



A Single-Tunnel Technique for Coracoclavicular and Acromioclavicular Ligament Reconstruction

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Abstract: Acromioclavicular (AC) joint separation is a common injury seen in the young adult athletic population. Both the indications for surgical management and the best operative technique remain controversial. One of the most popular reconstruction techniques is the anatomic double-tunnel coracoclavicular (CC) ligament reconstruction. However, there have been several case reports of clavicle fractures with this technique. This article presents a single-tunnel reconstruction technique that aims to restore both the CC and AC ligament function, while minimizing fracture risk.

Acromioclavicular (AC) joint separation is a common injury seen in the young adult athletic population. The injury usually occurs after a direct blow to the lateral aspect of the shoulder or a fall with the arm in an abducted position. The Rockwood classification system is typically used to guide treatment, with type I and II mostly managed conservatively and type IV to VI surgically. Treatment of type III injuries remains controversial and depends on the patient's activity level.¹

A large number of surgical techniques have been described to treat AC joint separations, including both open and arthroscopic techniques, as well as reconstruction methods addressing primary repair of the coracoclavicular (CC) and/or AC ligaments, distal clavicle excision, (temporary) joint stabilization with hardware, suture augmentation, and auto-/allograft reconstruction. One of the most popular techniques remains the anatomic double-tunnel CC ligament

reconstruction, as introduced by Mazzocca et al.² However, biomechanical studies have shown a decreased strength in the clavicle after drilling the two 6-mm tunnels required.³ In addition, there have been several case reports of clavicle fractures.⁴⁻⁶ To minimize fracture risk, a single-tunnel technique could present a more suitable option, especially for high-level athletes involved in contact sports. Previously purposed single-tunnel reconstruction techniques were linked to a high failure rate with regard to maintenance of reduction.⁷ This may be associated with the failure to restore both the CC and AC ligament function. This article presents a single-tunnel reconstruction technique to restore both CC and AC ligament function (Table 1).

Surgical Technique

Patients receive a combination of general and regional anesthesia. Regional anesthesia consists of an interscalene block (Video 1; Tables 2 and 3).

The patient is positioned in the lateral decubitus position. After examination under anesthesia, the involved upper extremity is prepped and draped in routine sterile fashion. Ten pounds of balanced suspension is then applied. The bony landmarks, portals, and planned incisions are drawn onto the skin for orientation (Fig 1).

Standard posterior and anterior portals are established and a diagnostic arthroscopy is performed to assess for associated chondral, labral (Fig 2), biceps, and rotator cuff pathology. The rotator interval is explored to facilitate evaluation of the CC ligament and preparation of the coracoid. Using a combination of electrocautery and arthroscopic shaving, the coracoid is debrided, including remnants of the CC ligament (Figs 3 and 4). Both the 30° and 70° arthroscope can be used interchangeably to aid

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Table 1. Advantage and Disadvantages of Single-Tunnel Technique for Coracoclavicular and Acromioclavicular Ligament Reconstruction

Advantages	Risks/Limitations
Less theoretical risk of clavicle fracture by using a single small tunnel and protecting it with a Dog Bone Button	Not truly an anatomic technique, but modified anatomic
Less theoretical risk of coracoid fracture by using SutureTape in a luggage tag around the coracoid	Need for allograft availability or autograft harvest
No need for hardware removal or secondary surgery	
Theoretically stronger than conventional single-tunnel technique as it reconstructs both CC and AC ligament function	
Restores the biomechanical properties of the AC joint similar to double-tunnel anatomic CC ligament reconstruction with regard to anterior-posterior AC joint stability	
Ability to do procedure open or arthroscopically assisted	

AC, acromioclavicular; CC, coracoclavicular.

in optimal visualization. Care must be taken to protect the conjoint tendon and nearby neurovascular structures, specifically the musculocutaneous nerve.

For the open portion of the procedure, a 2-cm longitudinal incision is placed over the distal aspect of the clavicle and carried down sharply through the subcutaneous tissue onto the deltotrpezial fascia. This fascia is carefully split in line with the clavicle and preserved to facilitate a layered closure at the end of the procedure. The platysma is sharply reflected off the clavicle

Table 2. Pearls and Pitfalls of Single-Tunnel Technique for Coracoclavicular and Acromioclavicular Ligament Reconstruction

Pearls	Pitfalls
Use arthroscopic assistance to facilitate small incisions, diagnostic and operative glenohumeral or subacromial arthroscopy, and passage of instruments and sutures	Protect the conjoint tendon and nearby neurovascular structures, specifically the musculocutaneous nerve
Switch between the 30° and 70° arthroscope for optimal visualization	During retrieval of the 2 ends of the FiberLink from the anterior inferior portal, avoid creation of a soft tissue bridge
Use intraoperative fluoroscopy to confirm acromioclavicular joint reduction	Avoid a large knot stack on top of the Dog Bone Button in thin patients as this can be prominent, painful, and aesthetically unpleasing

Table 3. Steps of the Single-Tunnel Technique for Coracoclavicular and Acromioclavicular Ligament Reconstruction

Place patient in a lateral decubitus position, balanced suspension
After an intra-articular diagnostic arthroscopy, debride the coracoid and remnants of the CC ligament
Make a 2-cm longitudinal incision over the distal clavicle
Resect 1 cm of bone from the distal clavicle
Use a coracoid passer to place a wire around the coracoid in an anterior to posterior direction
Retrieve the wire out of the anterior inferior portal
Place a FiberLink into the looped end of wire passer and pass around the coracoid
Prepare a graft such that it fits easily through a 5-mm sizing guide and whip-stitch the ends with FiberLoop
Place free end of graft with a FiberLoop and the looped end of a SutureTape into previously passed FiberLink and pass around the coracoid
Place the SutureTape through its own loop and pull to create a luggage-tag configuration around the coracoid
Place a guidewire and overdrill a 6-mm single tunnel at the location of the conoid tubercle of clavicle
Use a coracoid passer to pass the medial graft limb around the posterior aspect of the clavicle
Pass the lateral graft limb through the clavicle along with the SutureTape
Pass the medial graft limb through the clavicle from a superior to inferior direction
Remove balanced suspension and reduce the AC joint using a bone tamp
Place a biotenodesis screw loaded with previously placed SutureTape in the tunnel while applying tension to the graft limbs
Use a Dog Bone Button to tie the SutureTape over the tunnel
Place a SutureTak in the acromion to bring the residual lateral graft limb across the superior aspect of the AC joint using a tension-slide technique to reconstruct the superior AC joint capsule
Irrigate, perform layered closure, and dress the incision sites

AC, acromioclavicular; CC, coracoclavicular.

using electrocautery, taking care to preserve the periosteum. Dilators are used to facilitate later passage of the coracoid passer from this incision and around the coracoid (Fig 5).

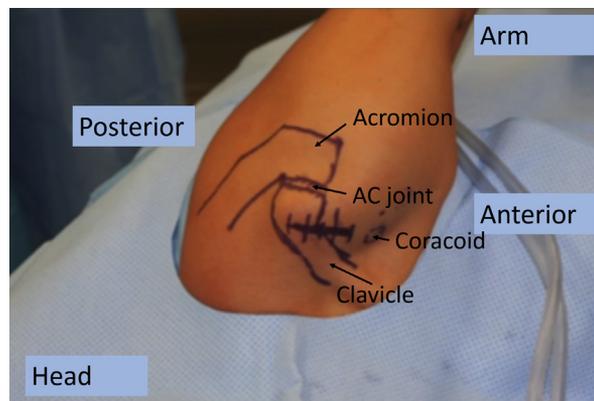


Fig 1. Setup for left shoulder arthroscopy. Lateral decubitus position with anatomic landmarks for arthroscopically assisted single-tunnel AC and CC ligament reconstruction drawn on the patient's skin. (AC, acromioclavicular; CC, coracoclavicular.)

Fig 2. (A and B) Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal showing a labral tear found during diagnostic arthroscopy.

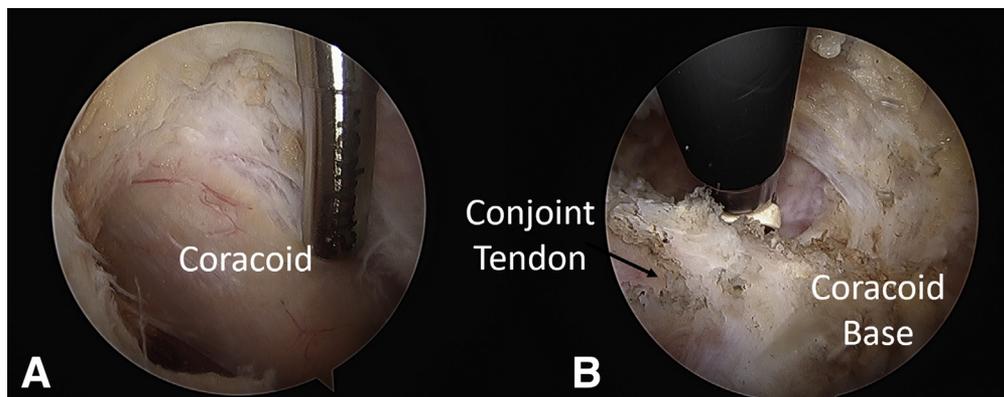
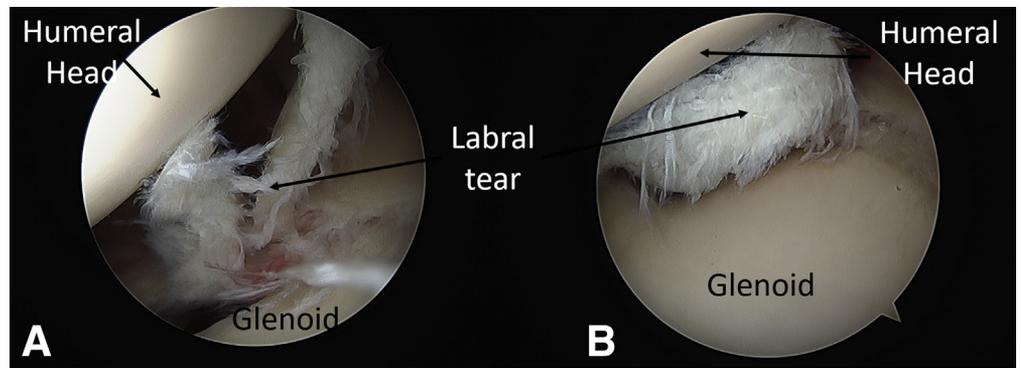


Fig 3. Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal. (A) Using a 30° scope, a shaver is first used through the anterior portal to expose the coracoid. (B) Then the scope is switched to a 70° scope, and electrocautery is used to debride the coracoid base circumferentially, as well as remnants of the CC ligament. (CC, coracoclavicular.)

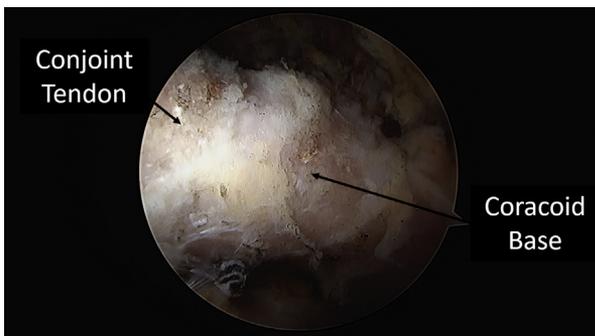


Fig 4. Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal with the 70° scope showing the coracoid after preparation with electrocautery and shaving.

Using a saw, approximately 1 cm of bone is resected off the distal clavicle. The coracoid passer (Arthrex, Naples, FL) is then used to place a wire around the coracoid in an anterior to posterior direction, under direct visualization with the arthroscope (Fig 6A). In reference to the coracoid, this is going in a medial to lateral direction. This wire is then retrieved from the anterior portal using an arthroscopic grasper; again, this is done under direct visualization with the arthroscope (Fig 6B). A FiberLink (Arthrex) is then placed into the looped end of the wire passer and passed around the coracoid. When retrieving both free limbs, care must be taken to avoid creation of a soft tissue bridge.

A semitendinosus allograft is used as the graft type. The graft is prepared such that it fits easily through a 5-mm sizing guide. The free ends are whip-stitched

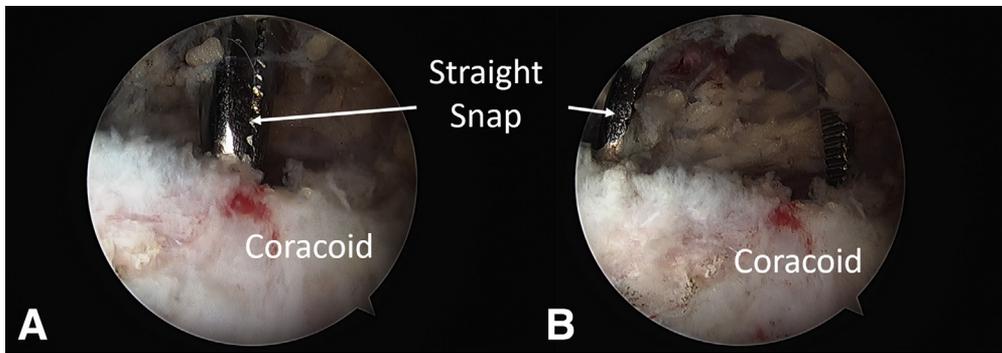


Fig 5. (A) and (B) Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal with a 70° scope. A straight snap is used through the open incision over the distal aspect of the clavicle to dilate the soft tissue to facilitate later passage of the coracoid passer from this incision and around the coracoid.

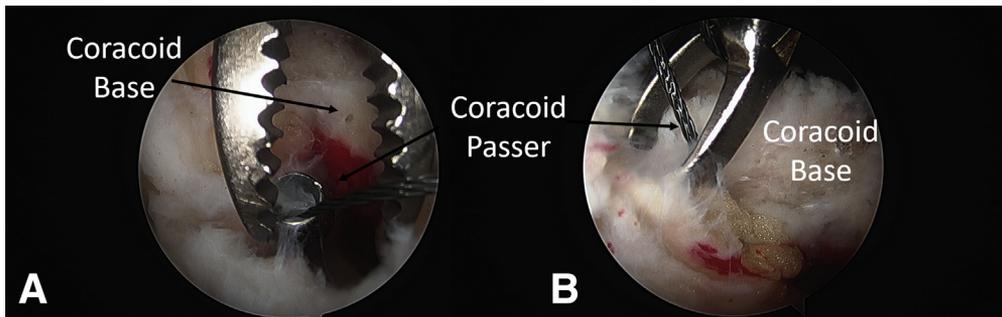


Fig 6. Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal with a 70° scope. (A) The coracoid passer is used to place a wire around the coracoid in an anterior to posterior direction, under direct visualization with the arthroscope. (B) The wire is then retrieved from the anterior portal using an arthroscopic grasper.

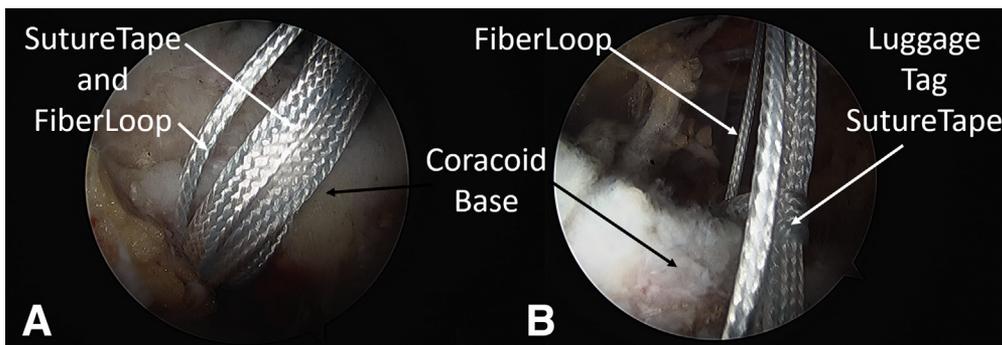
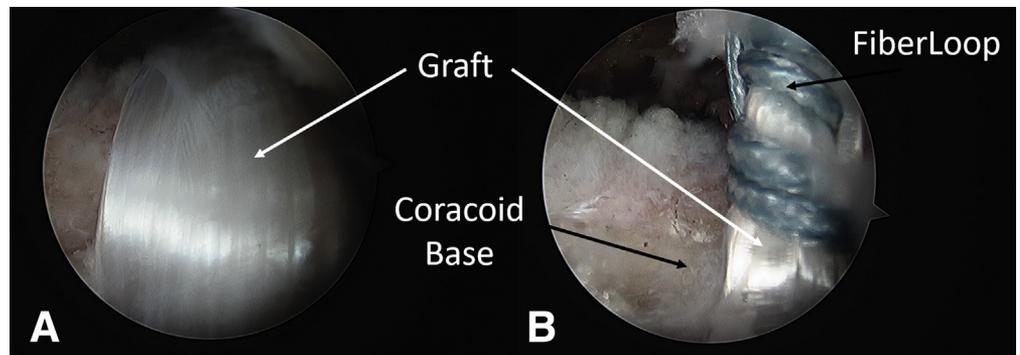


Fig 7. Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal with a 70° scope. (A) The FiberLoop from the graft and the looped end of a SutureTape are passed around the coracoid. (B) The tails of the SutureTape are placed through its own loop and pulled to create a luggage tag configuration around the coracoid to minimize the sawing effect on the coracoid and reduce the risk of coracoid fracture.

Fig 8. (A) and (B) Arthroscopic view of the left shoulder, lateral decubitus position, through the posterior glenohumeral portal with a 70° scope. The FiberLoop whipstitched to the graft is now pulled to pass the graft around the base of the coracoid over the top of the luggage-tagged SutureTape.



using a FiberLoop (Arthrex). Fifteen pounds of tension is applied for 15 minutes to precondition the graft. One free end of the graft with its FiberLoop (Arthrex) and the looped end of a SutureTape (Arthrex) are placed into the previously passed FiberLink (Arthrex) and passed around the coracoid. This is done under direct visualization with the arthroscope. The tails of the SutureTape (Arthrex) are then placed through its own loop and pulled to create a luggage tag configuration around the coracoid (Figs 7 and 8). This is intended to minimize the sawing effect on the coracoid and reduce the risk of coracoid fracture.

The conoid tubercle is identified, approximately 3.5 cm from the AC joint. A guidewire is placed in the clavicle at the conoid tubercle. This guidewire is then overdrilled to a 6-mm single tunnel. The coracoid passer (Arthrex) is then used to pass the medial limb of the graft around the posterior aspect of the clavicle. The

lateral limb of the graft is now passed through the clavicle along with the SutureTape (Arthrex) in an inferior to superior direction. The medial limb is then taken and passed through the clavicle from a superior to inferior direction.

Balanced suspension is then taken down and the AC joint reduced using a bone tamp. This is confirmed using intraoperative fluoroscopy. A 5.5 × 8-mm PEEK (polyether ether ketone) biotenodesis screw loaded with the previously placed SutureTape is placed into the tunnel while applying tension to the graft limbs. A Dog Bone Button (Arthrex) is used to tie the SutureTape (Arthrex) over the top of the tunnel. In addition to providing fixation, this button also spans the cortical defect resulting from the tunnel in the clavicle, thereby reducing the risk of clavicle fracture. Lastly, a 3.0-mm single-loaded PEEK SutureTak (Arthrex) is placed in the acromion to bring the lateral limb of the graft across

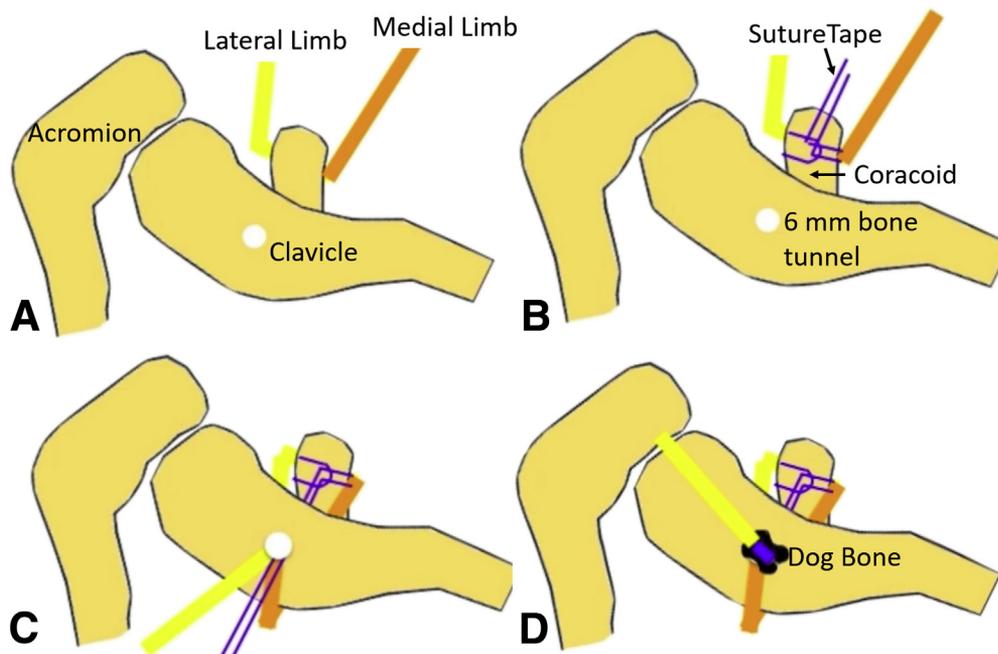


Fig 9. Diagram of the steps of single-tunnel AC and CC ligament reconstruction. (A) Passing of the medial and lateral graft limb under the coracoid. (B) Passing of the SutureTape in a luggage tag fashion. (C) Passing of the graft limbs and the SutureTape through a single 6-mm bone tunnel. (D) Placement of the Dog Bone Button over the tunnel and then fixation of the lateral graft limb to the acromion for AC joint reconstruction. (AC, acromioclavicular; CC, coracoclavicular.)

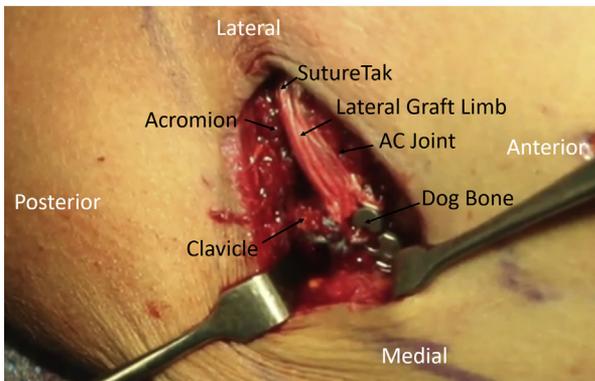


Fig 10. Left shoulder after arthroscopically assisted single-tunnel AC and CC ligament reconstruction, showing the single tunnel in the clavicle, covered by the Dog Bone Button, and the residual lateral graft limb spanning the AC joint and fixed with a SutureTak in the acromion to restore the superior AC joint capsule. (AC, acromioclavicular; CC, coracoclavicular.)

the superior aspect of the AC joint using a tension slide technique to reconstruct the superior AC joint capsule (Figs 9 and 10).

The wound is then copiously irrigated, and layered closure is performed. A no. 2.0 Vicryl suture is used for the deltotrapezial fascia, followed by no. 3.0 Vicryl for the subcutaneous tissue and no. 4.0 Monocryl for the skin. A sterile dressing is placed, followed by a sling, and the patient is awoken from anesthesia.

Postoperatively, plain radiographs are taken (Fig 11). The affected arm is immobilized in a sling for 1 month. For the first month, only passive range of motion is allowed. Over the next 4 weeks, patients are progressed to active range of motion, as long as full passive range of motion is obtained. After another 4 weeks, patients are encouraged to start strengthening. This is all done under the supervision of a licensed physical therapist. Patients are then prepared to return to their sports using sport-specific training. Clearance to return to contact sports is usually given between 6 and 9 months.

Discussion

This paper presents a single-tunnel CC and AC ligament reconstruction technique (Tables 1-3; Video 1). This technique intends to provide stability to the AC joint while reducing the risk of both clavicle and coracoid fracture.

Spiegel et al. performed a controlled laboratory study comparing 2 common CC reconstruction techniques. Two groups of matched-pair cadaveric clavicles were prepared with either 2.4-mm tunnels and a cortical fixation button or 6-mm tunnels with a graft and tenodesis screw. A 3-point bending load was applied to the distal clavicle until failure. The graft tunnel technique significantly reduced clavicle strength relative to the contralateral intact clavicle and caused significantly more strength reduction than the cortical fixation button technique. This study also showed that relative tunnel width, expressed as percentage of total clavicle width, was correlated with strength reduction.³

A case series of 59 patients who underwent the same 2 aforementioned reconstruction techniques revealed a higher complication rate in the patient who underwent the tunnel graft technique compared with those who received the cortical fixation button. Clavicle fractures were seen more in the graft tunnel group, whereas the cortical fixation button group had more loss of reductions and one coracoid fracture. These authors did not use the SutureTape luggage tag configuration used in the present Technical Note. Patient-reported outcome scores at final follow-up had increased compared with those preoperatively in both groups, with the exception of patients who had complications.⁴ Turman et al.⁵ report on 3 cases of clavicle fracture with the tunnel graft technique as well.

In another case series on 10 active duty military patients who underwent CC reconstruction using a different single-tunnel technique, 80% had lost reduction at an average of 7 weeks after surgery and 40% required revision. The authors concluded that the single-clavicular tunnel technique was not a reliable approach to CC ligament reconstruction. However, in this study, only the CC ligaments were reconstructed and

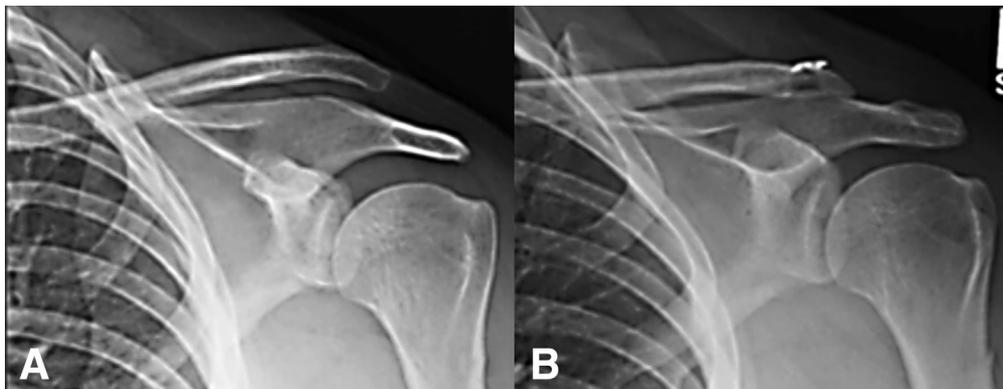


Fig 11. Preoperative (A) and postoperative (B) radiographs of the left shoulder after arthroscopically assisted single-tunnel AC and CC ligament reconstruction. The single tunnel in the distal clavicle and the Dog Bone Button can be seen. (AC, acromioclavicular; CC, coracoclavicular.)

the AC joint capsule was not reconstructed as it is in the currently presented technique from our institution.⁷

One recent study proposed a triple-tunnel technique. The study included 26 patients, but all had chronic high-grade AC joint instability. They underwent anatomic graft tunnel reconstruction and additional AC reconstruction (triple-tunnel) or conventional single-tunnel reconstruction. The triple-tunnel reconstruction resulted in comparatively superior clinical and radiologic results. No fractures were reported by the authors. The single-tunnel technique had a higher failure rate, with 21% loss of reduction.⁸

The results of an in vitro biomechanical study performed at our institution on the single-tunnel technique described in this Technical Note indicate that this method restores the biomechanical properties of the AC joint similar to double-tunnel anatomic CC ligament reconstruction with regard to anterior-posterior AC joint stability, while reducing the fracture risk. However, a formal clinical study regarding the safety and outcomes of this technique is still ongoing.

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