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Michael Dittrich[1] · Barbara Wirth[1] · Florian Freislederer[1] · Frederik Bellmann[1] · Markus Scheibel[1,2]
[1] Department of Shoulder and Elbow Surgery, Schulthess Clinic Zürich, Zurich, Switzerland
[2] Department of Shoulder and Elbow Surgery, Center for Musculoskeletal Surgery, Charité—Universitaetsmedizin Berlin, Berlin, Germany

Arthroscopically assisted stabilization of chronic bidirectional acromioclavicular joint instability using a low-profile implant and a free tendon graft

A technical note

Video online

The online version of this article (https://doi.org/10.1007/s11678-020-00576-y) contains the video: "Arthroscopically assisted stabilization of chronic bidirectional acromioclavicular joint instability using a low-profile implant and a free tendon graft." You will find the video at the end of the article as "Supplementary material." Video by courtesy of M. Dittrich, B. Wirth, F. Freislederer, F. Bellmann, Department of Shoulder and Elbow Surgery, Schulthess Clinic Zurich, Switzerland; M. Scheibel, Department of Shoulder and Elbow Surgery, Schulthess Clinic Zurich, Switzerland; and the Department of Shoulder and Elbow Surgery, Center for Musculoskeletal Surgery, Charité—Universitaetsmedizin Berlin, Germany; all rights reserved 2020.

Background

Various surgical techniques have been described to treat chronic acromioclavicular (AC) joint instability. They can be divided into three main categories: 1. synthetic fixation between the clavicle and the coracoid with suture loops, pulley-like implants, or synthetic ligaments; 2. biological purchase with tendon and/or ligament transfer such as in the Weaver–-Dunn operation or reconstruction with allografts or autografts; and 3. a combination of synthetic and biological techniques [1].

Fauci et al. showed that biological grafts lead to significantly better clinical outcomes as compared to synthetic ligament reconstruction in chronic AC joint instability [2].

Biomechanical studies have highlighted the importance of including the AC joint for improving horizontal stability. Furthermore, it has been shown that a combination of coracoclavicular and AC stabilization in the acute setting can reduce instability of the AC joint in the horizontal and vertical plains and therefore lead to good and excellent clinical results [3, 6].

Kraus et al. achieved good clinical results for horizontal and vertical stabilization in chronic primary and revision AC joint instability using a gracilis tendon autograft in combination with a TightRope device (Arthrex, Naples, FL, USA). In the initially described technique, three transclavicular, two transcoracoidal, and one transacromial drill hole was made. Postoperative tunnel widening in the transclavicular graft holes was detected but did not lead directly to negative clinical results, although dynamic posterior translation was observed in some cases [4]. Multiple drill holes may weaken the bone and lead to fractures of the coracoid and clavicle postoperatively. In addition, the tunnel of the TightRope device showed bone resorption due to frictional damage of the high-tensile sutures or tapes. Therefore, the authors present herein a modification of the above-described technique using combined biological and synthetic stabilization of chronic bidirectional AC joint instability using a hamstring tendon graft and a low-profile TightRope implant that reduces bone tunnels through the clavicle and the coracoid and minimizes soft tissue irritation due to knot stacks, impaired wound healing, and implant irritation ([5]; Fig. 1).

Surgical technique

After administration of perioperative antibiotics and under general anesthesia, the patient is placed in the beach chair position. The shoulder is prepped and draped in a sterile fashion.

Through a posterior viewing portal, diagnostic arthroscopy is performed. Concomitant lesions of the glenohumeral

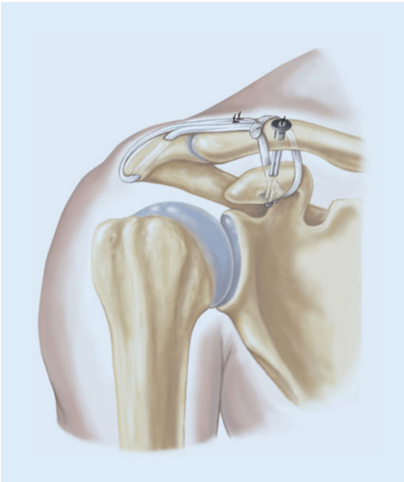

Fig. 1 ▲ Schematic representation of the surgical technique showing combined acromioclavicular and coracoclavicular reconstruction augmented by a low-profile TightRope device (Arthrex, Naples, Fl, USA)

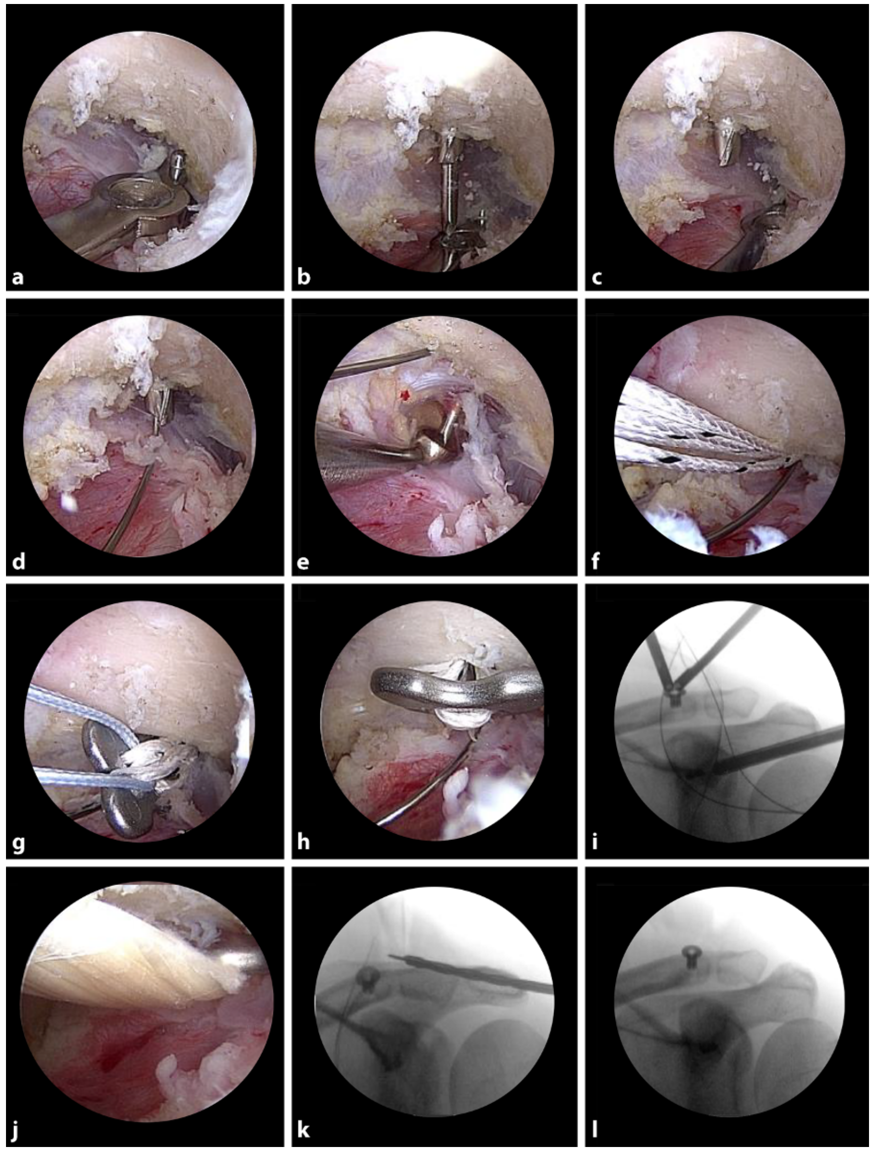

Fig. 2 ▲ **a–c** Arthroscopic view of the subcoracoid positioning of the drill guide and subsequent preparation of the coracoclavicular passage for the TightRope device (Arthrex, Naples, Fl, USA). **d, e** Arthroscopic view showing the passage of the medial and lateral Nitinol suture passing wires that are used for subsequent graft transfer. **f–i** Arthroscopic and image-intensifier views showing placement of the low-profile TightRope, the DogBone button (Arthrex), and the medial and lateral Nitinol suture passing wires that are used for subsequent graft transfer. **j** Arthroscopic view showing the tendon graft passing underneath the coracoid. **k** Image-intensifier view of the acromioclavicular drilling technique and placement of the Nitinol suture passing wire. **l** Final image-intensifier control shows the anatomic reduction of the acromioclavicular joint

joint can be detected and treated during the same operation.

An anteroinferior working portal is established using an outside-in technique, slightly above the tendon of the subscapularis muscle. Under arthroscopic view, an anterolateral transtendinous viewing portal is placed approximately 1 cm posterior of the anterior edge of the supraspinatus muscle, parallel to the tendon fibers. With the help of a switching stick the camera is placed into the anterolateral portal. Through the anteroinferior working portal, the subcoracoid space is dissected and the base of the coracoid is exposed using a radiofrequency ablation device and a shaver. Debridement of the coracoid base is important on the one hand for good visualization for drilling and on the other hand for healing of the subsequently placed graft.

About 2–3 cm medial of the AC joint, a 3-cm sagittal incision is made above the clavicle. Under proper hemostasis, the deltotrapezial fascia is opened and the surface of the clavicle is cleaned of soft tissue.

Coracoclavicular drilling

Under arthroscopic visualization and with the help of an image intensifier, the marking hook of a drill guide is placed through the anteroinferior portal close to the base of the coracoid. The drill sleeve is placed about 3 cm medial to the AC joint at the center of the clavicle. After x-ray control, a 2.0-mm K-wire is drilled transclavicular–transcoracoidal. In primary cases, the drill hole is located between the origins of the coracoclavicular ligaments. In revision cases tunnel placement might be slightly more medial or lateral due to previous drill holes. With a 5.1-mm drill bit the surface of the clavicle is monocortically overdrilled using the K-wire as a guide. Thereafter, a 3.5-mm cannulated drill bit is used to finalize tunnel placement for the TightRope device. The K-wire can now be removed and a Nitinol suture passing wire is inserted with its loop-end up through the drill bit and retrieved through the anteroinferior portal. The drill bit can now be removed (◘ Fig. 2a–c).

Preparation of the graft passage

A 2.0-mm K-wire is placed manually under image-intensifier and arthroscopic control posterior to the clavicle and close to the medial aspect of the coracoid into the subcoracoid space. A 4.0-mm cannulated drill bit is placed over the K-wire by hand (without drilling). The K-wire is removed afterwards. A Nitinol suture passing wire is shuttled through the drill bit with its loop-end up and retrieved through the anteroinferior working portal. Another Nitinol wire is placed via the same technique with its loop-end first from anterior to the clavicle and lateral to the coracoid aspect into the subcoracoid space (◘ Fig. 2d, e).

Coracoclavicular stabilization

The inferior sutures of the low-profile TightRope are attached to the eyelet of the central transclavicular–transcoracoidal Nitinol suture passing wire. Under arthroscopic visualization, the sutures of the TightRope are pulled through the clavicula and the coracoid and are retrieved through the anteroinferior portal. A DogBone button (Arthrex) is added to the inferior sutures and stabilized with a clamp. By pulling in reverse, the DogBone button is shuttled through the anteroinferior portal and placed underneath the coracoid arch. The passing sutures are removed. Under radiographic and arthroscopic control, the sutures are pulled in an alternating manner until the AC joint is reduced and the top head button reaches its final position inside the clavicle (◘ Fig. 2f–i). With the use of a suture tensioner, 80–100 N are applied for each suture in order to reach perfect tension and correct reduction of the joint. A slight overcorrection of 2–3 mm is accepted. The sutures tighten themselves and an additional three knots per suture are performed for back-up fixation and placed inside the top head button. The sutures are cut at the level of the low-profile button so that no knot stacks appear.

Preparation and placement of the graft

A hamstring tendon autograft or allograft (e.g., semitendinosus tendon) for biological reconstruction is used. The graft should ideally be 24–26 cm long and 3–5 mm in diameter. The graft is reinforced on both ends with #2 FiberWires (Arthrex) in a baseball-stitch technique. With the previously placed Nitinol suture passing wires, the inferior part is shuttled from retroclavicular proximal paracoracoidal to anteroinferior. From here it is shuttled backwards paracoracoidal lateral and anterior to the clavicle, medial of the AC joint. Under arthroscopic visualization one can see that the tendon graft creates a loop around the coracoid arch and lies close to the DogBone button (◘ Fig. 2i, j).

Acromioclavicular drilling and cerclage

In order to treat the horizontal instability component an additional AC cerclage is performed. Under image-intensifier control, a 1.25-mm K-wire is drilled percutaneously transacromial from posterior and lateral to medial and superior. At the lateral entry point of the K-wire, a small skin incision is needed before a 3–4-mm cannulated drill bit (depending on the thickness of the graft) can be used for overdrilling (◘ Fig. 2k). The K-wire is removed and a Nitinol suture passing wire with its loop-end up is inserted before the drill bit is removed.

The FibreWire of the lateral part of the graft is now attached to the loop-end of the transacromial Nitinol suture passing wire. The graft is now pulled laterally through the transacromial drill hole. Using a clamp the FibreWire is shuttled subcutaneously backwards to the medial incision above the clavicle. Both ends of the tendon graft lie next to each other. The crossed graft ends are additionally sewn together.

The deltotrapezial fascia is closed above the graft in order to stabilize the AC joint. Final radiographic control shows correct reduction of the AC joint (◘ Fig. 2l). The skin incisions can now be closed.

Rehabilitation

Postoperative rehabilitation takes place under physiotherapeutic supervision. For 8 weeks postoperatively the shoulder is protected in the Ultrasling Quadrant (DJO, Dallas, TX, USA) in the neutral "handshake" position. For the first 2 weeks, only elbow, wrist, and hand mobilization was allowed. In weeks 3 and 4, passive flexion and abduction up to 45°, external rotation up to 30°, and internal rotation as far as the patient's belly is possible. During the fifth and sixth weeks, passive flexion, abduction, external rotation up to 60°, and internal rotation to the belly were allowed. In weeks 7 and 8, actively assisted flexion und abduction up to 90° and free external and internal rotation is possible. The aim is to regain full range of motion (ROM) after 2 months. Muscle strengthening exercises start step by step after 12 weeks.

Discussion

Minimally invasive arthroscopically assisted techniques for AC joint stabilization have shown benefits in comparison to open operations, such as satisfactory cosmetic results, lower infection rates, and the possibility of treating concomitant lesions of the glenohumeral joint. The presented technique minimizes the number of drill holes in the clavicle and the coracoid. The tendon graft is wrapped around the coracoid. Therefore, we preserve the bones of the shoulder girdle and especially the coracoid from weakening due to drill holes, which can cause postoperative fractures, loss of stabilization, and revision surgery. In the described technique the clavicle is in between the two ends of the graft, which minimizes dynamic posterior translation and therefore creates a stable horizontal plane in addition to the AC reconstruction.

Corresponding address

Markus Scheibel, MD
Department of Shoulder and Elbow Surgery, Center for Musculoskeletal Surgery, Charité—Universitaetsmedizin Berlin
Augustenburger Platz 1, 13353 Berlin, Germany
markus.scheibel@charite.de

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Compliance with ethical guidelines

Conflict of interest. M. Scheibel is a consultant for Arthrex. M. Dittrich, B. Wirth, F. Freislederer, and F. Bellmann declare that they have no competing interests.

For this article, no studies with human participants or animals were performed by any of the authors. All studies performed were in accordance with the ethical standards indicated in each case.

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