Technical Note

All-Endoscopic Treatment of Acromioclavicular Joint Dislocation: Coracoclavicular Ligament Suture and Acromioclavicular Ligament Desincarceration

Thibault Lafosse, M.D., Thibaut Fortané, M.D., and Laurent Lafosse, M.D.

Abstract: Acute acromioclavicular (AC) joint dislocations are common and difficult to manage. The physiopathologic pattern begins with the rupture of the AC ligaments, then the coracoclavicular (CC) ligaments, and with an invasion of the clavicle through the deltotrapezial fascia. Therefore, we tend to perform a true suture of the CC ligaments, along with a release of the AC ligaments from the joint. We thus propose an all-endoscopic CC ligament suture and AC joint release. It starts with glenohumeral exploration enabling a repair of concomitant lesions when necessary. Dissection of the coracoid process is made, along with the lateral border of the conjoint tendon, medially the pectoralis minor tenotomy, and plexus brachial exposition and protection. Superiorly the CC ligaments are tagged and exposed. A major difference with others procedure then arises. We dissect the inferior and superior surfaces of the clavicle and the AC joint, although we maintain the continuity between the deltotrapezoid fascia and the AC ligaments. The AC dislocation is reduced under endoscopic control performing a true suture of the CC ligaments by the mean of 2 suture tapes and dog bones. After surgery, a shoulder brace is used for 6 weeks. Physiotherapy then begins.

Acute acromioclavicular (AC) joint dislocations are a common traumatic reason for consultation in shoulder surgeons' offices, but their management is difficult and controversial.[1,2] AC dislocations are mainly caused by a fall on the shoulder stump with the entire upper limb pushed down. This results first in a rupture of the AC ligament, then in a rupture of the coracoclavicular (CC) ligaments, then in the final stage an invasion of the clavicle through the deltotrapezoid fascia, as described in the Rockwood classification.

Some authors remain convinced it should never be addressed surgically; however, most agree with conservative treatment in stages I or II of Rockwood and surgical treatment in stages IV, V, and VI.[3] Despite the fact that many techniques exist, including arthroscopic techniques, few all-endoscopic techniques with both CC ligament repair and AC ligament release are documented. In 2015, Barth et al.[4] recommended addressing both the CC and AC ligaments in to ensure good stabilization in both the vertical and horizontal planes. We present in this note a technique enabling the repair of the CC ligaments without creating any tunnels in the coracoid, by the means of cerclages, the extraction of the clavicle from the deltotrapezoid fascia, release of the AC ligament, and the reduction of the AC dislocation using an all-arthroscopic approach.

Anatomy and Pathology Pattern

This surgery is almost entirely performed out of the glenohumeral joint. It takes place in the anterosuperior and anteroinferior shoulder. It is important to identify correctly and dissect the brachial plexus so as not to damage it during the procedure at the inferior and medial border of the coracoid.

The whole upper limb is attached to the axial skeleton through the clavicle and AC joint. This joint is stabilized by AC ligaments (horizontal plane) and by CC ligaments (vertical plane). Therefore, to obtain a good outcome on the stabilization in both planes, the surgery must address both ligaments in acute AC dislocation, repairing the CC ligaments, and at least extract the

From the Hand, Upper Limb, Brachial Plexus, and Microsurgery Unit (PBMA), Alps Surgery Institute (ASI) Clinique Générale d'Annecy, Annecy, France.

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Address correspondence to Thibaut Fortané, M.D., Alps Surgery Institute, Clinique Générale d'Annecy; 4 Chemin de la Tour la Reine, 74000 Annecy, France. E-mail: tfortane@gmail.com

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Table 1. Pearls and Pitfalls

Step	Action	Pearls	Pitfalls and Tricks
1	GH exploration	Use a needle to place the portal under endoscopic control	Associated lesions on labrum or rotator cuff tendons
2	Coracoid dissection	Release far distally CT	Bleeding may occur at this stage
		Retract the deltoid with a switching stick in the D portal	
		Visualize the musculocutaneous nerve in the space between the Pm and the CT before tenotomy	Adhesions may occur between the Pm and brachial plexus
3	Clavicle dissection	Retract the anterior deltoid with a switching stick	Do not damage CC ligaments
4	AC dissection	Maintain the continuity between the deltotrapezoid fascia and the AC ligaments	Anteroposterior instability if AC ligaments severed
5	Clavicle drill	Locate with K wire the anterior, posterior, and lateral edges of the clavicle	Clavicle fracture if tunnels are poorly located
		Protect vessels and nerves with a curette	Nerves and vascular injuries
6	CC fixation	Use alternatively medial (M) and lateral (E, J) portals for instruments	Mini -open incision problems: difficult exposition at the end (swollen shoulder) or pressure drop at the beginning
		Reduction of the clavicle with the switching stick	
		Control AC reduction and absence of AC ligament incarceration	

AC, acromioclavicle; CC, coracoclavicle; CT, conjoint tendon; GH, glenohumeral; Pm, pectoralis minor.

incarcerated tissue from the AC joint, including the AC ligament.[5] The technique we present enables one to safely perform all of the aforementioned in an all arthroscopic fashion with pearls and pitfalls (Table 1) and advantages and disadvantages (Table 2) discussed.

Surgical Technique (With Video Illustration)

The surgery (Video 1) is performed with the patient under general anesthesia. The patient is placed in the beach chair position with the arm in traction.

Endoscopic Portals

The endoscopic portals are as follows (Fig 1):

- A: posterior soft point.
- D: lateral portal, under the anterolateral angle of the acromion and parallel to the upper border of the subscapularis. Also used for lateral visualization during anterior dissection.
- E: anterolateral portal through the rotator interval.
- I: inferior and anterior portal, used for anterior visualization.
- J: between I and D, used for lateral dissection and manipulation.
- M: medial portal for medial dissection and manipulation.
- LSC: lateral superior clavicle portal to drill the lateral tunnel.
- MSC: medial superior clavicle portal to drill the medial tunnel.

Table 2. Advantages and Disadvantages Between Arthroscopic and Open Procedures

Step	Action	Advantages	Disadvantages
1	GH exploration	Verify associated lesions on labrum or rotator cuff tendons	
2	Coracoid dissection	Less-invasive coracoid dissection	Risk of injury on brachial plexus during Pectoralis minor tenotomy
		Preserves CC ligaments	
		Use of CA ligament to reconstruct AC ligament	
3	Clavicle dissection	No pressure loss due to skin incision	
		No scar	
4	AC dissection	Maintain the continuity between the deltotrapezoid fascia and the AC ligaments	Anteroposterior instability if AC ligaments severed
			No suture of deltotrapezoid fascia
5	Clavicle drill	Protect vessels and nerves with a curette	Nerves and vascular injuries
			Clavicle fracture if tunnels are poorly located
			Same in arthroscopic or open procedure
6	CC fixation	Control AC joint reduction	Two drills in clavicle with risk of clavicle fractures
		Control of absence of AC ligament incarceration	
		No drill in coracoid process	

AC, acromioclavicular; CA, coracoacromial; CC, coracoclavicular.

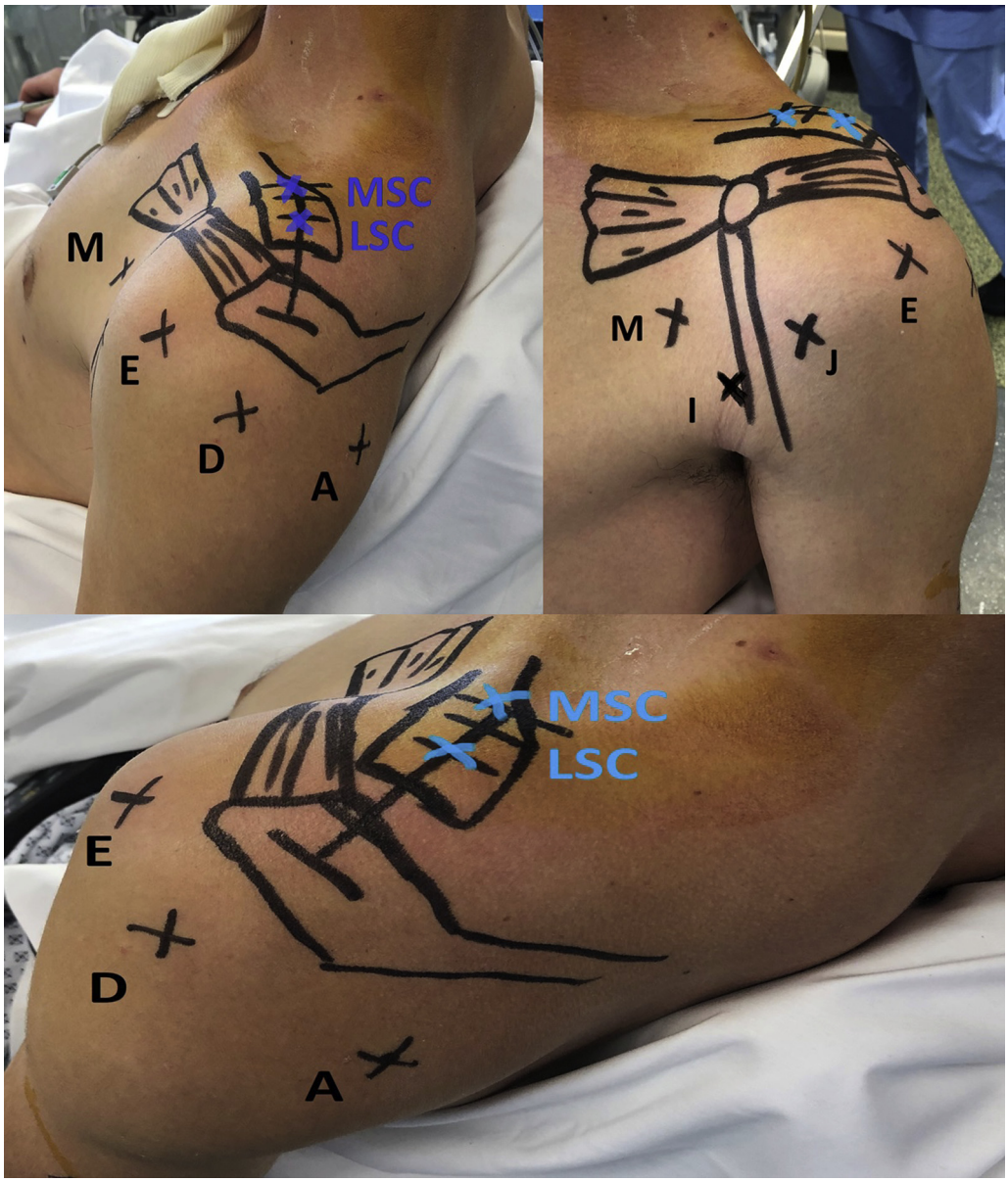

Fig 1. Endoscopic portals, left shoulder. (A, posterior soft point; D, lateral portal; E, anterolateral portal; I, anteroinferior portal; J, between I and E; LSC, lateral supraclavicular; M, medial approach; MSC, medial supraclavicular.)

First Step: Glenohumeral Exploration

The surgery is always started though a posterior approach in the glenohumeral joint, enabling exploration and repair of associated lesions (e.g. cuff or labral tears).[6,7] The rotator interval is opened, then the lateral margin of the conjoint tendon and inferior face of the coracoid are prepared.

Second Step: Coracoid Dissection

Lateral dissection (posterior view, A portal) (Fig 2A): The lateral border of the conjoint tendon and the coracoid is dissected. The coracoacromial (CA) ligament is tagged and either detached from the coracoid or loaded with sutures and prepared for clavicle reinsertion (e.g. transfer of the CA ligament coracoidal insertion to the clavicle). Tip: The lateral border of the conjoint tendon must be released far distally to increase the space around the coracoid and facilitate its further exposition.

Inferior and anterior dissection of the coracoid (lateral view) (Fig 2B): Through a lateral visualization portal (E) and the operative anterior inferior portal I, the exposition of the coracoid is completed, to release the soft tissue from its inferior surface, and to expose its anterior surface along with the insertion of the pectoralis minor (Pm). Tip: a switching stick can be introduced in the D portal and used as a retractor for the deltoid.

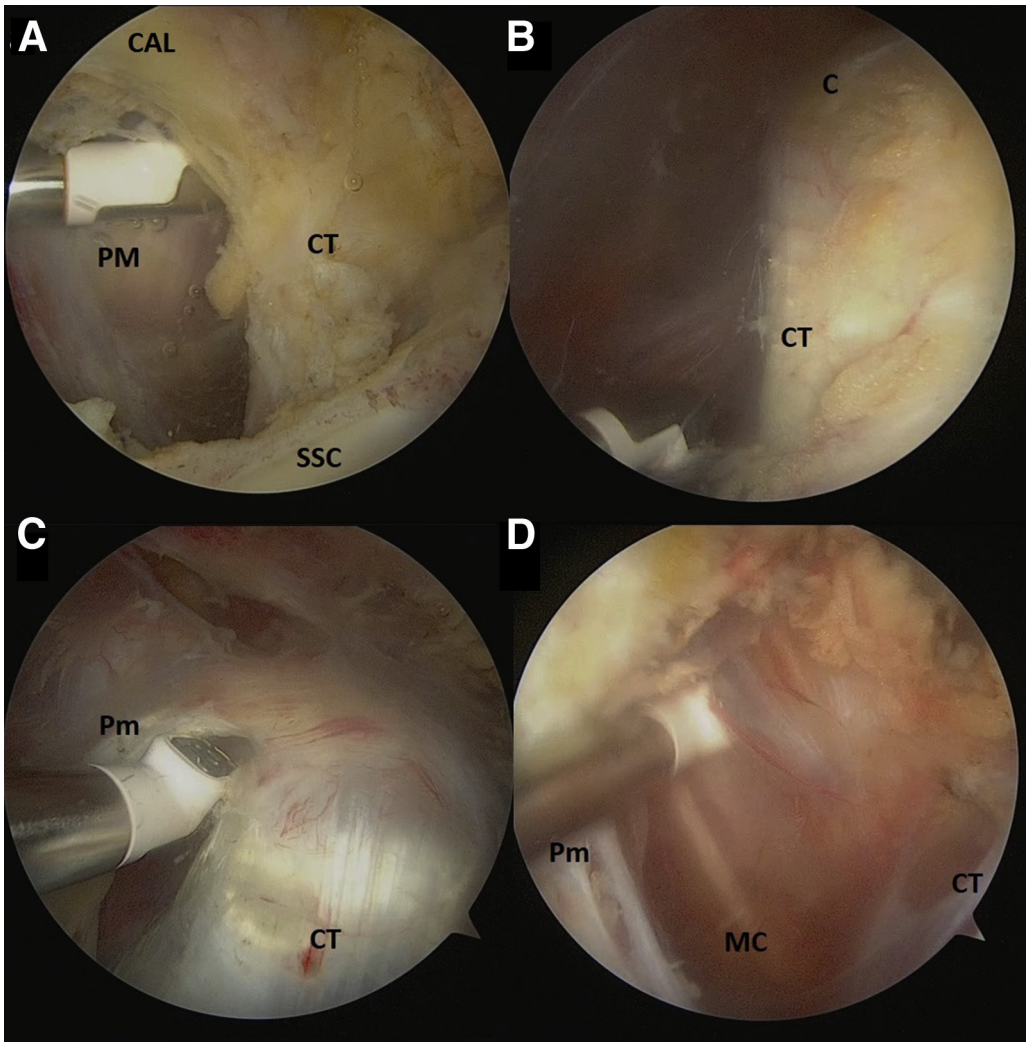

Fig 2. Coracoid and conjoint tendon dissection (left shoulder; a, b: posterior view; c, d: anterior view). (A) Posterior view (scope in soft point) of the rotator interval in the glenohumeral joint. (B) Lateral view (scope in D) of the coracoid process and conjoint tendon. (C) Anterior view (scope in I, instrument in M) of the coracoid process with pectoralis minor tenotomy. (D) Medial dissection of the coracoid process with musculocutaneous nerve dissection (scope in I, instrument in M) (C, coracoid process; MC, musculocutaneous nerve; Pm, pectoralis minor.).

Medial dissection (anterior view) (Fig 2C): The scope is switched to the I portal, and an operative medial (M) portal is created. The Pm is detached (Fig 2C), and care is taken to expose and protect the musculocutaneous (MC) nerve and the brachial plexus (Fig 2D). The upper border of the subscapularis is released, and the medial border of the coracoid is exposed. Tip: before detaching the Pm, it is safer to expose the space between the Pm and the conjoint tendon to visualize the MC nerve and ensure no adhesions between the nerve and the Pm place it at risk.

Superior dissection (anterior view) (Fig 3 A and B): The operative portals are alternatively medial (M) and lateral (D, E, J) according to the ideal position for coracoid and clavicle exposition. The superior surface exposition of the coracoid is completed, and the insertion of the CC ligaments is inspected. Their medial and lateral borders are clearly identified. The inferior face of the clavicle medially and laterally from the CC ligaments is exposed.

Third Step: Clavicle Dissection

The anterior, then superior, surface of the clavicle is dissected, and the deltotrapezoid fascia is detached from the clavicle. Progressing from medial to lateral enables one to extract the clavicle, which is incarcerated into the fascia (Fig 3 C and D). Tip: a switching stick is introduced in the D portal and used to elevate the anterior deltoid.

Fourth Step: AC Dissection

Moving from medially to laterally, the AC joint is exposed, and the AC ligament dissected and extracted from the AC joint (Fig 3D). Meniscus resection can be

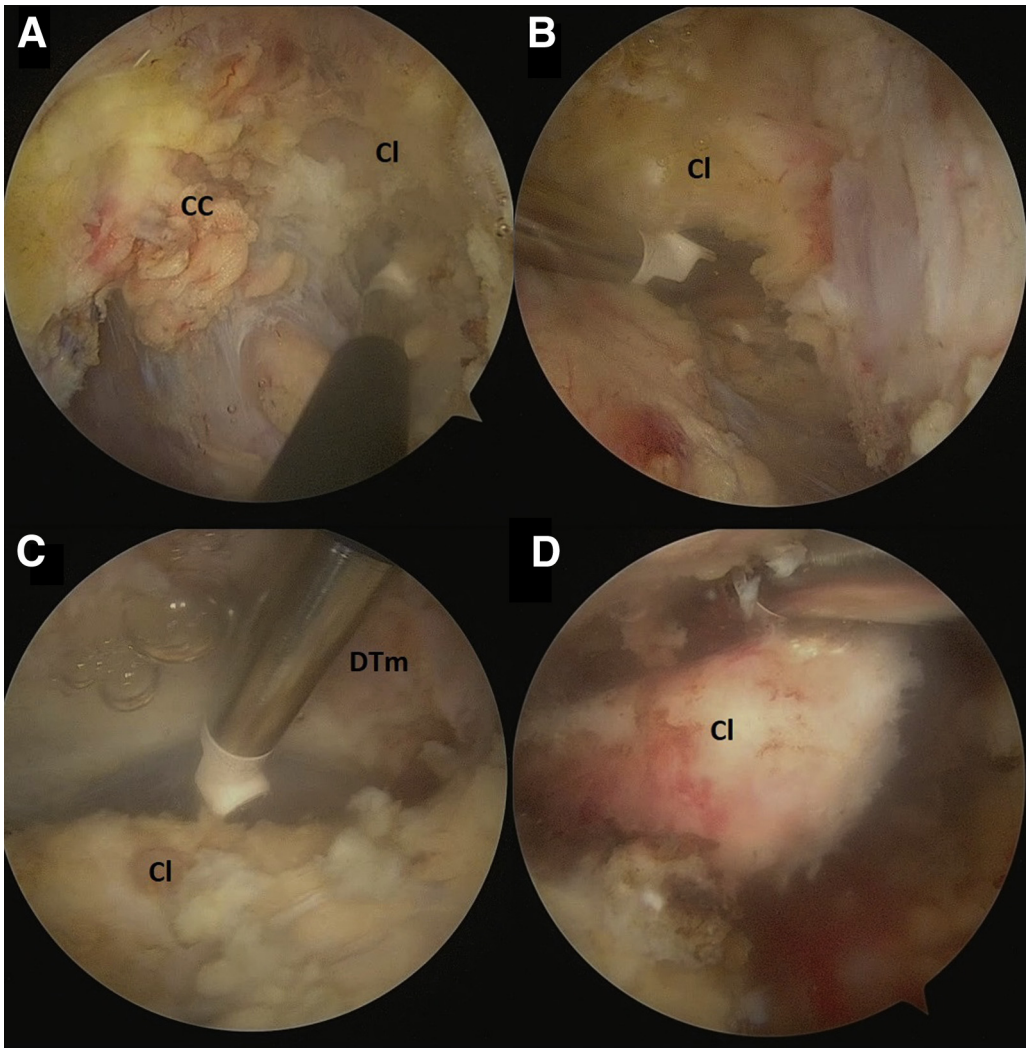

Fig 3. Preparation of the CC space with CC ligaments along with clavicle exposition and acromioclavicular ligament dissection (left shoulder, anterior view). (A) Superior and lateral exposition of the coracoid, dissection of the lateral border of the coracoclavicular ligaments (scope in I, instrument in M). (B) Inferior dissection of the clavicle medially to the CC ligaments. (scope in I, instrument in M). (C) Superficial dissection of the clavicle (scope in I, instrument in M). (D) Dissection of the lateral part of the clavicle with desincarceration of the acromioclavicular ligaments (scope in I, instrument in J). (CC, coracoclavicular ligaments; Cl, clavicle; DTm, deltotrapezius muscle.)

performed at this step if necessary. Tip: care is taken to maintain the continuity between the deltotrapezoid fascia and the AC ligaments to ensure the spontaneous repositioning and healing of the AC ligaments on top of the clavicle.

Fifth Step: Clavicle Drilling

Once the clavicle is exposed, with its posterior and anterior edges tagged, drilling of the medial and lateral clavicular tunnels is performed. Two 2.0-mm K wires are used to create the correct path. The drill is a 4.0-mm cannulated one (DePuy Synthes Mitek, Raynham, MA) Tips: the anterior and posterior edges of the clavicle can be located with palpation thanks to the K wires for accurate placement of the tunnels (Fig 4). A curette is used while drilling to prevent the K wires being pushed inferiorly into major vascular or neurologic structures (Fig 5). The lateral tunnel in the clavicle must be at least 1 cm from the lateral edge of the clavicle, and the 2 tunnels are separated by at least 2 cm to prevent clavicle fracture.

Sixth Step: Coracoclavicular Fixation

We use a suture passer from DePuy Synthes Mitek (ideal suture grasper 30°, ref. 251721) to pass the shuttle relay sutures in the clavicle tunnels and though the CC ligaments. The shuttle relay sutures are replaced by suture tape (PERMATAPE Suture Blue Braided Flat Suture, 2.5 mm, ref. 223170; DePuy Synthes Mitek) and a not is tight around a Dog Bone (Dog Bone

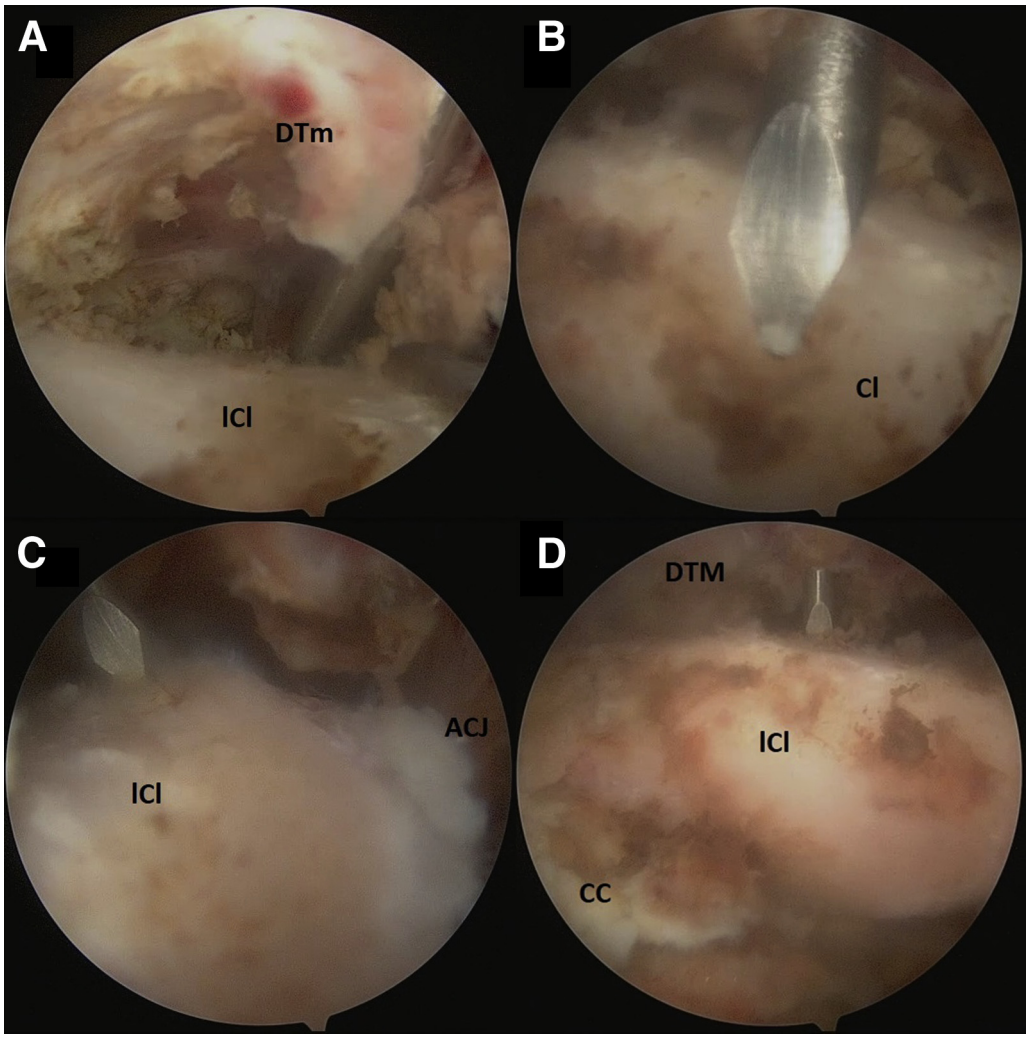

Fig 4. Lateral clavicle tunnel drilling (left shoulder, anterior view, scope in I, K wire in lateral supraclavicular). Posterior tracking (A), anterior tracking (B), and lateral tracking (C) of the lateral drill hole position. Lateral drill position in the clavicle (D). (ACJ, acromioclavicular joint; CC, coracoclavicular ligament; Cl, clavicle; DTm, deltotrapezius muscle; lCl, lateral clavicle.)

Button, ref. AR-2270; Arthrex, Naples, FL) while reducing the coracoclavicular diastasis (Figs 6 and 7).

Tip: the visualization is anterior (I portal). The suture passing device and a magic grasper (Suture Manipulator Grasper, ref. 214626; DePuy Synthes Mitek) are alternatively used in the medial (M) and lateral (E, J) portals. The suture passer is introduced in the medial supraclavicular and lateral supraclavicular portals to retrieve the shuttle relay sutures. The reduction of the clavicle is eased by the action of the switching stick introduced in the D portal, pushing the clavicle downwards against the coracoid. The AC reduction and absence of AC ligament incarceration is controlled with the scope (Fig 8).

Postoperative Care

The healing process requires one to prevent the weight of the upper limb to pull down the scapula. A 6-week immobilization period with a shoulder brace supporting the elbow is mandatory. Physiotherapy begins only then.

Discussion

Many techniques are described to manage acute AC joint dislocations. Most of them are performed arthroscopically. Some require the use of a C-arm and fluoroscopy, complicating the setup of the patient and the operating field. Many involve a mini-open step to extract the clavicle from the deltotrapezoid fascia and the repositioning and suture of the AC ligament.

In our technique, we choose to perform a dissection of the clavicle from the deltotrapezoid fascia and extract all the structures incarcerated endoscopically. An all-arthroscopic procedure limits the risks of infection. It enables a greater exposition of the clavicle, which can sometimes be difficult when performed through a mini-open incision, realized at the end of the procedure, when the shoulder is swollen, or creating a pressure drop

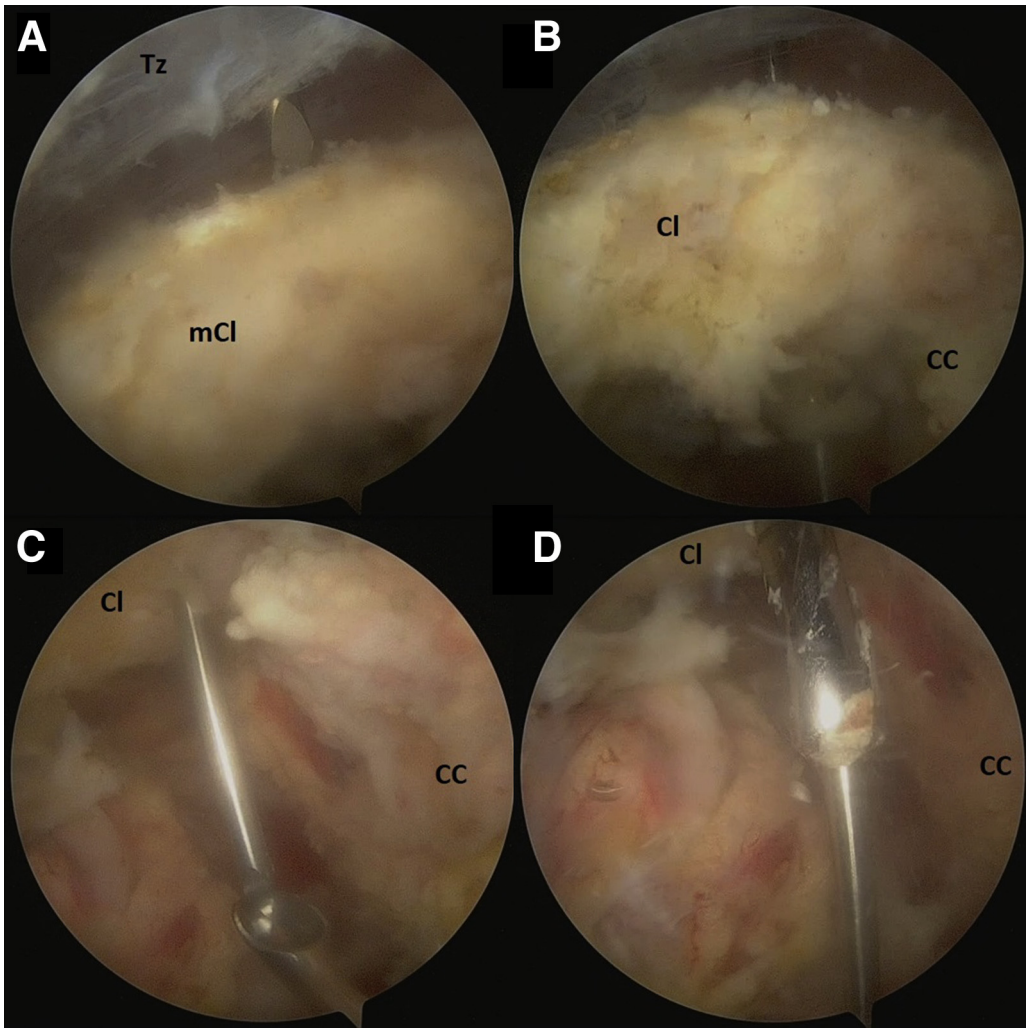

Fig 5. Medial clavicle tunnel drilling (left shoulder, anterior view). (A-D) Drilling of the medial clavicle with protection of the neurovascular structures, using a curette. Scope in I, K wire is introduced in MSC (medial supra clavicular portal). (CC, coracoclavicular ligament; Cl, clavicle; mCl, medial 2/3 of clavicle; Tz, trapezius.)

if performed at the beginning of the surgery. The cerclage with tapes around as opposed to tunnels drilled into the coracoid obviously lowers the risk of coracoid fracture.[8]

Of course, this technique presents risks due to the proximity of the brachial plexus during the dissection of the coracoid. The MC nerve must be identified to avoid injury during the tenotomy of the Pm. The classic complications linked to the use of strips under the coracoid can be found, such as the fracture of the coracoid by shearing or fracture of the clavicle at the level of the tunnels.

The complications of recurrent instability are limited by the use of 2 strips allowing the reconstruction of the conoid and trapezoid ligament. Even if the delto-trapezius muscle is not sutured, it is dissected and lifted flush with the periosteum to allow it to heal postoperatively. In addition, an improvement in the technique with reconstruction of the AC ligament by the CA ligament is possible. We simply detach the CA ligament from the lateral edge of the coracoid and fix it to the lateral clavicular hole by a lasso loop. This improves the anteroposterior stability.

Our technique enables a true suture of the CC ligaments, which are loaded with tape and reattached to the lower surface of the clavicle. Their potential healing is thereby improved.

However, we still believe, as shown by Barth et al., that acute AC joint dislocations should be managed within the first 10 days[4] if simple fixation is desired. Beyond this time frame, we favor CC ligament reconstruction with tendon grafts.

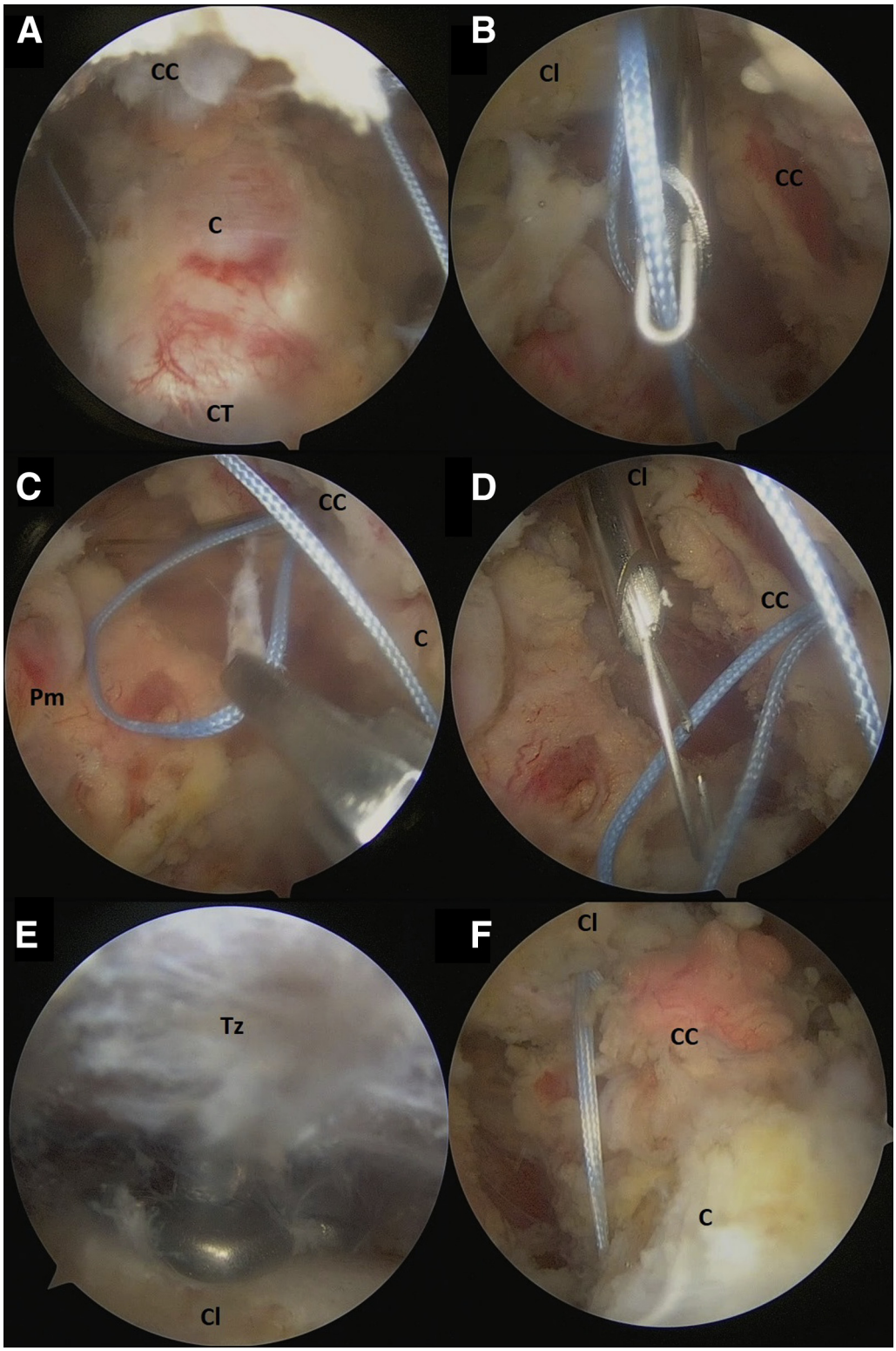

Fig 6. Conoid ligament suture (left shoulder, anterior view, scope in I, suture grasper and dog bone in MSC). (A) Passage of the suture under the coracoid process behind conjoint tendon from lateral to medial. (B) Passage of the medial strand of the shuttle relay through the medial clavicle tunnel. (C) Passage of the lateral strand of the shuttle relay through the conoid ligament. (D) Retrieving the lateral strand of the shuttle relay through the medial clavicle Tunnel. (E) Dog Bone application on the medial clavicle tunnel. (F) Suture of the conoid ligament: shuttle relay has been replaced by tape sutures. (C, coracoid process; CC, coracoclavicular ligaments; Cl, clavicle; CT, conjoint tendon; MSC, medial supra clavicular; Pm, pectoralis minor; Tz, trapezius.)

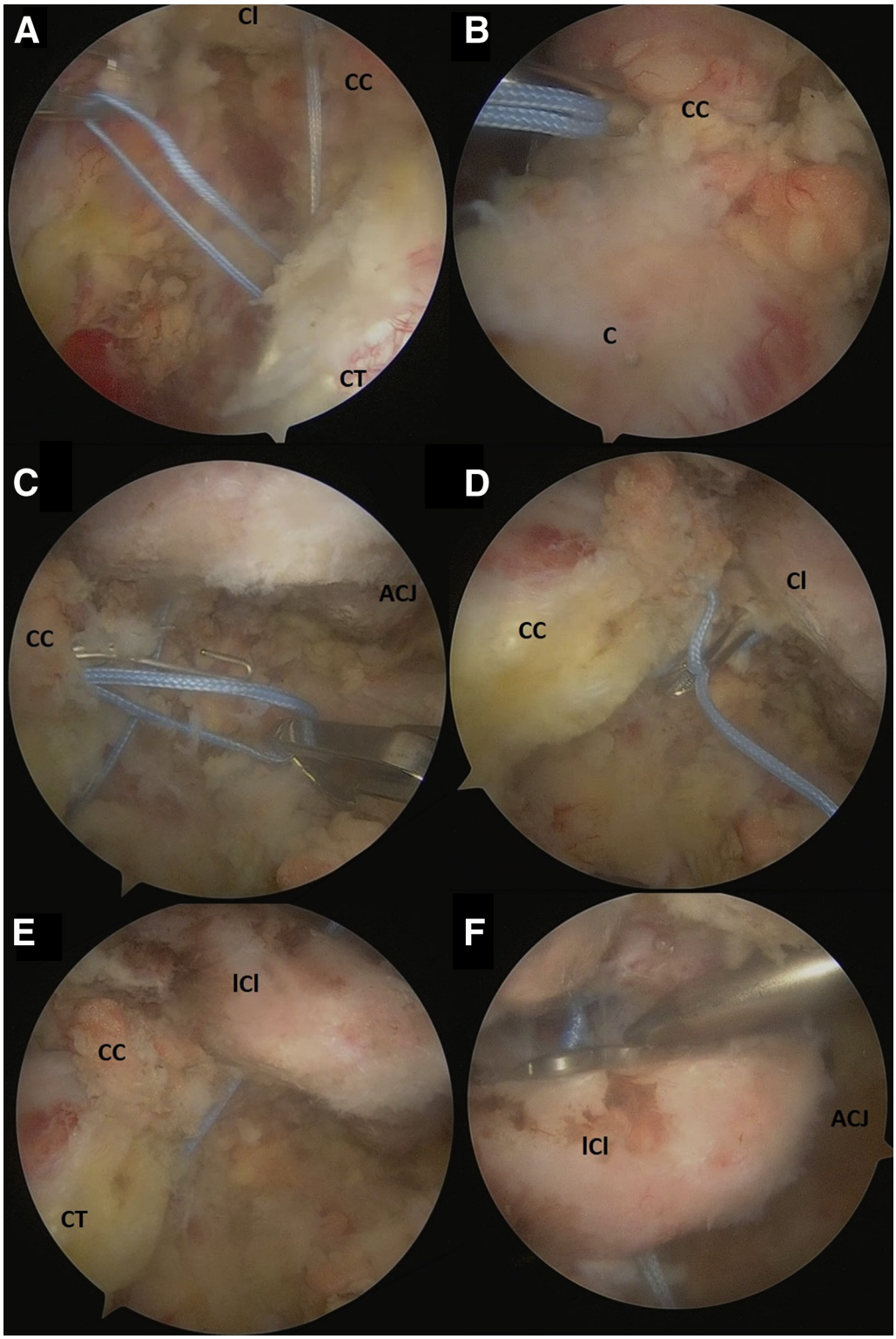

Fig 7. Suture of the trapezoid ligament (left shoulder, anterior view, scope in I, suture grasper alternatively in lateral supraclavicular and M, switching stick in J). (A) Passage of the shuttle relay under the coracoid process behind conjoint tendon, from lateral to medial. (B) Passage of the medial strand of the shuttle relay through the trapezoid ligament. (C) Retrieving the medial strand of the shuttle relay after passing though the trapezoid ligament. (D) Passage of the medial strand of the shuttle relay through the lateral clavicle tunnel. (E) Suture of the trapezoid ligament under the lateral part of the clavicle after the lateral strand of the shuttle relay was passed in the lateral clavicle tunnel, and replaced by a suture tape. (F) Dog Bone application on the lateral clavicle tunnel and reduction with the switching stick. (ACJ, acromioclavicular joint; C, coracoid process; CC, coracoclavicular ligament; Cl, clavicle; CT, conjoint tendon; lCl, lateral clavicle.)

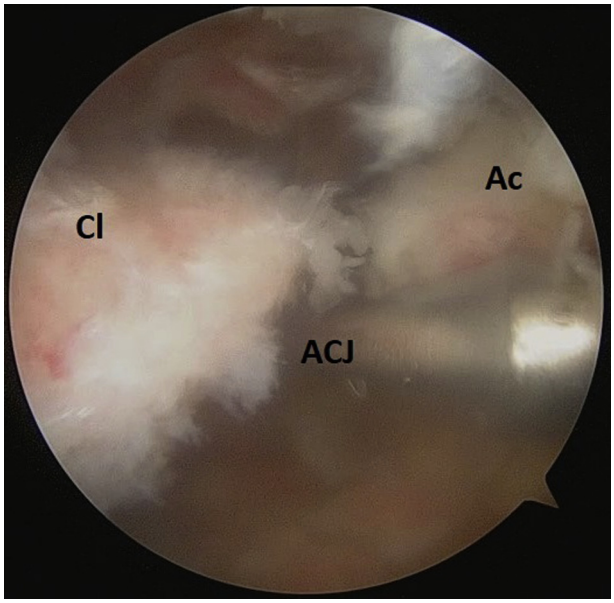

Fig 8. Control of the reduction of the ACJ with no incarceration of ACJ ligaments (left shoulder, anterior view, scope in I, switching stick in J). (Ac, acromion; ACJ, acromioclavicular joint; Cl, clavicle.)

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