Arthroscopic Technique for Stabilization of Chronic Acromioclavicular Joint Instability With Coracoclavicular and Acromioclavicular Ligament Reconstruction Using a Gracilis Tendon Graft

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Abstract: We present an arthroscopic technique for stabilization of chronic acromioclavicular (AC) joint instability using a transclavicular-transcoracoidal button technique, combined with a coracoclavicular and AC ligament reconstruction using the gracilis tendon. This arthroscopic technique achieves an anatomic reduction of the clavicle without further implant removal. It ensures vertical and horizontal stabilization of the AC joint. Using a horizontal drill hole through the clavicle and looping the gracilis tendon graft around the coracoid avoids weakening of the coracoid with the risk of fracture.

Stabilization of chronic acromioclavicular (AC) joint instability is a challenging procedure. Open techniques have shown mixed results[1,2] and often require excessive dissection of the clavicle, thus resulting in morbidity and scarring. Further implant removal is often necessary.[1,2]

First arthroscopic techniques for the stabilization of chronic AC joint dislocations have been described but are not yet established and reproducible. Most require several drill holes through the clavicle and the coracoid with potential disadvantages. There is still no arthroscopic technique established. A multitude of arthroscopic techniques using coracoclavicular ligament augmentation have been described.[3-7]

We present an arthroscopic technique for stabilization of chronic AC joint instability using a transclavicular-transcoracoidal button technique combined with a coracoacromial and AC ligament reconstruction using the gracilis tendon.

Surgical Technique

The indication for this procedure is a symptomatic, chronic AC joint instability (Rockwood III-V) without or with limited bony defects of the clavicle and the coracoid.

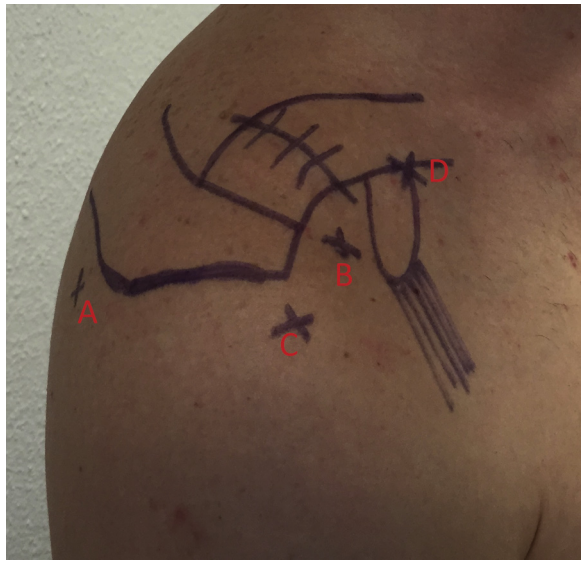

Fig 1. Four portals are required: standard posterior (A), anteromedial (B), anterolateral (C), and supracoracoidal (D), in addition to an incision 2 cm medial to the acromioclavicular joint.

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The authors report the following potential conflicts of interest or sources of funding: J.A. receives support from Arthrex (consultancy, employment, travel support, payment for lectures including service on speakers bureaus, patents, and payment for development of educational presentations).

Received June 28, 2016; accepted September 10, 2016.

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2212-6287/16608/$36.00

http://dx.doi.org/10.1016/j.eats.2016.09.036

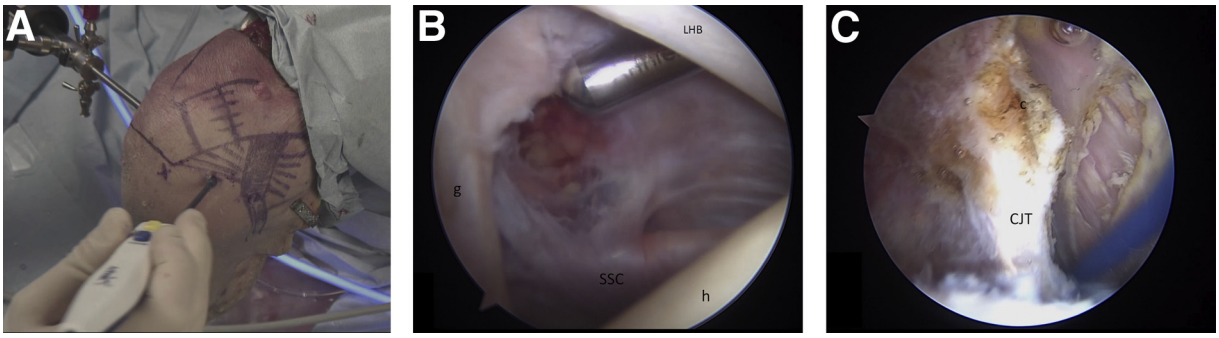

Fig 2. (A) Right shoulder, beach chair position—outside view. The arthroscope is in the dorsal standard portal (marked as A in Fig 1), the radiofrequency device is inserted through the anteromedial portal (marked as B in Fig 1). (B) The rotator interval is opened with a shaver to expose the anterior extra-articular space and to find the posterior surface of the coracoid. (C) With the help of a radiofrequency device, the coracoid is exposed posteriorly, laterally, and medially. The next step is to open the clavipectoral fascia. The conjoint tendons are exposed and the coracoid insertion of the CA ligament is detached. (c, coracoid; CJT, conjoint tendons; g, glenoid; h, humeral head; LHB, long head biceps tendon; SSC, M. subscapularis tendon.)

Fixed dislocations without reducibility into the anatomic position must be excluded (contraindication).

The surgery is performed under general anesthesia and an interscalene block, the patient is placed in beach chair position, and an armholder is used. The shoulder and the ipsilateral leg are prepped and draped in usual manner.

The principle of this technique is a primary fixation of the AC joint with a transclavicular-transcoracoidal button and the reconstruction of the coracoclavicular and AC ligaments with a gracilis tendon graft. The graft is looped around the coracoid in a figure-of-8 and then fixed intraosseously in the clavicle through a sagittal tunnel. Four portals are required: standard posterior (A, Fig 1), anteromedial (B, Fig 1), anterolateral (C, Fig 1), and supracoracoidal portal (D, Fig 1) and an incision 2 cm medial to the AC joint.

Step 1. Graft Harvest

The gracilis tendon is harvested from the ipsilateral leg and muscle tissue is removed. Both ends of the tendon are whip-stitched using nonresorbable sutures (FiberWire No. 2; Arthrex, Munich, Germany). The following arthroscopic steps of our technique are shown and explained in Video 1.

Step 2. Arthroscopic Preparation of the Coracoid

Using the standard posterior viewing portal (A, Fig 1), an examination of the glenohumeral joint is performed and concomitant lesions are treated if necessary. An anteromedial portal (B, Fig 1) is created through the lateral part of the rotator interval. The rotator interval is opened and the extra-articular space anterior to the shoulder is exposed. The posterior surface of the coracoid is visualized (Fig 2 A and B). The coracoacromial ligament is detached from its

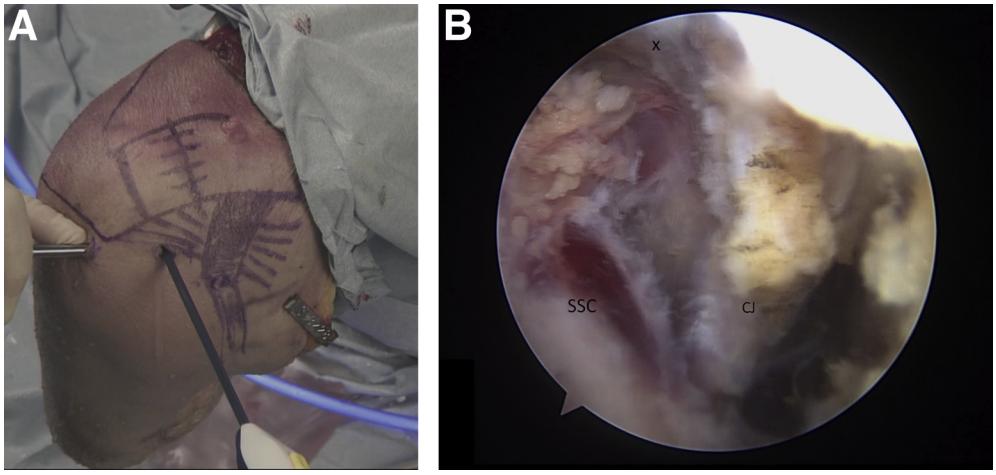

Fig 3. (A) Outside view. The camera is in the anterolateral viewing portal (marked as C in Fig 1). The radiofrequency device is inserted in the anteromedial portal (marked as B in Fig 1). (B) The undersurface of the coracoid and the CJ tendons are visualized. (CJ, conjoint tendons; SSC, upper border of the subscapularis tendon; X, undersurface of the coracoid.)

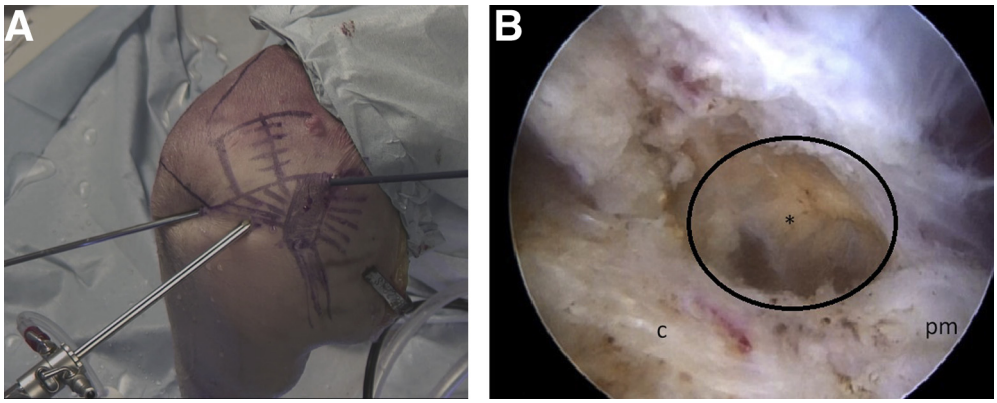

Fig 4. (A) To enhance the view, the deltoid muscle is retracted with a switching stick from the anterolateral portal (marked as C in Fig 1). The arthroscope is in the anteromedial portal (marked as B in Fig 1), and the radiofrequency device is in the supra-coracoidal portal (marked as D in Fig 1). (B) The medial part of the coracoid is now visualized from extra-articular. The superior third of the insertion of the m. pectoralis minor is detached. *Created space for further passage of the graft around the coracoid. (c, coracoid; pm, pectoralis minor tendon.)

coracoidal insertion and the lateral border of the coracoid is exposed (Fig 2C).

For further dissection, the arthroscope is switched to an anterolateral (C, Fig 1) portal, which is created at the anterolateral border of the acromion. The undersurface of the coracoid as well as the conjoint tendons and the upper border of the subscapularis tendon are visualized (Fig 3).

Then the arthroscope is moved again and switched to the anteromedial (B, Fig 1) portal. To enhance the view, the deltoid muscle is elevated with the use of a switching stick inserted through the anterolateral portal (C, Fig 1) (Fig 4A). At the medial border of the coracoid, a supracoracoidal portal (D, Fig 1) is created.

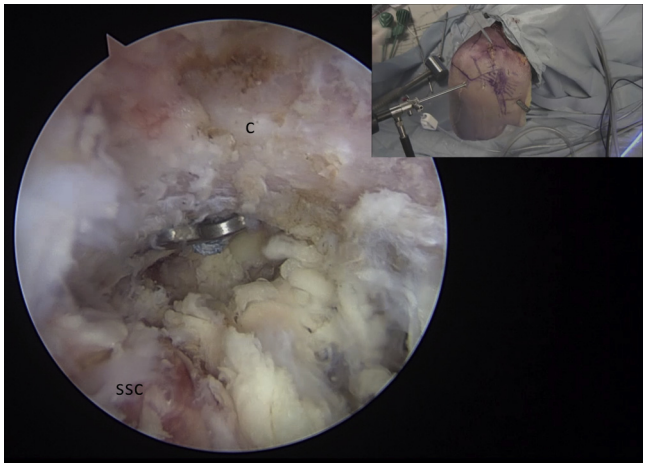

Fig 5. Arthroscopic and outside view. A transclavicular and transcoracoidal hole is drilled and a cortical button is placed in the posterior aspect of the coracoid knee. The second cortical button is placed 2 cm medial to the acromioclavicular joint in the middle of the anterior posterior dimension of the clavicle. The primary reduction is made by knot tying on top of the second cortical button. (c, coracoid; SSC, upper border of the m. subscapularis.)

The medial border of the coracoid, the pectoralis minor muscle, and tendon are exposed. For further passage of the graft around the coracoid (Fig 4B), the superior third of the insertion of the pectoralis minor is detached.

Step 3. Primary Reduction of the AC Joint

A specific aiming device (Arthrex) is inserted through the anteromedial (B, Fig 1) portal and placed under-neath the coracoid. A 1.5-cm skin incision is made on top of the distal part of the clavicle, 2 cm medial to the AC joint. The deltotrapezoidal fascia is elevated from the distal clavicle.

The clavicle is prepared in a subperiostal manner and the drill guide is adjusted in the middle of the anterior posterior dimension of the clavicle. With a 3.0-mm drill (Arthrex) and the use of the aiming device (Arthrex), a transclavicular-transcoracoidal hole is drilled. The cortical button (Dog Bone Button; Arthrex) is inserted using standard technique.

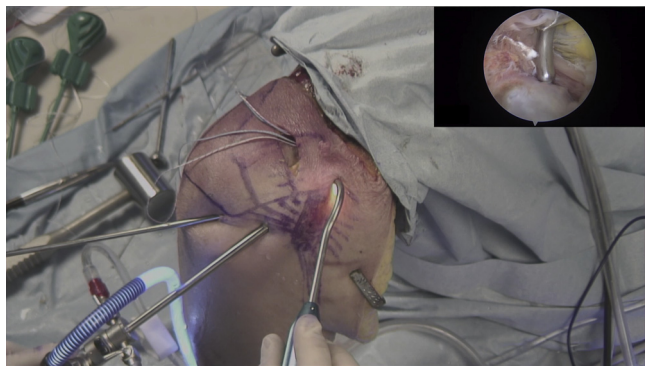

Fig 6. A specific arthroscopic Dechamps is used for graft passage. It is inserted in the supracoracoidal portal (marked as D in Fig 1) around the medial aspect of the coracoid.

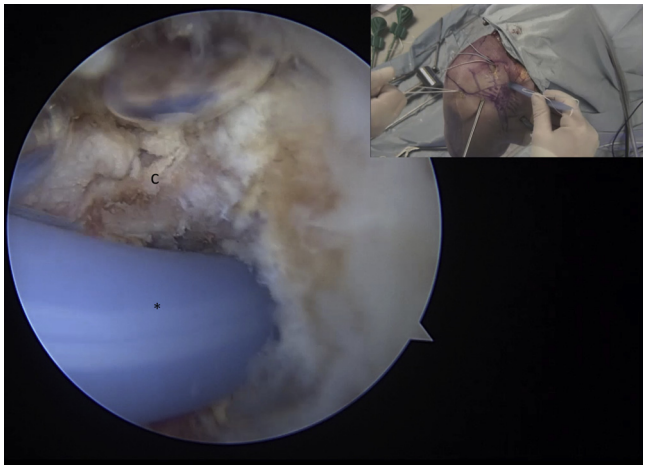

Fig 7. A flexible graft dilator is used to make a good gracilis graft passage. It is pulled from the medial supracoracoidal portal (marked as D in Fig 1) to the anterolateral portal (marked as C in Fig 1). *Flexible graft dilator. (c, coracoid.)

The position of the subcoracoidal Dog Bone Button (Arthrex) is in the posterior aspect of the coracoid knee to leave space for the gracilis tendon being pulled around the coracoid later more anteriorly (Fig 5). The clavicle can now be reduced into anatomic position and fixed by tying the sutures on top of the clavicle button.

Step 4. Graft Insertion

The next step is the preparation of the graft passage for the gracilis tendon around the coracoid. A specific arthroscopic Dechamps (Arthrex) is inserted through the supracoracoidal portal (D, Fig 1). It is placed around the medial border of the coracoid under arthroscopic control (Fig 6). Using a suture shuttle, a flexible dilator is pulled from the supracoracoidal portal (D, Fig 1) to the anterolateral portal (C, Fig 1), to dilate the space for graft passage (Fig 7). After this preparation, the gracilis tendon is pulled from the medial supracoracoidal portal (H) to the lateral anterolateral portal (C, Fig 1) (Fig 8). The gracilis graft is hereby located under the coracoid and anterior to the Dog Bone Button (Arthrex).

The sagittal drill hole for the intraosseous clavicular graft fixation is now prepared. Lateral to the clavicular cortical button, a Kirschner wire (K-wire) is drilled through the clavicle in a sagittal direction from anterior to posterior. The K-wire is overdrilled with a 4.5-mm drill (Fig 9).

The lateral end of the graft is retrieved through the supracoracoidal portal (D, Fig 1) anterior to the clavicle. The medial end is retrieved through the supracoracoidal portal (D, Fig 1) posterior to the clavicle (Fig 10). The graft is looped in a figure-of-8 around the coracoid, with the medial part of the tendon anterior to the lateral one (Fig 11), to increase the stability.

Step 5. Clavicular Graft fixation

The 2 free ends of the graft are pulled against each other through the sagittal clavicle tunnel (Fig 12). Under tension on both ends, a SwiveLock 4.75-mm anchor (Arthrex) is inserted from anterior to posterior into the tunnel to fix the tendon as an interference screw (Fig 13).

If necessary, the remaining graft ends are fixed laterally to the acromion using a 2.9-mm titanium FASTak anchor (Arthrex) for AC ligament reconstruction. The deltotrapezoidal fascia is repaired with polydioxanone (PDS) sutures. It is closed on top of the dog bone and the fiber tapes to maintain the integrity of this soft tissue layer and prevent infection.

Postoperative Rehabilitation

For 4 weeks, the shoulder is maintained in a sling to support the healing process of the reconstruction. Range of motion is limited to 90° of active elevation. The elbow, wrist, and hand are allowed to move

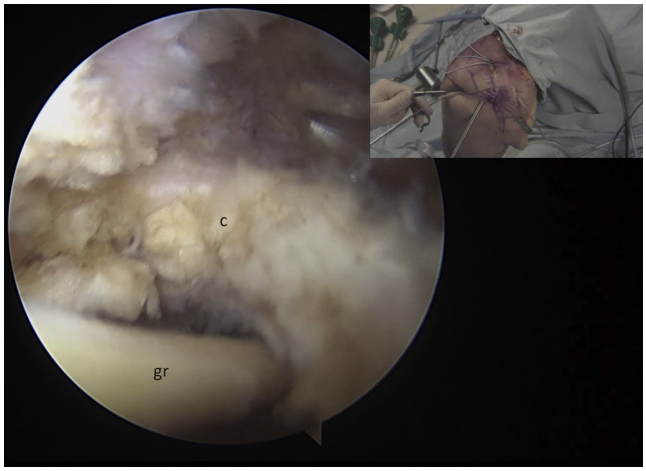

Fig 8. The looped end of the graft dilator is used to pull the prepared gracilis tendon around the coracoid from medial to lateral. The gracilis tendon is anterior to the cortical button. (c, coracoid; gr, gracilis tendon graft.)

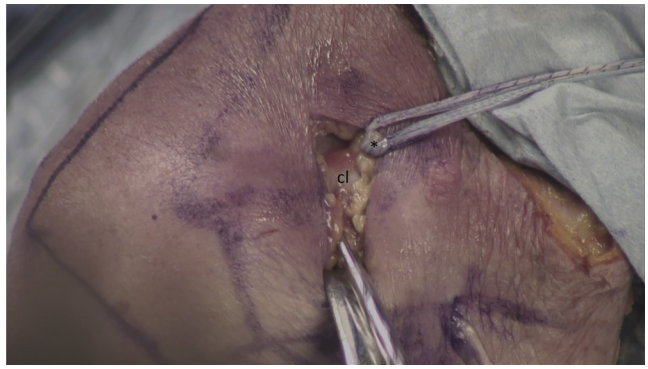

Fig 9. Lateral to the previously placed cortical button, a K-wire is drilled through the clavicle in a sagittal direction from anterior to posterior. The K-wire is overdrilled with a 4.5-mm drill. *Cortical button. (cl, clavicle.)

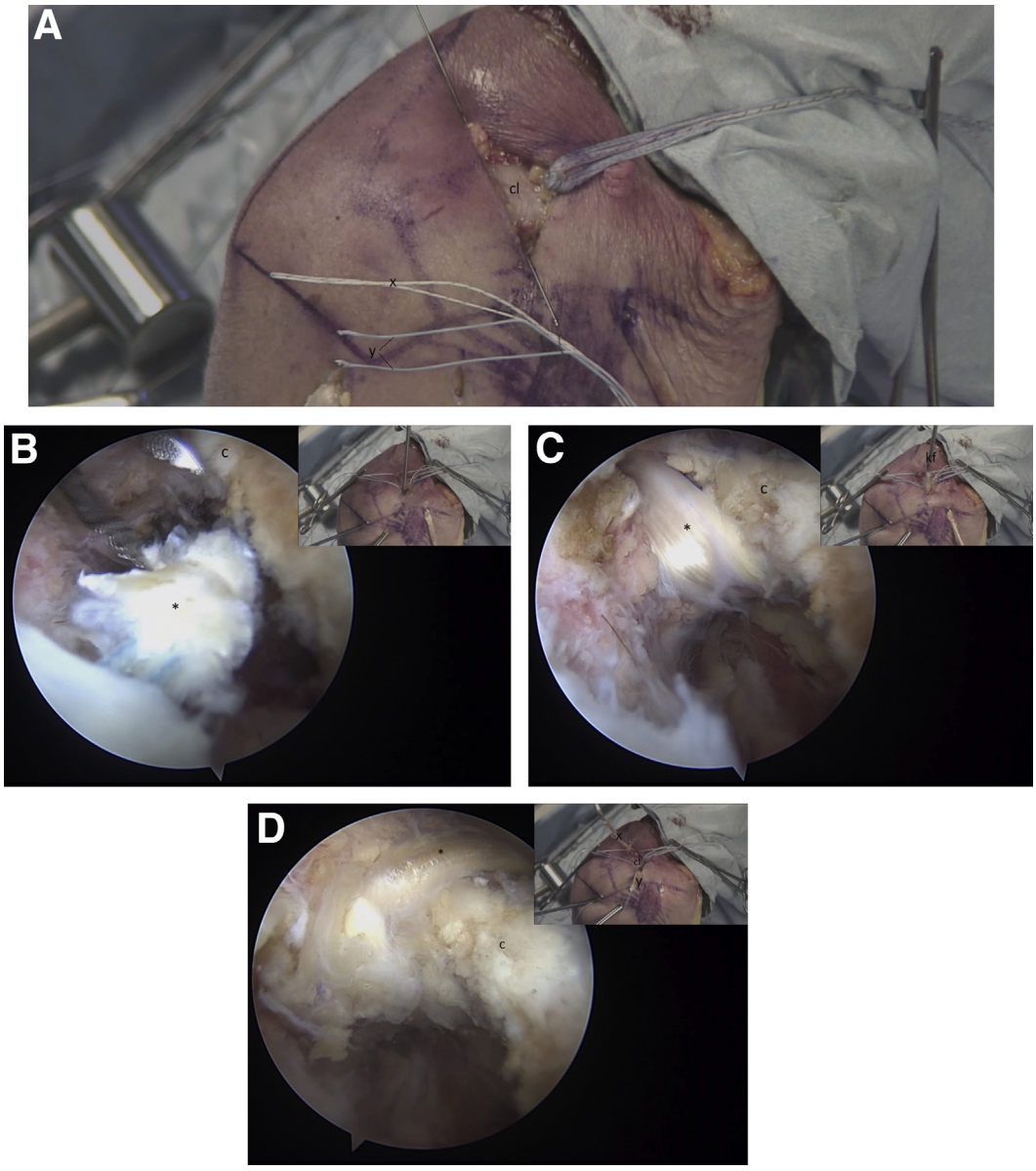

Fig 10. (A) By using a nitinol wire, 2 FiberWires (Arthrex), which are used as shuttle sutures later, are pulled through the sagittal clavicular drill hole. One loop is placed anteriorly (x) and the other one posteriorly (y). (B) A KingFisher suture retriever (Arthrex) is inserted from anterior to the clavicle in an antero-inferior direction, and the lateral end of the gracilis tendon graft is retrieved. *Lateral end of the gracilis tendon graft. (C) Through the trapezius fascia, posterior to the clavicle the medial end of the gracilis tendon is retrieved. *Medial end of the gracilis tendon graft. (D) Both graft ends are retrieved. The medial end of the tendon graft (x) is posterior, and the lateral graft end (y) anterior, to the clavicle. *Gracilis tendon graft. (c, coracoid; cl, clavicle; kf, KingFisher posterior to the clavicle.)

actively without limitation. After 4 weeks, the range of motion can be extended in dependence of pain. Weight lifting is limited to 5 kg for 3 months. Contact and highly demanding sports should be avoided for 4 to 6 months after surgery.

Discussion

Stabilization of chronic AC joint instability remains a challenging procedure. Open techniques show mixed results and often require implant removal and excessive dissection of the clavicle, thus resulting in morbidity and scarring.[1,2]

Arthroscopic techniques are technically sophisticated but do not require further implant removal and enable detection and treatment of possible glenohumeral lesions. Studies have shown a high prevalence of concomitant glenohumeral pathologies, of which some indicate additional surgical therapy and could be missed by an isolated open AC repair.[8]

Arthroscopic techniques using tendon grafts are already described but are not established yet.

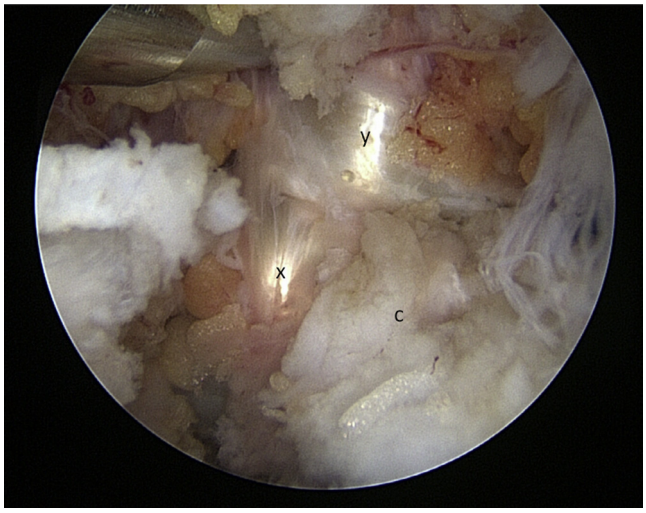

Fig 11. The graft is looped in a figure-of-8 around the coracoid, the medial part of the tendon is anterior to the lateral one. (c, coracoid; x, lateral end of graft; y, medial end of graft.)

Biomechanical studies have shown that anatomical AC joint reconstruction with a tendon graft re-creates at least the tensile strength of the native AC joint complex and is superior to a modified Weaver-Dunn repair.[9,10]

Our technique offers several advantages. It ensures a save and visually controlled graft passage. Open surgery does not allow direct visualization of looping the graft around the coracoid. Morbidity of pericoracoidal dissection is decreased in contrast to open surgery. Looping the tendon around the coracoid instead of drilling several holes through the coracoid for graft fixation minimizes the risk of coracoid fracture.

Another feature is the clavicular fixation, which is neither through vertical drill holes nor on top of the clavicle but through a single sagittal drill hole. The use of a sagittal and not a vertical clavicular tunnel and the configuration of the tendon loop in the figure-of-8 are intended to enhance stabilization and transmission of force. Morbidity of several clavicular drill holes can be avoided (Table 1).

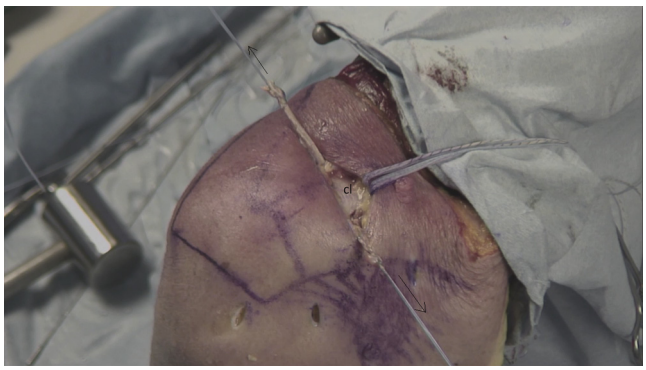

Fig 12. With the earlier-placed shuttle sutures, the free ends of the gracilis tendon are now pulled against each other in the sagittal drill hole of the clavicle. (cl, clavicle.)

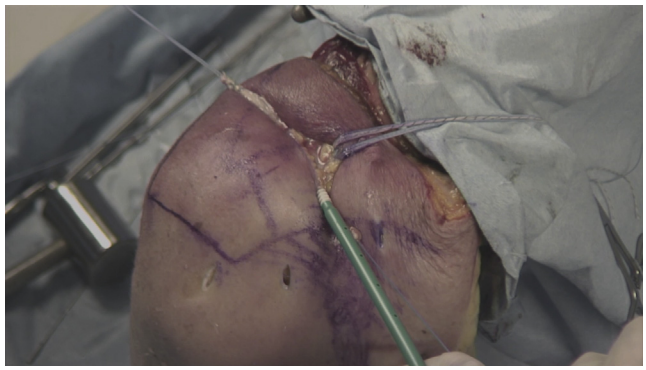

Fig 13. Under tension on both ends, a SwiveLock 4.75-mm biocomposite anchor (Arthrex) is inserted from anterior to posterior in the drill hole.

This fully arthroscopic technique for stabilization of chronic AC joint dislocation is safe and reproducible. Compared with other open or arthroscopic techniques, it offers several advantages with potential improvement of stability and the reduction of complication and morbidity.

Table 1. Pearls, Pitfalls, Advantages, and Disadvantages of Technique

Pearls
The medial border of the coracoid must be exposed, and the superior third of the pectoralis minor tendon must be detached to guarantee a simple graft passage.
The position of the subcoracoidal cortical button must be in the posterior aspect of the coracoid knee, to leave enough space for the gracilis tendon.
To create a figure-of-8 with the graft, the medial part of the tendon must be anterior to the lateral one.
For a secure graft fixation in the clavicle, both ends must be pulled against each other while inserting a SwiveLock 4.75-mm anchor (Arthrex).
Pitfalls
There is a potential risk of neurovascular damages related to the vessels and nerves medial to the coracoid and underneath the clavicle.
Improper handling of the graft may lead to tendon rupture.
Placing the cortical button in the anterior aspect of the coracoid knee may result in an unstable graft loop.
Several misdrillings for placing the coracoid button may lead to coracoid fracture.
Not creating a figure-of-8 may reduce stability.
Advantages
It is minimally invasive.
It allows a safe and visually controlled graft passage around the coracoid.
Several holes through the coracoid can be avoided.
Sagittal drill hole of the clavicle may enhance stability and transmission of force.
No implant removal is needed.
Acromioclavicular ligament reconstruction is possible.
Disadvantages
The procedure is technically sophisticated, especially for surgeons who are not used to extra-articular dissection.
Morbidity of graft harvest is possible.

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