Technical Note

Arthroscopic Coracoclavicular Fixation Technique Using Multiple All-Suture Anchors

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Abstract: Acromioclavicular (AC) joint dislocation is a common injury, particularly among active young individuals. Numerous surgical procedures for treating acute, high-grade AC joint dislocation have been reported. However, no standard surgical procedure that restores the normal kinematics of the AC joint is available. Among the available coracoclavicular (CC) fixation techniques, cortical button fixation was recently introduced, and it has had successful outcomes. Moreover, it is advantageous because it can be used in arthroscopic procedures. However, because of the limited number of fixation tools, a fundamental problem in terms of horizontal instability and gradual subsidence of cortical buttons has been observed, eventually leading to a threat to vertical stability. Therefore, we developed a unique CC fixation technique with multiple small tunnels using all-suture anchors, which may overcome potential complications caused by cortical buttons that require bone tunnels with relatively large diameters. This arthroscopic CC fixation technique was designed to achieve the ideal horizontal and vertical stability that may restore native AC kinematics.

Numerous surgical procedures for treating acute, high-grade acromioclavicular (AC) joint dislocation have been reported.[1] Open techniques, such as those that use a hook plate or Bosworth screw, are still widely used; meanwhile, arthroscopic techniques have recently been developed and are being increasingly used to treat various AC joint dislocations.[2] Although most studies have reported that both methods have good short-term clinical effects, a standard surgical procedure that restores the normal kinematics of the AC joint is still not available. Existing surgical concepts focus on restoring the function of the coracoclavicular (CC) ligament using tendon grafts, synthetic slings, or tapes because fixation options for the AC joint itself are limited.[3]

Among the available CC fixation techniques, cortical button fixation was recently introduced, and it has had successful outcomes. Moreover, it is advantageous because it can be used in arthroscopic procedures.[4] However, there are some concerns regarding the capability of this method in providing horizontal stability, and it has complications correlated with metal subsidence with the loss of CC reduction and the risk of fracture of the coracoid process or clavicle.[1]

Although the double—cortical button technique was introduced to overcome these disadvantages, clinicians still find it challenging to place 2 holes in the coracoid process and clavicle without the risk of fracture of either bony structure.[5] Consequently, achieving horizontal and vertical stability without causing a stress fracture remains a challenge. Therefore, we developed a unique CC fixation technique with multiple small tunnels using all-suture anchors, which may overcome potential complications caused by cortical buttons that require bone tunnels with a relatively large diameter. This arthroscopic CC fixation technique was designed to achieve ideal horizontal and vertical stability that may restore the native AC kinematics.

Arthroscopic Repair Technique

The procedure aims to provide good healing of freshly ruptured soft tissue and to minimize complications such

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as residual AC instability and postoperative fracture of the coracoid process and/or clavicle. Under general anesthesia with an interscalene block, the patient is placed in the lateral decubitus position. The operative arm is placed in 20° to 30° of abduction and 20° of forward flexion (Star Sleeve Traction System; Arthrex, Naples, FL) with 15 lb of side-arm traction. The pillow at the head of the patient is removed because it can interfere with subsequent clavicle drilling. Three (posterior, anterolateral, and anterior) or two (anterolateral and anterior) standard arthroscopic portals are created (Fig 1). The posterior portal is only the initial introductory portal that helps identify the anterolateral and anterior portals. The anterolateral portal is the primary viewing portal. The anterolateral portal is created approximately 1.5 cm lateral to and in line with the anterior border of the acromion. A 30° arthroscope is inserted directly into the subacromial space through the anterolateral portal, and the anterior portal is then established with the out-and-in technique using a spinal needle while the surgeon visualizes directly through the anterolateral portal. The anterior portal is used for the instrumentation of the undersurface of the coracoid base. A radiofrequency ablator and arthroscopic shaver are introduced through the anterior portal to approach the base of the coracoid process. After the soft tissues are removed, the coracoid base on the subscapularis muscle is exposed (Fig 2).

Next, a 1.5-cm skin incision that is approximately 1 cm medial to the tip of the distal clavicle following the longitudinal axis of the distal clavicle is made. The deltotrapezial fascia is incised, and dissection is performed down to the clavicle. After exposure of the superior surface of the distal clavicle, the clavicular portion of the trapezoid and conoid ligament are roughly estimated by identifying the conoid tubercle. To determine the drilling points, a mark is made 0.5 cm anterior and 0.5 cm lateral to the conoid tubercle on the superior surface of the clavicle.

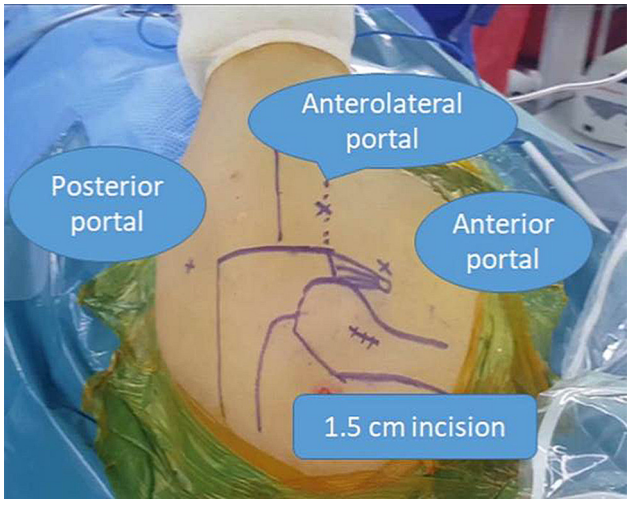

Fig 1. Overview of operating site. Left shoulder, lateral decubitus position. Standard posterior, anterolateral, and anterior portals and an additional skin incision over the distal clavicle are used.

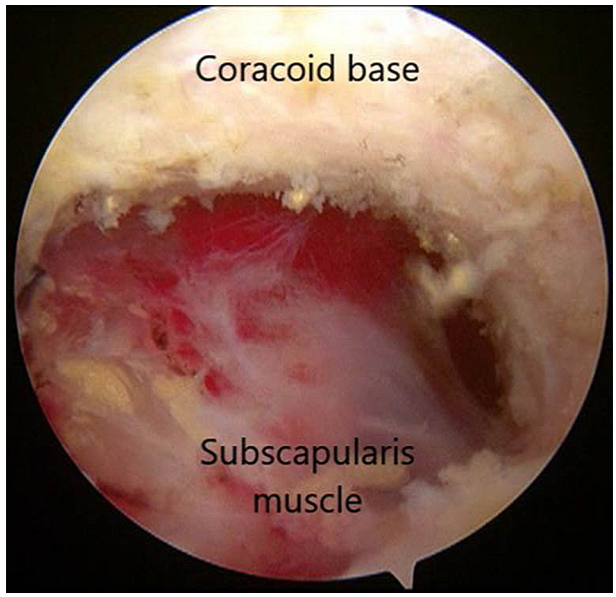

Fig 2. Subacromial space view of a left shoulder, through the anterolateral viewing portal, with the patient in the lateral decubitus position. The coracoid base is exposed by performing bursectomy using an ArthroCare device (ArthroCare, Autsin, TX) along the coracoacromial ligament. The subscapularis muscle is observed under the coracoid base.

A standard AC drill guide (Arthrex) is introduced into the subcoracoid space through the anterior portal (Fig 3). The tray of the aiming guide is placed at the base of the coracoid process and at the center between its medial and lateral edges. The ratchet drill sleeve of the AC drill guide is positioned at the aforementioned points where the conoid ligament is attached. A 1.8-mm guide pin is used to drill bicortically through the clavicle and coracoid process under a direct arthroscopic view to ensure correct positioning and to prevent overpenetration. After the first opening is made (Fig 4), the guide pin is replaced with a 1.1-mm nitinol suture-passing wire (Arthrex) that is inserted into the hole created from the superior surface of the clavicle and is passed through the hole (first opening) of the coracoid process and then through the anterior portal (Fig 5). Through the anterior portal, the suture-passing wire is pulled out using a retriever (Arthrex) and then shuttle relayed together with the 4 limbs of an all-suture anchor (Y-Knot RC; Linvatec, Largo, FL) from the anterior portal. Consequently, the limbs of the all-suture anchor are passed through the coracoid process and clavicular tunnel from the base of the coracoid process, and part of the soft knot is anchored to the entrance of the tunnel at the base of the coracoid process (Fig 6).

The second drill sleeve is positioned approximately 2 cm lateral to the first tunnel. The tray of the aiming

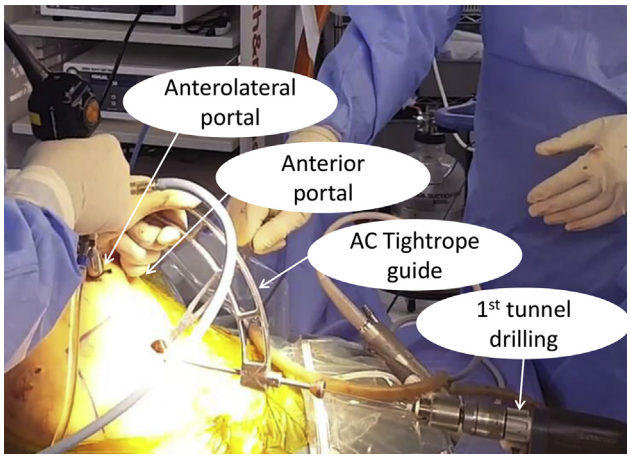

Fig 3. Outer view of trans-clavicular trans-coracoid drilling (with anterolateral portal as viewing portal and anterior portal as working portal).

guide is also placed at the base of the coracoid process, which is right next to the first knot of the all-suture anchors. Similarly, the limbs of the second all-suture anchor are shuttled into the second tunnel.

The third tunnel is established between the 2 existing tunnels for additional fixation, and stable fixation is achieved by the same procedure. Parts of the 3 soft knots are all anchored at the entrance of the tunnel at the base of the coracoid process (Fig 7).

The AC joint is vertically reduced by applying downward forces on the lateral clavicle with a bone tamp under C-arm guidance. Each limb of the all-suture anchors is securely anchored with a giant knot on the clavicular tunnel, which is created by placing 6

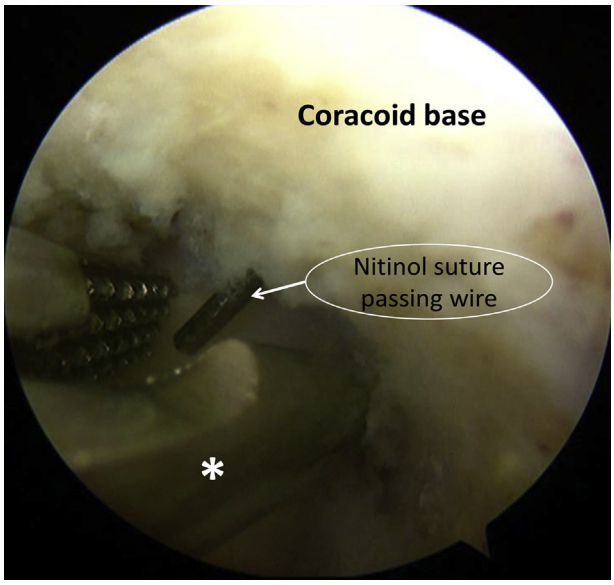

Fig 5. Subacromial space view through the anterolateral portal. The nitinol suture-passing wire is inserted into the first tunnel to shuttle relay the Y-Knot limbs. A retriever (asterisk) is used to pull the nitinol suture-passing wire out of the anterior portal.

subsequent half-hitches on either side of the existing knots (Fig 8). The entire surgical technique is shown in Video 1, with audio narration. Table 1 presents tips, pitfalls, and key points of using this technique.

Postoperatively, the patient is immobilized with a Kenny Howard sling (Seoulbrace, Seoul, Republic of Korea) for 6 weeks. Passive range-of-motion exercise is started 6 weeks after surgery. During this period, only

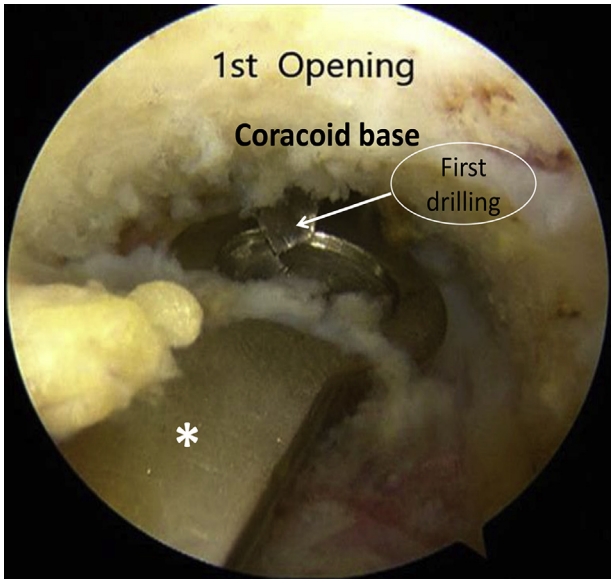

Fig 4. Subacromial space view through the anterolateral portal. Trans-clavicular trans-coracoid drilling is performed through the AC TightRope guide (asterisk) into the anterior portal to create the first tunnel.

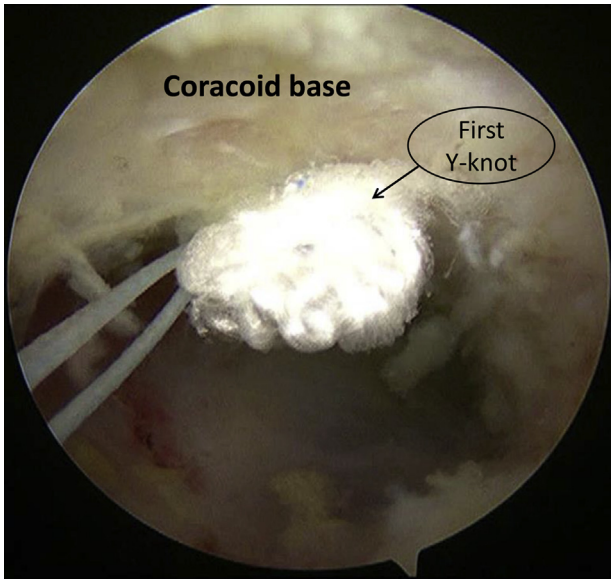

Fig 6. Subacromial space view through the anterolateral portal. The first knot is anchored under the base of the coracoid process.

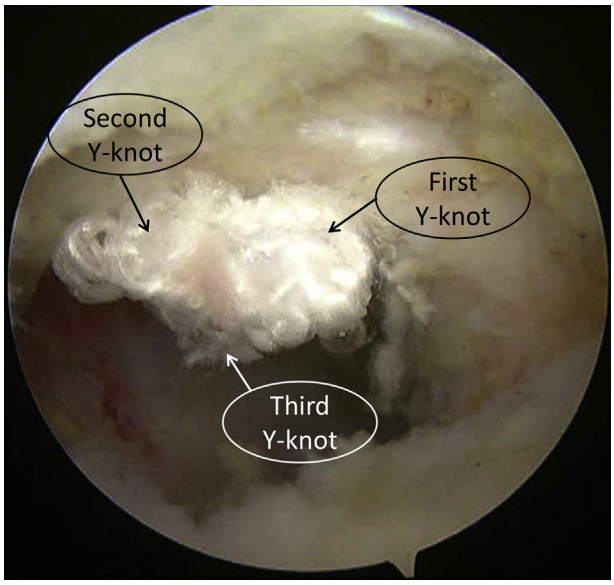

Fig 7. Subacromial space view through the anterolateral portal. The 3 knots are anchored under the base of the coracoid process.

isometric muscle strengthening is permitted. Gentle isokinetic muscle training is initiated 3 months after full active range of motion is achieved. Contact sports are not permitted until 12 months after surgery.

Discussion

We have introduced a surgical technique that uses multiple all-suture anchors that are thought to be safe and effective. This technique has several notable features. First, multiple strands are used through multiple tunnels for sufficient fixation. Theoretically, the use of 2 or more vertical stabilizers along the course of the CC ligament is more effective at restoring the anatomy and biomechanical properties of the native ligaments.[6]

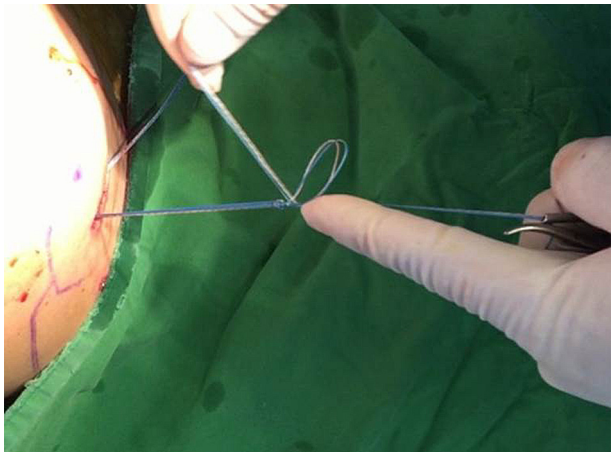

Fig 8. Outer view of an oversized, giant knot made by placing 6 subsequent half-hitches on either side of the existing knots just before the reduction.

Table 1. Pearls and Pitfalls

Pearls
The head height should not be raised because this may interfere with drilling; thus, no pillow should be placed under the patient's head while in the lateral decubitus position.
The location for drilling should be along the lateral direction starting from the conoid tubercle. Drilling holes are located at regular intervals alongside the midline of the clavicle.
Finding the coracoid base in the subacromial space can be achieved by ablating the bursal tissues along the coracoacromial ligament using an ArthroCare device.
Pitfalls
The most medial drilling position should not cross the medial side of the conoid tubercle.
Care should be taken not to detach the deltoid muscle insertion site of the clavicle.

Second, a small-width tunnel is used to reduce complications, such as the risk of fracture. The use of 2 TightRopes (Arthrex) puts a patient at risk of fracture of the clavicle or coracoid process owing to the diameter of the drill holes. Therefore, to achieve favorable results, this complication must be avoided by cautiously creating small-width bone tunnels.[7] In this context, the CC fixation method with small-width multiple tunnels can predictably reduce the risk of fracture of the clavicle or coracoid process and ensure considerable sufficient mechanical strength and horizontal stability from a mathematical point of view. In addition, drilling small tunnels results in less damage to pre-existing torn CC ligaments because the ligaments have a higher healing capacity than large tunnels.[8] Third, this technique can induce the natural healing of the ligaments because this technique is fixed without direct exposure of the pre-existing torn AC joint ligament and CC ligament. Finally, this technique is advantageous because it does not require a second operation for metal implant removal because such an implant is not used. However, this technique has some limitations. That is, it is fixed using multiple soft giant knots on the superior surface of the clavicle. Thus, its use in the osteoporotic bone of old patients is questionable. Table 2 depicts the advantages and disadvantages of this technique.

Table 2. Advantages and Disadvantages

Advantages
The addition of vertical as well as horizontal stability contributes greatly to initial fixation stability.
The technique provides better healing conditions because fixation is attempted without directly viewing the injured CC ligament and AC ligament.
There is less risk of fracture of the clavicle or coracoid process.
Metal implant removal is not required.
Disadvantages
Because the technique is technically demanding, a learning curve is needed.
The technique is not suitable for old patients with osteoporotic bone.

AC, acromioclavicular; CC, coracoclavicular.

We have introduced arthroscopic CC fixation using multiple all-suture anchors, which are thought to be effective for sufficient vertical and horizontal stability. This technique can be the best option for surgeons to appropriately treat acute, high-grade AC joint dislocation.

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