Technical Note

All-Arthroscopic Coracoacromial Ligament Transfer: The Modified Neviaser Procedure for Acromioclavicular Dislocations

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Abstract: Over the course of the years, the topic of optimizing the management of acromioclavicular joint dislocations has gained popularity, remaining a subject of debate. It has been determined that posterior horizontal instability appears to be one of the factors influencing both clinical and radiographic outcomes, postsurgical reconstructions with coracoclavicular techniques. In contrast, the acromioclavicular ligament complex (ACLC) has been experimentally demonstrated to play a crucial role in horizontal translation and rotational stability of the clavicle. Although several strategies have been established, perfect surgical timing, and its potential impact during the healing process, remain poorly defined. Furthermore, appropriate surgical techniques to restore normal acromioclavicular joint kinematics while ensuring an adequate biological environment remain unclear. Due to the existence of multiple features present in acromioclavicular joint reconstruction techniques, an ideal approach involves ACLC and coracoclavicular combination reconstruction, minimal clavicular drilling, and biological enhancement to ensure anatomical reduction and an adequate process of ligament healing. The purpose of this Technical Note is to present a modified surgical technique of the Neviaser procedure. This modified surgical technique combines an all-arthroscopic single tunnel coracoclavicular fixation with the transfer of the coracoacromial ligament to reconstruct the ACLC.

The inability to establish a consensus for Rockwood type III injuries regarding operative decision-making has influenced the current ambiguity in determining the gold standard treatment for acromioclavicular joint (ACJ) dislocations.[1] Based on clinical and radiographic evidence of posterior instability, Rockwood type III injuries can be further subdivided to distinguish stable subtype IIIA from unstable subtype IIIB.[2] In efforts to assess the acromioclavicular ligament complex (ACLC) function and improve reconstructions in horizontal translation and rotational torque stability, many studies have been published[3] secondary to reported inferior outcomes in patients with residual dynamic posterior translation (DPT) after coracoclavicular (CC) fixation.[4] However, the most appropriate surgical method to address these lesions is still unclear.

The surgical technique presented in this Technical Note is a modification of the Neviaser procedure. We combine a single-tunnel full-arthroscopic CC reconstruction with a suspensory device and reconstruct the anteroinferior bundle (AIB) of the ACLC by a coracoacromial (CA) ligament transfer. The described procedure aims to treat subacute (>1 week, <6 weeks) Rockwood type IIIB, IV, and V lesions and acute, high-grade injuries in patients who may benefit from biological augmentation graft.[5] Contraindications include chronic high-grade dislocations, patients with irreparable rotator cuff tears, and the absence of an autograft source (Table 1).

Surgical Technique (With Video Illustration)

This technique enables ACJ reconstruction by using a single tunnel suspensory device for stabilization of the

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Table 1. Advantages and Disadvantages

Advantages	Disadvantages
• Simultaneous management of concomitant pathologies is achieved through the arthroscopic approach. • Distal clavicular bone resection is not necessary for graft fixation. • It is not necessary to intervene on the acromial side. • There is no morbidity associated with the donor site when using local autograft. • By keeping the acromial insertion of the CA ligament intact, vascularity is partially preserved. • The fixation and orientation of the graft are determined by the normal anatomy of the anterior anteroinferior bundle of the AC ligament. • The quality of the reduction can be assessed by direct arthroscopic visualization of the AC joint. • Two 2.4-mm clavicular tunnels each could theoretically reduce the risk of fracture. • Management of the components to restore vertical, horizontal, and rotational instability.	• The learning curve and the initial surgical time can be a concern. • Aimed at highly qualified and experienced arthroscopists • Theoretical advantages in the shoulder kinematics following this CA ligament transfer have not been evaluated. • The biomechanical advantages of this surgical configuration have not yet been proven.

AC, acromioclavicular; CA, coracoacromial.

Table 2. Pearls and Pitfalls

Pearls	Pitfalls
Create the classic anteroinferior portal, but slightly lateral and inferior. An outside-in technique is recommended.	The misplacement of the anteroinferior portal could damage the CA ligament and the efficacy of instrument handling for coracoid drilling.
Initiate the dissection of the subdeltoid space after the rotator interval is open and before switching the camera to the lateral portal.	An early switch of the camera to the lateral portal could hinder the release of the conjoint tendon and the correct visualization of the subdeltoid space.
Keeping a switching stick in the lateral portal is crucial to improve visualization when the camera is placed in the anterior shoulder region.	The anterior subdeltoid space tends to be narrow; it is helpful if a surgical assistant can manage the retraction of the deltoid fibers.
A complete dissection underneath and behind the CA ligament facilitates the management of the sutures through its fibers.	Suturing of the ligament should be initiated after ensuring complete resection of the underlying soft tissue.
A straight needle inserted within the AC joint is used as a landmark during clavicle dissection.	The presence of scar tissue or remnant ligament fibers may prevent a precise exposure of the distal clavicle. In addition, keeping the joint line localized avoids excessive resection of the AC ligament.

AC, acromioclavicular; CA, coracoacromial.

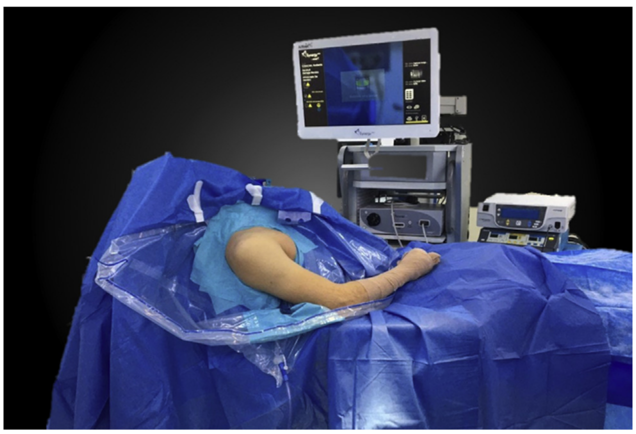

Fig 1. The patient is placed in a beach-chair position for arthroscopic coracoacromial ligament transfer. The C-arm should be placed on the back of the patient.

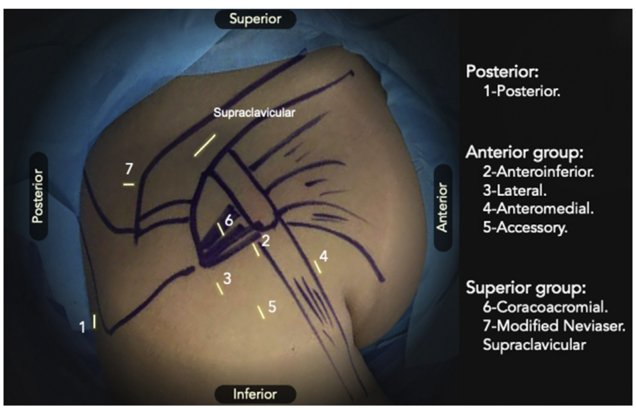

Fig 2. Positions of the portals marked on the right shoulder in the beach-chair position.

Table 3. Technical Tips and Tricks for Portal Positioning

Posterior
Classic posterior
It is the classic portal established in the soft spot.
Use a needle to confirm the position parallel to or slightly lateral to the glenoid face.
Anterior group
Anteroinferior
Insert a needle through the anterior deltoid muscle 1 cm medial and 1 cm distal to the coracoid tip using an outside-in technique.
Confirm the location by a direct arthroscopic vision to avoid damage to the CA ligament or CT.
Lateral
Insert a needle 2 cm lateral and 1-2 cm anterior to the anterolateral corner of the acromion.
Viewing from the posterior portal, confirm the direction of the needle.
Create a portal parallel to the subscapularis tendon and below the level of the coracoid.
Anteromedial
Create this portal under direct vision with the camera in the lateral portal.
It must be established once the subdeltoid space has been created, so it is mandatory to release the anterior adhesions of the CT adequately.
Place a spinal needle 2cm proximal to the apex of the axillary fold.
Confirm the direction of the needle lateral to the CT and toward the CA ligament.
Superior group
Accessory
To establish this portal, place the camera in the anteromedial portal.
Locate the midpoint between the lateral and anteroinferior portal, go distally, and place a spinal needle at the height of the anteromedial portal.
Upon arthroscopic visualization, confirm the direction towards the CA ligament.
Coracoacromial (CA)
The camera is located in the anteromedial portal.
Using an outside-in technique, insert a needle at the midpoint between the acromion and the coracoid process.
Place the portal perpendicular to the fibers and above the center of the CA ligament.
An oblique or anterior orientation of the CA portal could prevent adequate reach of the posterior bundle of the CA ligament.
Neviaser
Use an outside-in technique under direct vision with the camera in the accessory portal.
This portal is slightly medial in comparison to the classic Neviaser.
Insert a needle at 1.5 cm medial to the AC joint line.
Confirm the location once the tip of the needle reaches the posterosuperior quadrant of the clavicle.

AC, acromioclavicular; CA, coracoacromial; CT, conjoint tendon.

CC, in addition to the arthroscopic transfer of the CA ligament over the anteroinferior aspect of the clavicle (Table 2). Informed consent was obtained, and the right to privacy of human subjects was always respected. The study was conducted in conformity with the Helsinki declaration and its own modifications, and ethical approval was obtained from our institutional Medical Ethics Committee (Hospital Militar de Santiago, Chile).

Patient Positioning and Anesthesia

The surgical procedure (Video 1) requires positioning the patient in a beach-chair position, under general

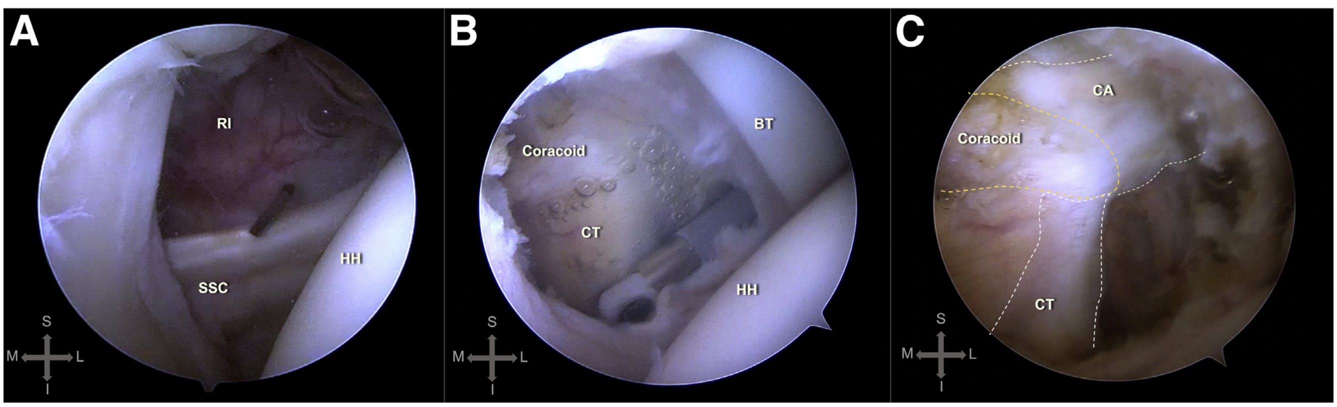

Fig 3. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the posterior viewing portal. (A) A spinal needle is placed in the rotator interval (RI), proximal to the subscapularis (SSC) tendon. (B) A radiofrequency device is inserted in the lateral working portal. The coracoid process, the conjoint tendon (CT), the biceps tendon (BT), and the humeral head (HH) are shown. (C) Dissection and exposure of the coracoacromial ligament (CA) after opening the RI.

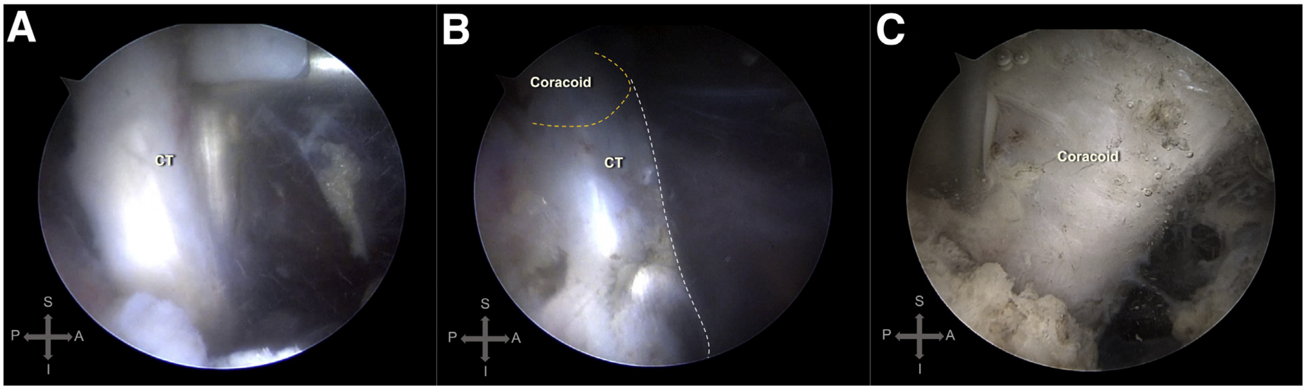

Fig 4. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the lateral portal. (A) Lateral border of the conjoint tendon (CT), the radiofrequency device is inserted through the anteromedial portal. (B) The subdeltoid space was created after the resection of the bursa. The tip of the coracoid and the anterior aspect of the conjoint tendon (CT) are identified. (C) Complete exposure of the base of the coracoid after resection of the soft tissue beneath its base.

anesthesia, followed by an interscalene nerve block. The shoulder is prepared and draped under sterile conditions (Fig 1).

Diagnostic Arthroscopy and Opening of Rotator Interval

This technique requires 7 portals and 1 incision (Fig 2, Table 3). Using a standard posterior portal, a diagnostic arthroscopic is initially performed. Establishing an anteroinferior working portal within the rotator interval follows. Using radiofrequency for dissection, the lateral border of the coracoid process is exposed, which is facilitated by creating a working lateral portal. The preservation of the CA ligament and the conjoint tendon is crucial (Fig 3). Continue dissection of the subcoracoid space for coracoid base expose.

Opening Subdeltoid Space

The camera is changed to the lateral portal. First, establish the anteromedial portal using the outside-in technique. Next, expose the lateral half of the conjoint tendon and superior aspect of the CA ligament by creating an anterior subdeltoid space. Remove soft tissue from under the coracoid for optimal visualization of the medial border and base (Fig 4).

Coracoclavicular Drilling and Fixation

A 1.5-cm supraclavicular incision is made on the long axis of the clavicle 3.5 cm medial to the ACJ line. With fluoroscopy assistance, use a 2.4-mm cannulated drill bit at 3.5 cm medial to the ACJ. Using arthroscopic visualization, insert the marking hook of an acromioclavicular guide (Arthrex, Naples, FL) through the anteroinferior portal and place it underneath the center of the coracoid's base.

Insert a SutureLasso Wire-Loop (Arthrex) through the drill bit and retrieve it via the anteroinferior portal (Fig 5A). Clip the FiberTape Loop onto a Dog Bone Button (Arthrex). Retrieve suture strands by pulling the SutureLasso through the clavicular bone tunnel. Place the button at the coracoid's base (Fig 5B) and reduce the ACJ under fluoroscopic control. The 2 suture strands and the FiberTape loop are clipped into the second button and alternatively pulled until the latter is

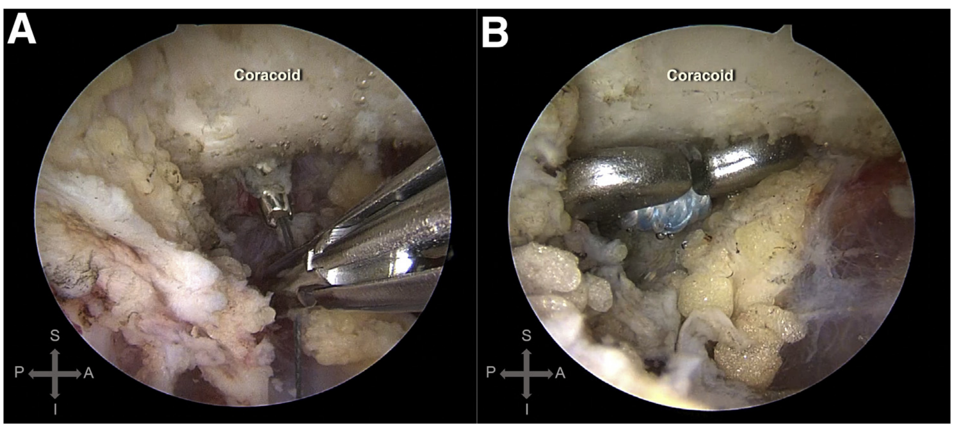

Fig 5. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the lateral portal. (A) Retrieval of the SutureLasso Wire Loop from the drill bit exiting through the base of the coracoid. The grasper is inserted into the anteroinferior working portal. (B) Final position of the inferior button beneath the coracoid.

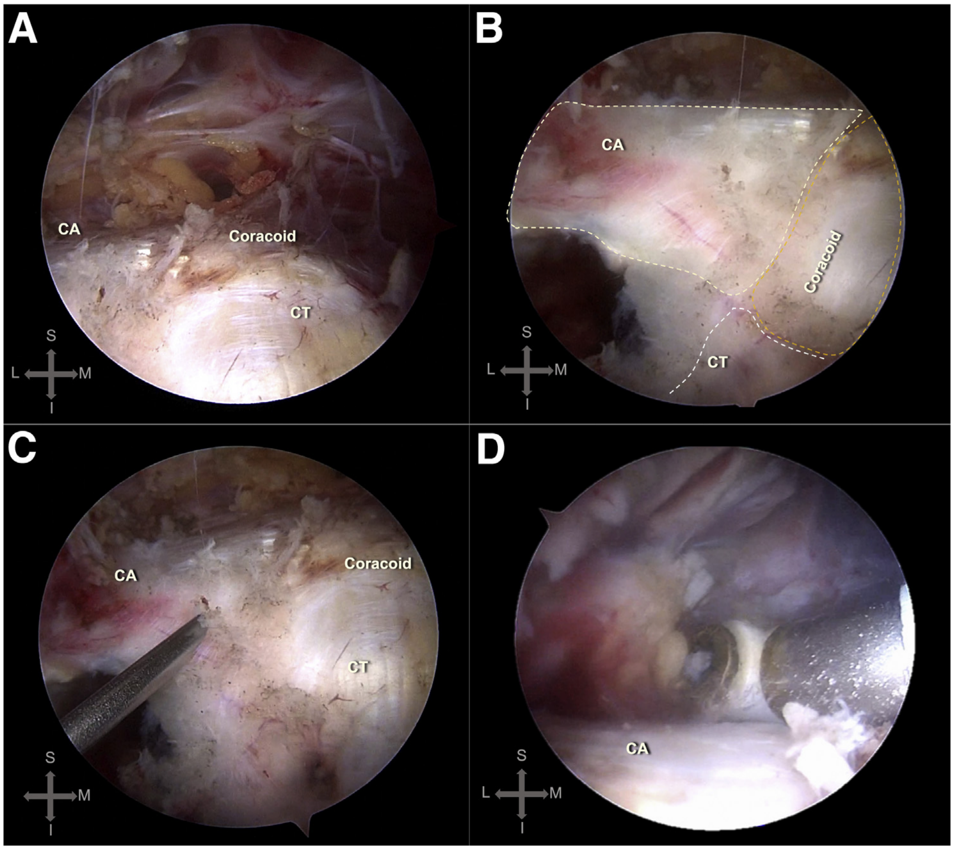

Fig 6. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the anteromedial portal. (A) Frontal view showing the coracoacromial (CA) ligament, the coracoid process, and the conjoint tendon (CT) fibers. (B) After a counterclockwise rotation of the scope and adequate debridement, the entire coracoacromial (CA) ligament can be exposed. (C) Spinal needle placed to establish an accessory portal. (D) Soft-tissue dissection anterior to the acromioclavicular joint. The radiofrequency device is inserted into the accessory portal.

placed on the superior cortex of the clavicle. Finally, the sutures are firmly knotted.

Suture of the CA Ligament

Relocate the camera to the anteromedial portal. An accessory portal is established to conduct a careful dissection of the CA ligament using a radiofrequency device (Fig 6). A switching stick is maintained in the lateral portal underneath the deltoid as a separator and dissector. Upward release of the anterior deltoid insertion facilitates exposure of the anterior clavicle and ACJ identification (Fig 7 A and B). The CA portal is created to introduce a 2.75-mm BirdBeak (Arthrex) with the nonabsorbable suture #2 (Fig 7 C and D). The suture is inserted to perform a single-cinch stitch near the acromial insertion of the anterior bundle. Select 1 of the 2 strands to make the first lasso-loop stitch in the anterior bundle of the CA ligament. The remaining suture strand of the single-cinch stitch is used to perform 2 consecutive lasso-loop stitches in the posterior bundle (Figs 8 A-C and 9). Procced by sectioning the CA ligament from its coracoid attachment and handling the 2 suture ends (Fig 8D).

Transfer and Fixation of the CA Ligament

To create a suitable clavicular attachment zone, the clavicle is accessed through the accessory and CA portals and prepared using a motorized rasp (Fig 10A). At 1.5-cm posteromedial to the ACJ line, the modified Neviaser portal is created (Fig 10B) to drill the clavicle using a 2.4-mm cannulated drill bit (Fig 10C). Using a SutureLasso Wire-Loop (Arthrex), take the strand from the posterior bundle of the CA ligament through the drilled hole (Fig 10D). Then, retrieve the suture from the anterior band of the ligament using a grasper (Fig 10E). As a result, the ligament is twisted on the anteroinferior aspect of the clavicle. Sutures are tightened alternatively to adjust the desired superoinferior location (Fig 10F). The ligament—bone fixation is achieved after firm knotting (Fig 11).

Postoperative Care

An abducted sling is used for four weeks immediately. Passive exercises are allowed since the second week. Active-assisted motion is recommended 4 to 6 weeks postsurgery. Begin strength training at week 8. Six months after surgery, patients are allowed to return to complete activities.

Discussion

The horizontal component of ACJ instability is poorly understood in high-grade injuries, leading to high failure rates after surgical stabilization.[4] There is no consensus

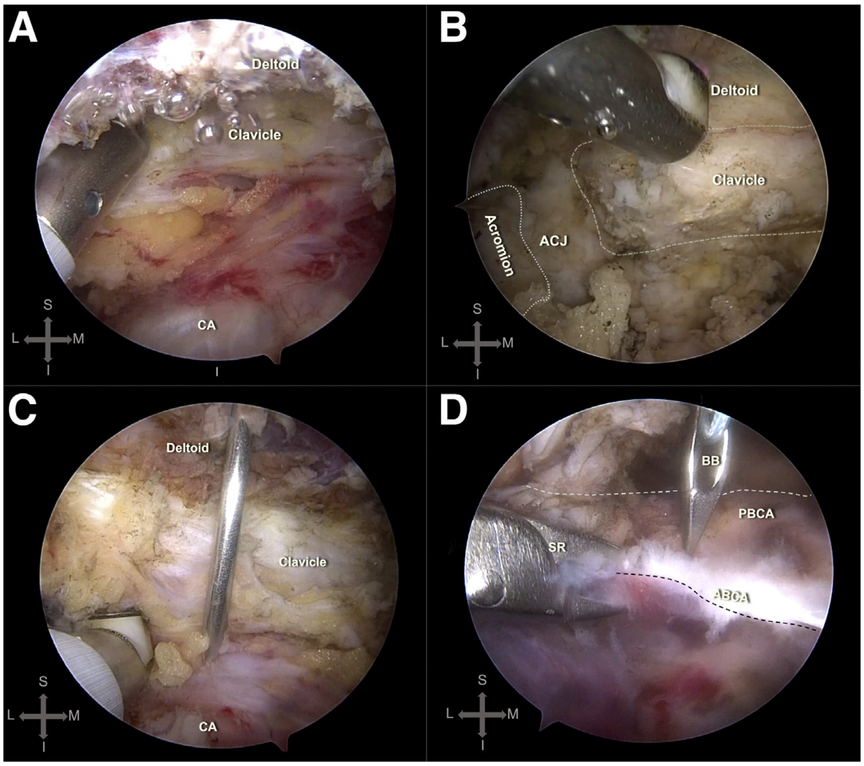

Fig 7. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the anteromedial portal. (A) Detachment of the anterior deltoid fibers inserted on the clavicle. A switching stick (not shown) is inserted into the lateral portal and used as a deltoid retractor. The radiofrequency device is inserted into the accessory portal. (B) Acromion, acromioclavicular joint (ACJ), clavicle, and deltoid are exposed after soft tissue resection and partial detachment of the deltoid. (C) A spinal needle was inserted between the acromion and the coracoid to establish a coracoacromial (CA) working portal. (D) A BirdBeak (Arthrex) (BB) is introduced through the CA portal to initiate suturing of the anterior bundle of the coracoacromial ligament (ABCA). A suture retriever (SR) is used in the accessory portal to tension the ligament and manage the sutures. The posterior bundle of the coracoacromial ligament (PBCA) is also shown.

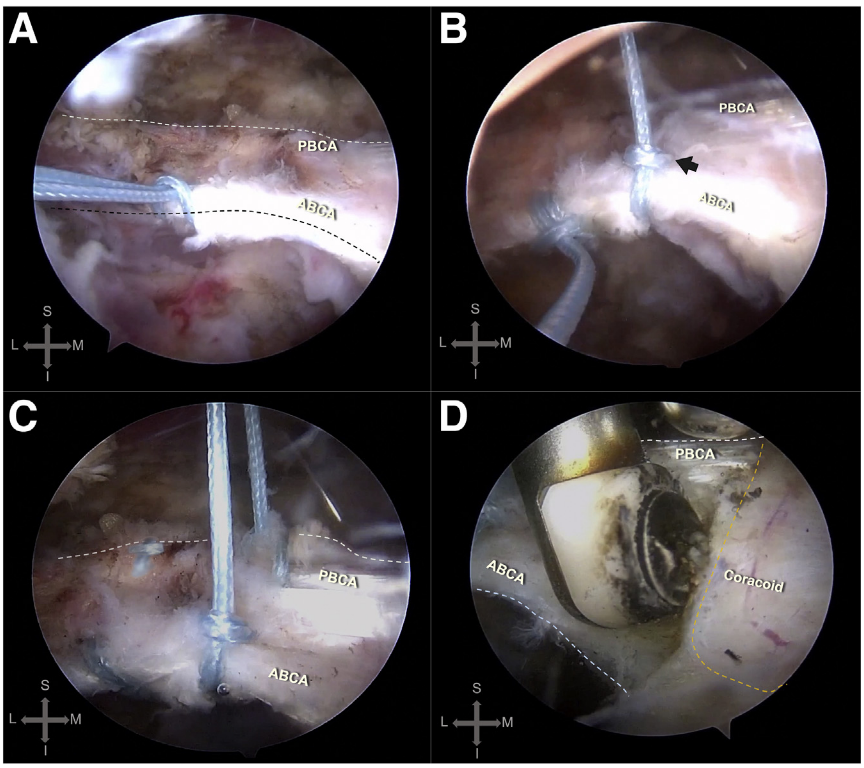

Fig 8. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the anteromedial portal. (A) A simple cinch stitch was placed on the anterior bundle of the coracoacromial ligament (ABCA) near the acromial insertion. (B) A lasso-loop stitch (black arrow) is placed in the ABCA, medial to the previous stitch, and near the coracoid insertion of the ligament. (C) Two additional lasso-loop stitches were placed in the posterior bundle of the coracoacromial ligament (PBCA). (D) Detachment of the coracoacromial ligament from its insertion of the coracoid. Anterior bundle of the coracoacromial ligament (ABCA).

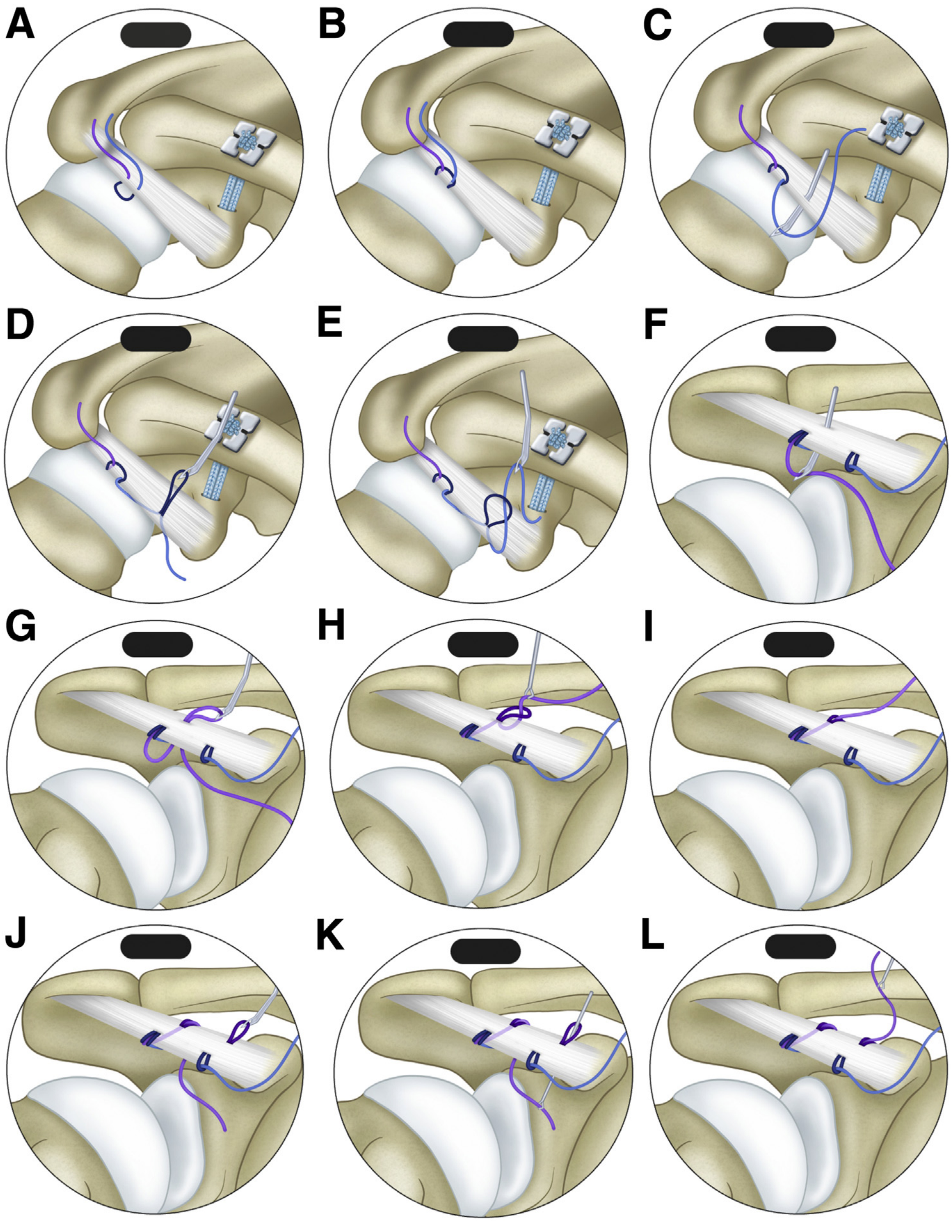

Fig 9. Illustrations summarizing the steps necessary to perform the all-arthroscopic coracoacromial transfer. Posterosuperior view of a right shoulder. (A-E) Suture of the anterior bundle of the coracoacromial ligament (ABCA). (F-L) Suture of the posterior bundle of the coracoacromial ligament (PBCA). (A) A double suture is passed from the upper to the lower aspect of the ABCA using a BirdBeak (Arthrex). The suture is placed approximately 8mm from the acromial attachment. After the instrument was removed, a loop was left under the ligament, and the 2 free suture ends exited the joint through the CA portal. (B) The 2 suture strands are passed through the loop using a suture retriever in the accessory portal and then tightened. One of the 2 suture strands is held outside through the CA portal (purple); the other (blue) is pulled inwards beneath the ligament. (C) To trap the strand (blue), a BirdBeak (Arthrex) is passed through the ABCA about 5 mm from the coracoid insertion. (D) The suture is retrieved through the ligament to create a loop. (E) The BirdBeak (Arthrex) is passed through the loop to pick up the same strand and create the first lasso-loop. (F) The suture held outside by the accessory portal (purple) is pulled inward beneath the ligament. A BirdBeak is passed through the posterior PBCA to catch the suture. (G) The suture is retrieved through the ligament to create a loop. (H) A suture retriever is passed through the loop and driven posterior to the ligament to catch the strand and create a lasso-loop. (I) The strand is pulled taut and then positioned beneath the ligament. (J) A BirdBeak is passed through the ligament to catch the strand and is partially retrieved to create the third loop. (K) A suture retriever is inserted into the loop and driven behind the ligament to trap the strand and create the last lasso loop. (L) Final view of the 2 rows of self-cinching stitches performed on the ligament.

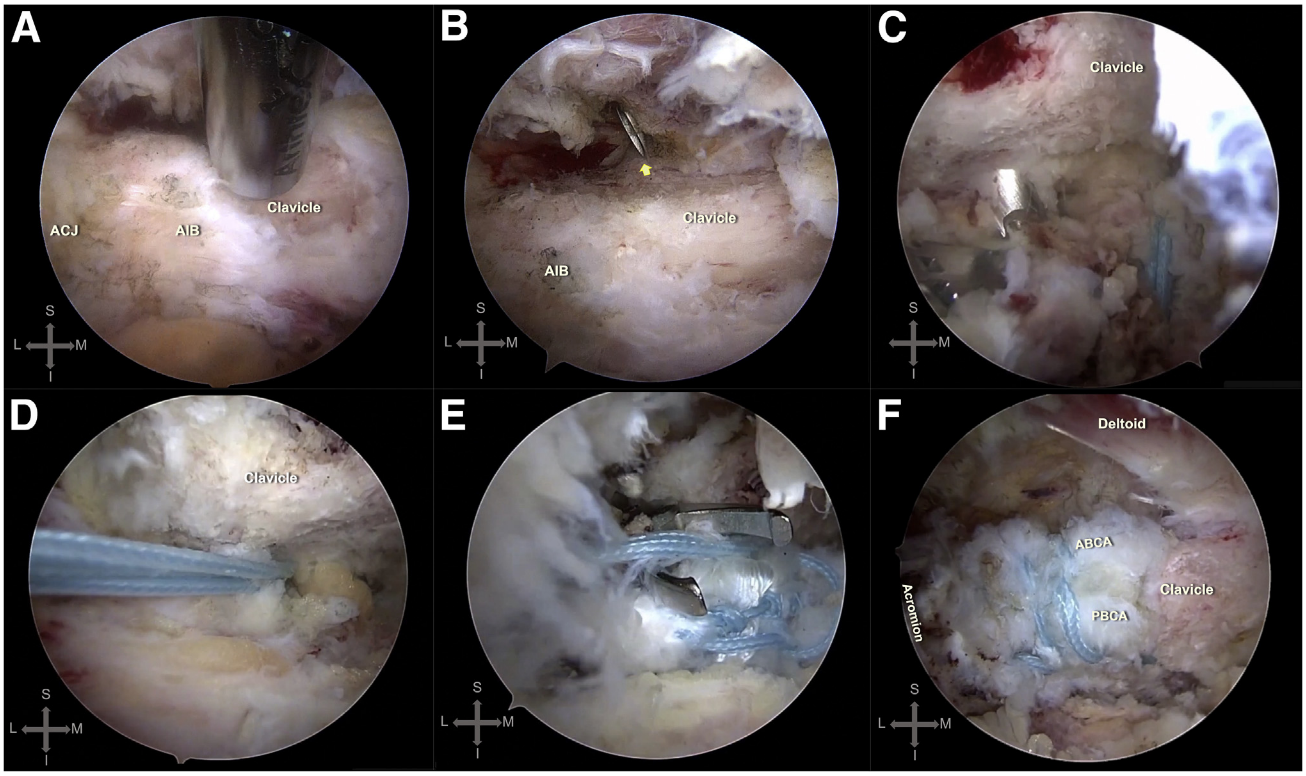

Fig 10. Arthroscopic view of the right shoulder in beach-chair position using a 30° arthroscope from the accessory portal. (A) Preparation of the transfer recipient site on the anterior aspect of the clavicle, using a motorized rasp and preserving the anteroinferior bundle (AIB) of the acromioclavicular ligament. (B) Needle (yellow arrow) marking the location of the modified Neviaser portal at the posterolateral quadrant of the distal clavicle. (C) Cannulated drill bit exiting the anteroinferior aspect of the clavicle. (D) The suture is transported through the clavicular bone tunnel. (E) A suture grasping is used to retrieve the remaining suture using the modified Neviaser portal. (F) Final view of the transferred ligament on the anterior aspect of the clavicle. Anterior bundle of the coracoacromial ligament (ABCA), posterior bundle of the coracoacromial ligament (PBCA).

available regarding the optimal surgical technique for this setting.[4,5] Persistent DPT has been observed after the isolate stabilization of the CC component. In a case series of 28 patients, 42% showed significantly worse outcomes due to residual DPT at the final follow-up.[3] In addition, a lower incidence of DPT (5.8%) in a prospective series of 34 patients has been associated with the additional ACJ cerclage used to reconstruct type V lesions.[6] Therefore, acromioclavicular augmentation in high-grade lesions could be considered to preserve horizontal stability.[5,7]

Transference of the CA ligament to the superior aspect of the clavicle, preserving the acromial insertion, was described in 1951 by Neviaser, showing excellent results in 92% of 112 chronic and acute cases at 10 years of follow-up.[8] According to the author, the growth of a new ligament after the transfer was the hypothesis of success.[9] We presented an arthroscopic

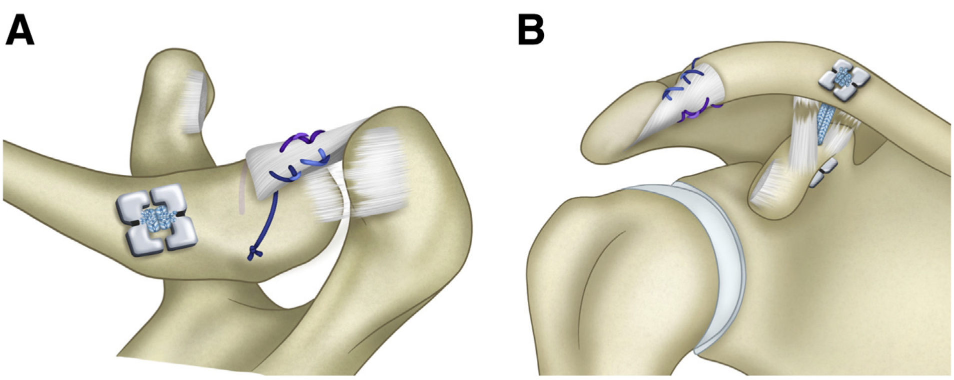

Fig 11. Illustration of the final aspect of the reconstruction. (A) Superior view of the right shoulder. The ligament is twisted on its axis and transferred over the anteroinferior part of the clavicle, so the posterior row of self-cinching stitches is located inferiorly, and the anterior row is located superiorly. (B) Anterior view of the right shoulder

modified Neviaser procedure to increase horizontal and torque stability and add biological augmentation. Nakazawa et al.[10] have divided the acromioclavicular ligament into 2 parts, the AIB and the superoposterior bundle. In the current surgical technique, we aimed to reconstruct the AIB using the CA ligament. According to previous reports, the anterior segment of the acromioclavicular ligament provides stability under rotational loading and posterior translation.[3] Moreover, biological reinforcement has been advised in acute high-grade dislocations[5] and may benefit patients aged >50 years.[6]

The chronicity of the injury remains poorly delimited, and most authors defined acute injuries as less than 3 weeks and chronic dislocations further than 6 weeks.[7] We define subacute injuries as between 3 and 6 weeks. This separation may be crucial in assessing low-grade injuries and improving the decision-making process during the selected treatment. For patients who have been injured for more than 3 weeks, surgical methods involving biological augmentation have been recommended to assist in healing.[11] Therefore, in the acute or subacute scenario, high-grade injuries might be suitable for treatment using our approach.

The current technique used a suspensory system in the CC component rather than a K-wire fixation on the ACJ, as occurs in the original technique.[8] Biomechanical results support single tunnels for CC reconstruction, showing similar properties to the intact state.[12] Celik et al.[13] compared the biomechanical stability of 3 distinct approaches for CC reconstruction. The findings of this study demonstrated that all CC reconstruction approaches were capable of restoring vertical translation of the AC joint. Furthermore, the combination of CC and ACLC reconstruction methods showed the closest restoration of AC rotational and translational stability in a biomechanical model.[14]

Overall, the advantages of using this technique include a minimally invasive procedure, theoretical risk reduction of clavicular fractures, increased biological reinforcement using a small bone tunnel, and reconstruction of the CC ligament and the AIB of the ACLC. However, a high level of arthroscopic skills is recommended; otherwise, the surgical time may be prolonged.

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