to retract upward and laterally the inferior corner of the scapula instead of pushing the shoulder upward through the elbow. After reduction of the ACJ, we tie the four suture pairs in order to reduce the ACJ on the anteroposterior and superoinferior direction. Usually, the anterior sutures are tied first (each one with the respective suture limb through the clavicular bone tunnel) because in most of the type III, and of course in type IV and V dislocations, there is a posterior translation of the clavicle related to the scapula. In this way, the posterior translation of the clavicle can be reduced, even though we should be careful not to over-reduce

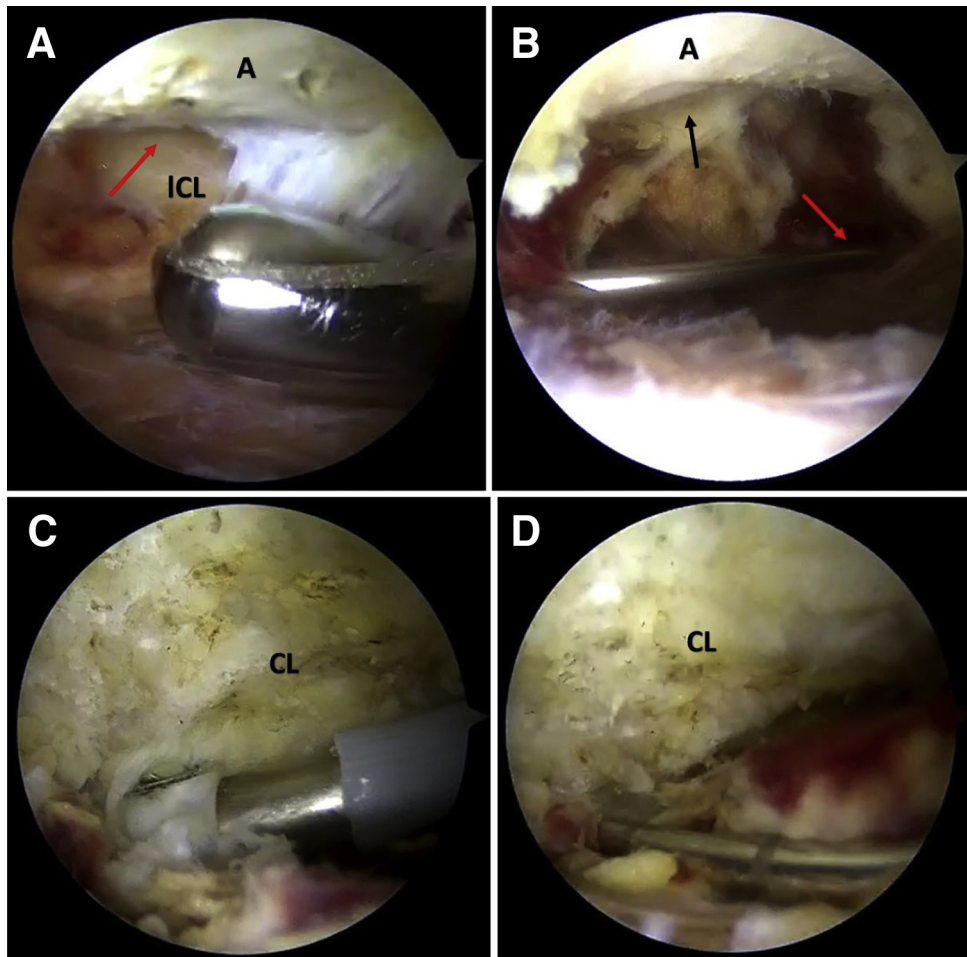


Fig 6. Dissection of acromioclavicular joint and lateral clavicle. Beach chair position, right shoulder, arthroscopic view from the lateral portal. (A) Through the midglenoid as working portal the inferior part of the acromioclavicular joint (ACJ) (red arrow) is debrided and exposed. (B) An accessory anterosuperior (AS) portal parallel to ACJ (black arrow) is created with the outside-in technique using a spinal needle (red arrow). (C) Through the AS working portal, the debridement of the ACJ and medial part of lateral clavicle proceeds. (D) Through the midglenoid as working portal, the underlying soft tissue of coracoclavicular space can be pushed down with a probe to facilitate the viewing and dissection. A, acromion; CL, medial part of lateral clavicle; ICL lateral clavicle.

anteriorly the clavicle. Then, the two posterior limbs are tied one by one with their respective suture limbs from the clavicle tunnel (Fig 10). The reduction is confirmed by fluoroscopy, and usually, a slight inferior over-reduction of few millimeters is preferred. At the end, remnants of the superior capsule and then the delto-trapezial fascia are reconstructed with vicryl suture (Fig 11). The wound is closed in typical fashion.

Postoperative Care

Immobilization for the healing period, especially the first 5 weeks postoperatively is mandatory in order to avoid loading the repair through the weight of the arm. Range of motion exercises can start immediately after this period.

Discussion

Numerous surgical techniques have been described for the treatment of acute AC joint dislocation.⁹⁻²³ The goals of the new anatomic CC ligament reconstruction techniques are to achieve anatomic reduction of the ACJ and adequate fixation in order to allow and facilitate primary healing of AC and CC ligaments, and also to minimize the risk of associated complications.

We present the arthroscopically assisted surgical technique for the double-loop suture repair that has been originally described as an open procedure.^{13,21,22} The advantages of the double-loop suture repair technique are the following: This technique provides adequate stabilization of the AC joint, and the long-term results of the open procedure were good to

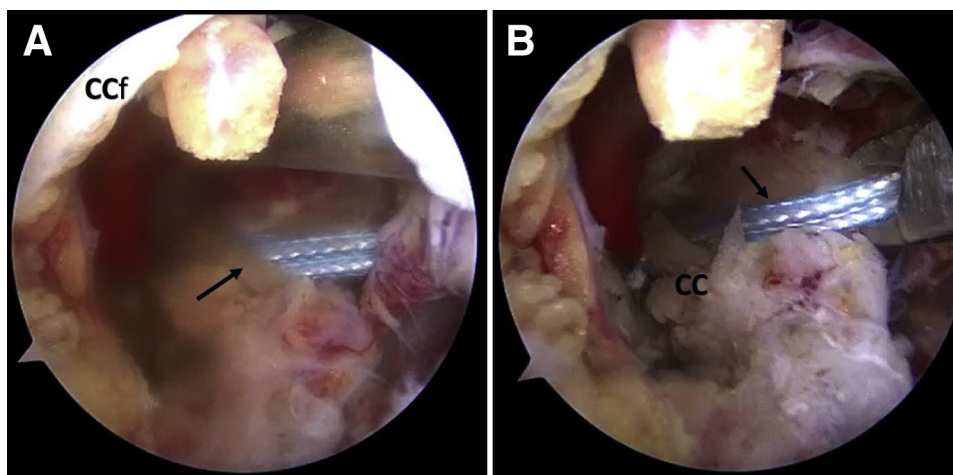


Fig 7. Preparation of coracoclavicular space. Beach chair position, right shoulder, arthroscopic view from the anterolateral portal. (A) The coracoclavicular space is adequately debrided, and the lateral limbs of the four Ethibond sutures are visible and accessible (black arrow). The radiofrequency ablation device is through the midglenoid portal. (B) The lateral limbs of the Ethibond sutures (black arrow) are taken through the midglenoid portal to ensure their unhindered route and free them from surrounding soft tissue. CCf, coracoclavicular fascia CC, coracoclavicular space.

excellent, with 5.8% loss of reduction (less than half of the clavicle width) but with no clinical consequences for the patients, no fractures, no signs of arthritis, but one case (3%) with persistent tenderness at the AC joint.¹³ In addition, the technique minimizes the number of bone tunnels by passing the sutures around the base of the coracoid, thus avoiding the possible complications related to coracoid tunnels (coracoid fracture, tunnel widening, and consequent instability).² Also, as shown in a recent meta-analysis, suture-based techniques may provide more cost-effective and greater

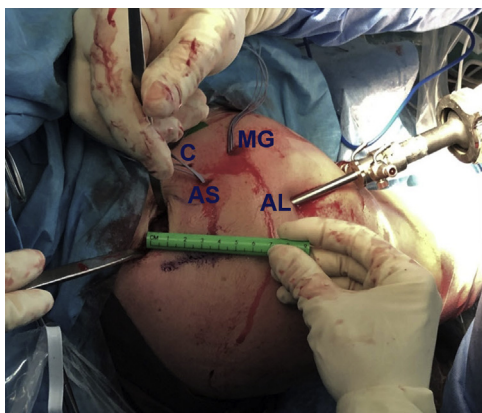


Fig 8. Clavicular bone tunnel. Beach chair position, right shoulder. Outside view showing the skin incision made at the superior aspect of clavicle at 2.5-3 cm from the acromioclavicular joint. The clavicle has been dissected and Hohmann retractors have been placed at the anterior and posterior clavicle borders. The four sutures have been placed on the midglenoid (lateral limbs) and anterosuperior (medial limbs) portals. AL, anterolateral; AS, anterosuperior; C, coracoid; MG, midglenoid portal.

value treatment for AC joint injury and could be considered in the surgical management especially of cost-sensitive populations.²³ Finally, the percentage of associated lesions, mostly intra-articular (rotator cuff tears, superior labrum anterior to posterior SLAP tears, biceps pathology), that can be treated at the time of the ACJ procedure has been reported ranging from 18 to 49%.^{24,25}

The technique is not absolutely equal to the techniques that use a single strand (sutures, tapes, or graft) that is placed between the insertion of conoid and trapezoid ligaments at clavicle and fixed at the superior surface of the clavicle with button devices. This is because in the double-loop suture repair technique, the sutures that pass around the clavicle (around the posterior and anterior margins) create a less rigid, yet stable, construct that may allow a small, but clinically necessary, degree of rotation (normal rotational movement of clavicle along its long axis is 5-8° at its ACJ edge) that provides adequate stability in long-term follow-up.^{13,26}

Although no biomechanical data exist to compare between our technique and other arthroscopically assisted techniques, especially for the control of horizontal instability, the double-loop suture repair technique controls both the horizontal and vertical components of stability only by the CC internal bracing and offers a stable construct at both planes that allow for primary healing of the AC and CC ligaments. This occurs because the heavy sutures are passed around the anterior and posterior cortex of the clavicle, thus controlling and preventing the posterior movement that is related to horizontal instability. By tying two pairs of nonabsorbable sutures anteriorly and then two pairs of

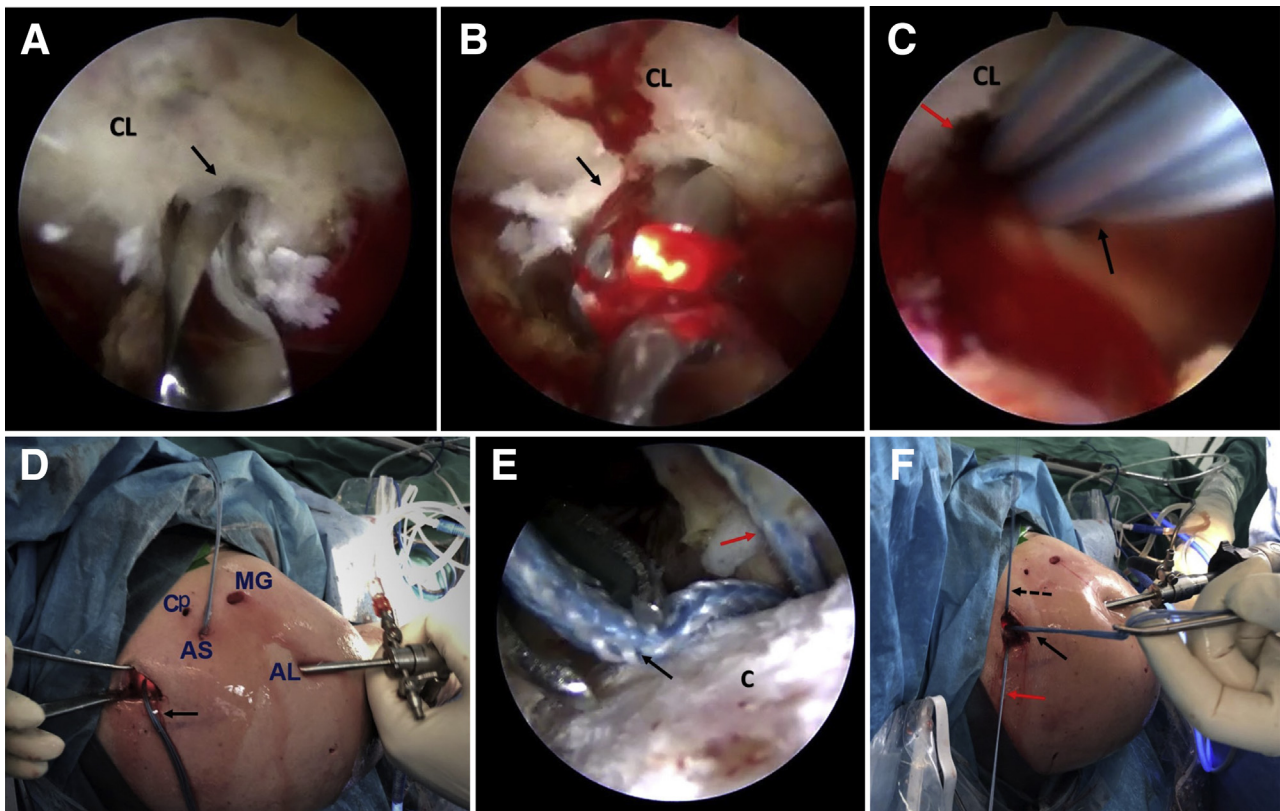


Fig 9. Step 5. Clavicular bone tunnel. Beach chair position, right shoulder, arthroscopic view from the anterolateral portal. (A) A K-wire has been placed through the distal clavicle at the middle of its anteroposterior width (black arrow), at the level between the conoid and trapezoid ligament insertion directed toward the coracoid base. The optimal position of the K-wire is controlled arthroscopically. (B) The K-wire is overdrilled using cannulated drill (black arrow) gradually up to the 4.5-mm drill bit. (C) Using a wire and a shuttle suture, the lateral four limbs of the four Ethibond sutures (black arrow) are passed through the clavicular bone tunnel (red arrow). (D) Respective outside view for part C. The lateral four limbs of the 4 Ethibond sutures are passed through the clavicular bone tunnel (black arrow), and the medial limbs are passed through the anterosuperior portal (AS). (E) The suture retriever is used to bring two of the medial limbs of sutures (black arrow) just anteriorly to the clavicle and the other two limbs of the medial sutures (red arrow) will be passed directly posteriorly to the clavicle. (F) Respective outside view for part E. The lateral four limbs of the 4 Ethibond sutures are passed through the clavicular bone tunnel (black arrow). Two of the medial sutures are passed posteriorly (red arrow) to the clavicle and the other two anteriorly (dashed arrow). AS, anterosuperior portal; AL, anterolateral portal; C, coracoid process; CL, clavicle; Cp, coracoid portal; MG, midglenoid portal.

sutures posteriorly, the surgeon may be able to adjust the reduction in the horizontal plane except from the obvious reduction on the vertical plane.^{21,22} However, we believe that we cannot restore horizontal stability with this technique in chronic cases. In our practice in chronic cases (>3-6 weeks), we modify our technique. On the other hand, although the technique does not use two bundles to reconstruct both conoid and trapezoid components of the coracoclavicular ligament complex, it has shown good clinical results and no increased risk for remaining or secondary instability in the vertical or horizontal plane.¹³ Moreover, the philosophy of all of these new anatomic techniques is not to rely only on the heavy sutures but to achieve the reduction of the AC joint and CC distance in order to allow for primary healing of the torn ligaments whenever possible. For this reason, in our surgical technique,

after the debridement of the essential clear coracoclavicular space, we always aim to find and reproduce the shortest coracoclavicular distance. In this way, the clavicular tunnel drilling corresponds between the attachment of conoid and trapezoid ligaments, but also importantly, it is the drilling directly over the coracoid that represents the shortest distance that the heavy sutures undertake to withstand loading.

During this surgical technique, no complications were reported. Regarding possible risks of the procedure, superficial and deep wound infection, hematoma, clavicular fracture, brachial plexus, and musculocutaneous nerve injuries should be mentioned. The coracoid portal is created in order to perform coracoid preparation safely and avoid nerve injuries. It is created exactly over the coracoid with the outside-in needle technique under direct visualization. It allows the

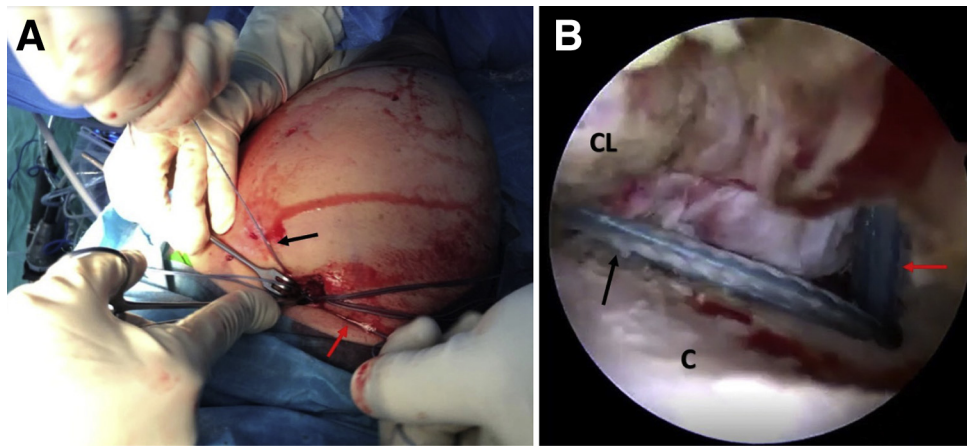


Fig 10. Step 6. Coracoclavicular fixation. Beach chair position, right shoulder. (A) Outside view. After reduction of the acromioclavicular joint, we tie the four suture pairs in order to reduce the ACJ on the anteroposterior and superoinferior direction. One of the anterior sutures (black arrow) is tied with the respective suture limb through the clavicular bone tunnel (red arrow). (B) Arthroscopic view from the anterolateral portal. Final construct after all the four pairs of the sutures have been tied. Two of the medial sutures are driven posteriorly (black arrow) to the clavicle and two anteriorly to the clavicle (red arrow). C, coracoid process; CL, clavicle.

surgeon to approach the coracoid directly in a safe way and not indirectly through other portals, which may result in limited visualization during coracoid debridement and preparation steps. Debridement of coracoclavicular space does not extend medially to the coracoid and conjoint tendon to protect brachial plexus, and for this reason pectoralis minor fascia is just partially detached and close to the coracoid bone. Also, debridement should not extend far distally (more than 5 cm from the conjoint tendon origin) in order to protect the musculocutaneous nerve. Although it is not necessary to dissect routinely the brachial plexus in this operation, it should be noted that the arthroscopic approach is safer than the open approach regarding brachial plexus due to scope visualization. Additionally, no nerve lesions from the brachial plexus or the

musculocutaneous nerve have been reported in the articles about open double-loop technique.^{13,21,22} Regarding clavicular bone tunnel, the use of a K-wire helps to assess correct positioning of the tunnel in anteroposterior dimension of the clavicle and avoid eccentric positioning. Gradual drilling of the clavicular tunnel up to the 4.5-mm cannulated drill bit also helps to minimize the risk for clavicle fracture.

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. Martetschläger F, Zampeli F. What to Do If It Goes Wrong? Solutions After Failure. April 2020. In book: ESSKA Instructional Course Lecture Book, pp175-181 https://doi.org/10.1007/978-3-662-61264-4_25.
3. Rockwood CA. Injuries to the acromioclavicular joint. In: Rockwood CA, Green DP, eds. *Fractures in Adults*. 2nd ed. Volume 1. Philadelphia, PA: JB Lippincott Co, 1984;860.
4. Rosso C, Martetschläger F, Saccomanno MF, et al. High degree of consensus achieved regarding diagnosis and treatment of acromioclavicular joint instability among ESA-ESSKA members. *Knee Surg Sports Traumatol Arthrosc* 2021;29:2325-2332. <https://doi.org/10.1007/s00167-020-06286-w>.
5. Beitzel K, Mazzocca AD, Bak K, et al. Upper Extremity Committee of I ISAKOS upper extremity committee consensus statement on the need for diversification of the Rockwood classification for acromioclavicular joint injuries. *Arthroscopy* 2014;30:271-278.
6. Weaver JK, Dunn HK. Treatment of acromioclavicular injuries, especially complete acromioclavicular separation. *J Bone Joint Surg Am* 1972;54:1187-1194.
7. Boileau P, Old J, Gstaad O, Brassart N, Roussanne Y. All-arthroscopic Weaver-Dunn-Chuinard procedure with

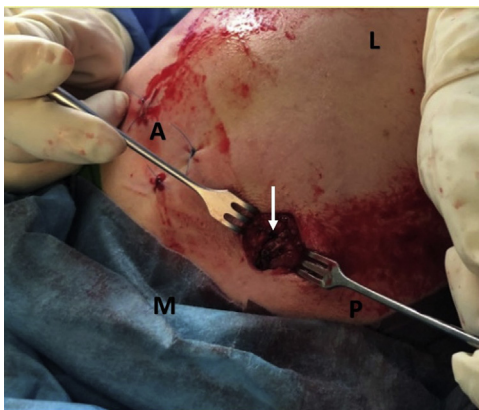


Fig 11. Remnants of the superior capsule and then the deltotrapezial fascia are reconstructed with vicryl suture (white arrow). A, anteriorly; L, laterally; M, medially; P, posteriorly.

- double-button fixation for chronic acromioclavicular joint dislocation. *Arthroscopy* 2010;26:149-160.
8. Millett PJ, Braun S, Gobeze R, Pacheco IH. Acromioclavicular joint reconstruction with coracoacromial ligament transfer using the docking technique. *BMC Musculoskeletal Disord* 2009;10:6.
 9. Beitzel K, Obopilwe E, Chowaniec DM, et al. Biomechanical comparison of arthroscopic repairs for acromioclavicular joint instability: Suture button systems without biological augmentation. *Am J Sports Med* 2011;39:2218-2225.
 10. Xue C, Song L, Zheng X, Li X, Fang J, Shen Y. Truly anatomic coracoclavicular ligament reconstruction with 2 EndoButton devices for acute Rockwood type V acromioclavicular joint dislocations: 5-year findings. *J Shoulder Elbow Surg* 2021;2(21):S1058-2746. <https://doi.org/10.1016/j.jse.2021.08.029>. 00701-1.
 11. Nuchtern JV, Sellenschloh K, Bishop N, Jauch S, et al. Biomechanical evaluation of 3 stabilization methods of acromioclavicular joint dislocations. *Am J Sports Med* 2013;41:1387-1394.
 12. Shin SJ, Jeon YS, Kim RG. Arthroscopic-assisted coracoclavicular ligament reconstruction for acute acromioclavicular dislocation using 2 clavicular and 1 coracoid cortical fixation buttons with suture tapes. *Arthroscopy* 2017;33:1458-1466.
 13. Panagopoulos A, Fandridis E, Rose GD, et al. Long-term stability of coracoclavicular suture fixation for acute acromioclavicular joint separation. *Knee Surg Sports Traumatol Arthrosc* 2021;29:2103-2109. <https://doi.org/10.1007/s00167-020-06158-3>.
 14. Gu F, Tan L, Wang T, Wen Q, Su Z, Sui Z, Yu T. Comparison of single versus double TightRope system in the treatment of acute acromioclavicular joint dislocation. *J Shoulder Elbow Surg* 2021;30:1915-1923. <https://doi.org/10.1016/j.jse.2020.10.002>.
 15. Teixeira Ramos J, Silva Gomes D, Quinaz Neto P, Sarmiento M, Moura N, Cartucho A. Arthroscopic-assisted acromioclavicular joint dislocation repair: A modified technique for horizontal stabilization using suture anchors. *Arthrosc Tech* 2021;10:e283-e288. <https://doi.org/10.1016/j.eats.2020.10.004>.
 16. 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.
 17. Martetschlager F, Tauber M, Habermeyer P, Selim HA. Arthroscopic coracoclavicular and acromioclavicular stabilization of acute acromioclavicular joint dislocation by suspensory fixation system. *Arthrosc Tech* 2019;8:e611-e615. <https://doi.org/10.1016/j.eats.2019.02.002>.
 18. Hachem AI, Rondenelli SR, Costa G, Verdalet I, Ezzeddine H, Rius X. Arthroscopically assisted comprehensive double cerclage suture fixation technique for acute acromioclavicular joint separation. *Arthrosc Tech* 2020;9:e1495-e1504. <https://doi.org/10.1016/j.eats.2020.06.012>.
 19. Lafosse T, Fortané T, Lafosse L. All-endoscopic treatment of acromioclavicular joint dislocation: Coracoclavicular ligament suture and acromioclavicular ligament desincarceration. *Arthrosc Tech* 2020;9:e1485-e1494. <https://doi.org/10.1016/j.eats.2020.06.011>.
 20. Joshi A, Basukala B, Singh N, Rijal S, Karki DB, Bista R, Pradhan I. Arthroscopy-assisted all-suture coracoclavicular and acromioclavicular joint stabilization in acute acromioclavicular joint injuries. *Arthrosc Tech* 2021;10:e1293-e1306. <https://doi.org/10.1016/j.eats.2021.01.029>.
 21. Dimakopoulos P, Panagopoulos A, Syggelos SA, Panagiotopoulos E, Lambiris E. Double-loop suture repair for acute acromioclavicular joint disruption. *Am J Sports Med* 2006;34:1112-1119. <https://doi.org/10.1177/0363546505284187>.
 22. Dimakopoulos P, Panagopoulos A. Functional coracoclavicular stabilization for acute acromioclavicular joint disruption. *Orthopedics* 2007;30:103-108.
 23. Marín Fermín T, Hovsepian JM, Rodrigues Fernandes VM, Terzidis I, Papakostas E, Koh J. Nonanatomic and suture-based coracoclavicular joint stabilization techniques provide adequate stability at a lower cost of implants in biomechanical studies when compared with anatomic techniques: A systematic review and meta-analysis. *Arthrosc Sports Med Rehabil* 2021;3:e573-e591. <https://doi.org/10.1016/j.asmr.2020.12.007>.
 24. Ruiz Ibán MA, Moreno Romero MS, Diaz Heredia J, Ruiz Díaz R, Muriel A, López-Alcalde J. The prevalence of intraarticular associated lesions after acute acromioclavicular joint injuries is 20%. A systematic review and meta-analysis. *Knee Surg Sports Traumatol Arthrosc* 2021;29:2024-2038. <https://doi.org/10.1007/s00167-020-05917-6>.
 25. Lamplot JD, Shah SS, Chan JM, et al. Arthroscopic assisted coracoclavicular ligament reconstruction: Clinical outcomes and return to activity at mean 6-year follow-up. *Arthroscopy* 2021;37:1086-1095.
 26. Ludewig PM, Behrens SA, Meyer SM, Spoden SM, Wilson LA. Three-dimensional clavicular motion during arm elevation: Reliability and descriptive data. *J Orthop Sports Phys Ther* 2004;34:140-149. <https://doi.org/10.2519/jospt.2004.34.3.140>.