Anatomic Coracoclavicular Reconstruction Surgical Technique

For Treatment of Chronic Acromioclavicular (AC) Instabilities

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Introduction

The modified Weaver-Dunn procedure involves transfer of the coracoacromial ligament into the distal end of the clavicle after approximately a 10- to 12-mm resection has been accomplished. This is augmented with a suture, tape, or screw that keeps the acromioclavicular joint reduced while the ligament transfer heals. There have been numerous complications reported with this involving hardware migration and fracture, as well as infection and failure of fixation. Another criticism of this technique is that it is felt to place the clavicle in a nonanatomic position which can lead to dysfunction over time.

Finally, the acromioclavicular ligament at times may be insufficient and small, leaving an “unsatisfactory” feeling when reconstructing this joint, especially in the dominant arm of a contact athlete. The increasing rate of failures in the nonanatomic position led us to examine the literature in an attempt to recreate the anatomy more effectively.

Fukuda and coworkers[1] stated, “If maximum strength of healing after an injury to the acromioclavicular joint is the goal, all ligaments should be allowed to participate in the healing process.” This statement is the basis for our technique. Urist[2] determined that the acromioclavicular ligament was the primary restraint to anterior and posterior displacement, and the coracoclavicular ligament, specifically the conoid, resulted in an overall superior displacement or an inferior displacement of the entire scapulohumeral complex. Fukuda determined that the acromioclavicular ligament contributed about 50% of the total restraining torque for small amounts of posterior axial rotation by superior displacement (65%). The force contribution of the conoid ligament to resist superior displacement increased significantly to 60% of the total with further displacement. Lee and coworkers[3] reported that the trapezoid and conoid ligaments play a major role in limiting excessive acromioclavicular joint displacements in both the superior and posterior directions, while the inferior acromioclavicular capsule ligament is the major restraint to anterior translation. They agreed with Fukuda’s recommendation that the coracoclavicular as well as the acromioclavicular joint capsule ligaments should be considered for reconstruction.

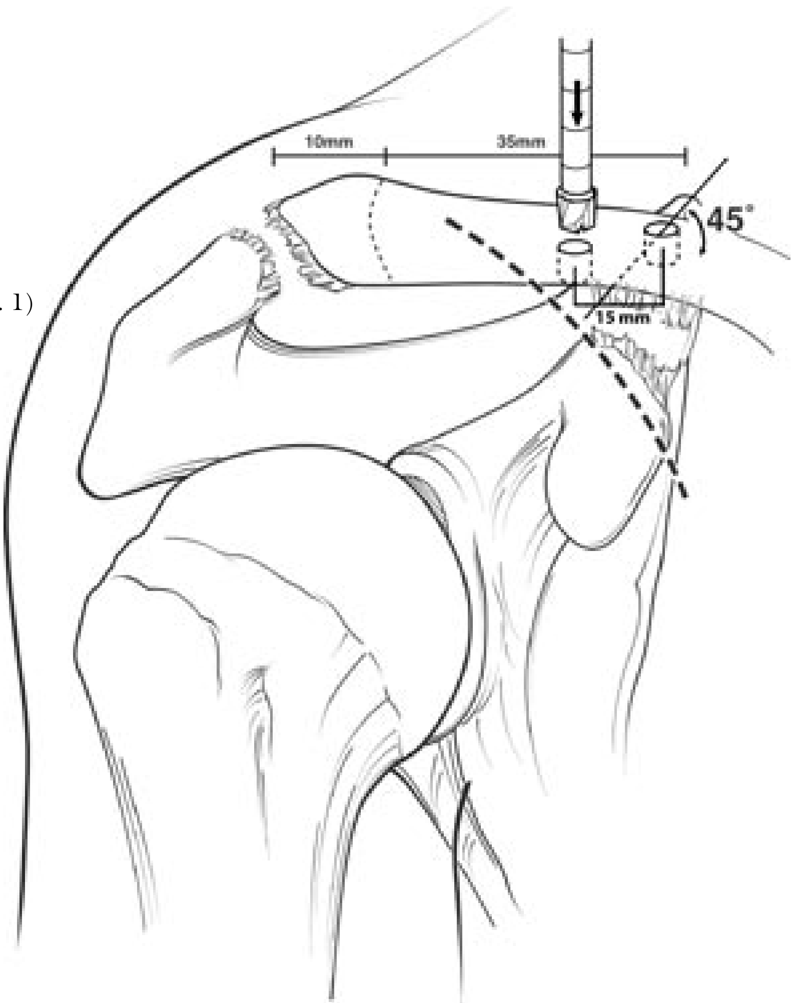
Klimkiewicz and coworkers[4] confirmed and reported that the superior and posterior acromioclavicular capsule ligaments are the most important in preventing posterior translation of the clavicle to the scapula.

Finally Debski and coworkers,[5] advancing on past research, recommended that the conoid and trapezoid ligaments should not be considered as one structure when surgical treatment is considered and that capsular damage resulted in a shift of load to the coracoclavicular ligaments. They also reported that the intact coracoclavicular ligaments cannot compensate for the loss of capsular function during anterior-posterior loading, as occurs in type-II acromioclavicular joint injuries.

Based on these five studies and anatomical and clinical observations, we set about to produce an operative procedure that would recreate both the conoid and trapezoid coracoclavicular ligaments and augment any remaining superior and posterior acromioclavicular ligaments.

The use of grafts for reconstruction of the acromioclavicular joint was first reported by Jones and coworkers.[6] In their study, an autogenous semitendinosus tendon graft was used to reconstruct the acromioclavicular joint. Lee et al[7] found that the semitendinosus graft stiffness was much closer than that of the acromioclavicular ligament transfer. They also found no statistical difference in load-to-failure among three tendon grafts tested (gracilis, toe extensors, and semitendinosus). They also found that stiffness after the suture and tape repairs was not significantly different from that after the tendon graft reconstruction. The clinical and biomechanical success of using semitendinosus auto- or allografts allowed us to modify these existing techniques and place them in an “anatomic” position. In the remaining sections of this paper, we describe the anatomic coracoclavicular ligament reconstruction.

(Fig. 1)



SURGICAL PROCEDURE

APPROACH

In osteological analyses of 118 clavicles, the mean length from the end of the clavicle, or the acromioclavicular joint, to the coracoclavicular ligaments was 46.3 ± 5 mm; the distance between the trapezoid laterally and conoid medially was 21.4 ± 4.2 mm. Thus, we center our incision roughly 3.5 cm from the distal clavicle or acromioclavicular joint and make it curvilinear in the lines of Langer toward the coracoid process. Control of the superficial skin bleeders down to the fascia of the deltoid is accomplished with a needle-tip bovie. Once the entire clavicle is palpated, full-thickness flaps are made from the midline of the clavicle both posteriorly and anteriorly, skeletonizing the clavicle. This is done in the area of the coracoclavicular ligament, (Fig. 1).

DISTAL CLAVICULECTOMY

For the surgeon who prefers to perform a distal claviculectomy, 10 mm of the distal clavicle is removed in a perpendicular fashion using an oscillating saw. The posterior 1/3rd of the distal clavicle is beveled with an oscillating saw or rasp to avoid potential contact with the spine of the scapula.

GRAFT PREPARATION

Depending on surgeon preference (semitendinosus, anterior tibialis), allograft or autograft can be used for this procedure. Lee and coworkers[7] found no difference in peak load-to-failure among semitendinosus, toe extensors, and gracilis tendons for reconstruction of the acromioclavicular joint.

This technique involves looping the tendon graft around the coracoid process and anchoring each tendon free end in the clavicle with Bio-Tenodesis™ (interference) screws. One to two Krakow sutures are placed in the two free ends of the graft and the graft is placed on the table in a moist sponge until the bone tunnels are prepared.

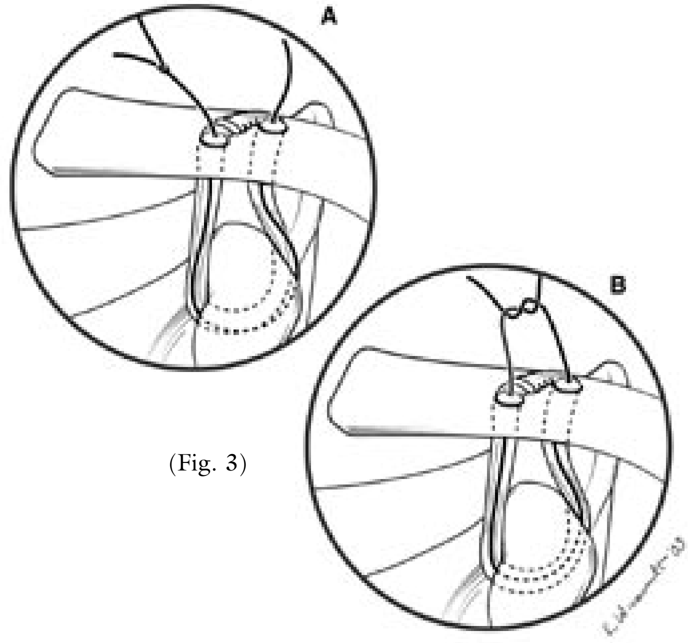
GRAFT FIXATION TO CORACOID PROCESS—LOOP TECHNIQUE

Looping the graft around the base of the coracoid process can be facilitated by the use of a curved aortic cross-clamp (Satinsky clamp) and a suture-passing device. At the same time that the graft is passed, a #2 FiberWire® (Arthrex, Inc) is also passed around the base of the coracoid. (Fig. 2).

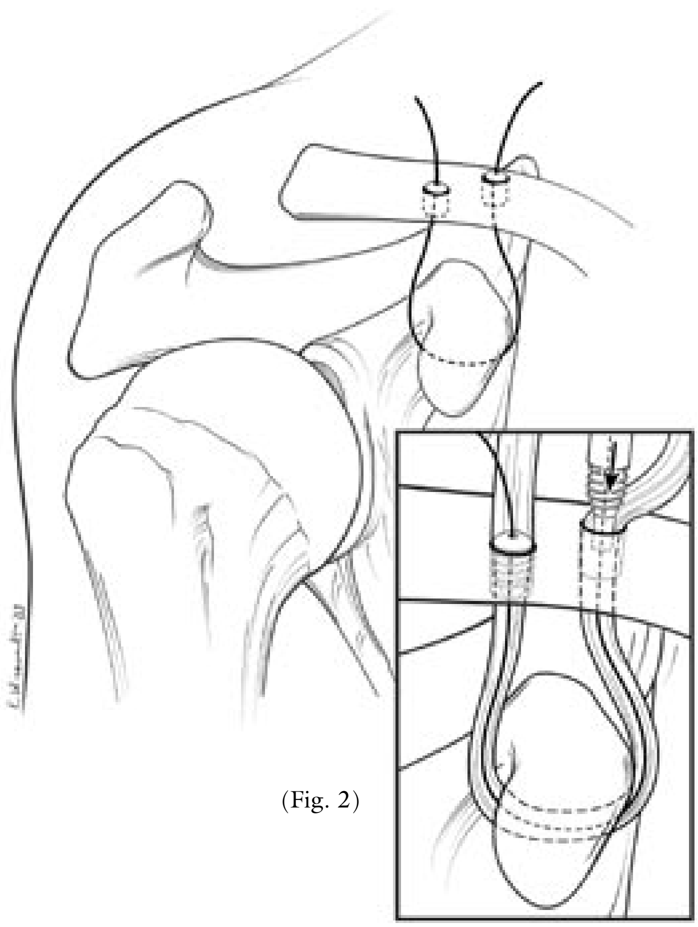
BONE TUNNELS IN THE CLAVICLE

It is important to make the bone tunnels in as accurate a position as possible to recreate the coracoclavicular ligament. The complex osteological measurements provided are to aid the surgeon in finding the insertions of the conoid and the trapezoid and not meant as absolute numbers. A cannulated reamer guide pin is used for placement of the tunnels. The first tunnel is for the conoid ligament, and that is roughly 45 mm away from the distal end of the clavicle in the posterior one half of the clavicle. The footprint of the conoid ligament is extremely posterior, along the entire posterior edge of the clavicle. That is why making this bone tunnel as posterior as possible is important. The guide pin is also angled approximately 45° from the direct perpendicular of the clavicle to recreate the oblique nature of the ligament. Once the guide pin is inserted in the direction of the eventual bone tunnel, the appropriate reamer is placed over the guide pin and confirmation that the tunnel will be as posterior as possible without “blowing out” the posterior cortical structure of the clavicle is established. The reamer size is proportionate to the outer diameter of the graft limb and the bone quality. Since the screw outer diameter is 5.5 mm, generally you will start with a 6 mm reamer. If the graft outer diameter is equal to or larger than 6 mm use a reamer with an outer diameter of one-half millimeter larger than the graft outer diameter. If screw purchase upon insertion is too tight, up ream incrementally by half millimeter sizes until screw purchase is appropriate. Once this is confirmed, a bone tunnel 15 to 16 mm long is created bicortically with the Cannulated Headed Reamer. (Fig. 1)

The same procedure is repeated for the trapezoid ligament. This is a more anterior structure than the conoid and is usually placed in the center point of the clavicle, approximately 15 mm away from the center portion of the previous tunnel. Two Drill Tipped Guide Pins are used before reaming to confirm accurate placement of the tunnels. The tunnels are reamed completely through the entire width of the clavicle. Copious irrigation follows to remove any bone fragments (Fig. 1).



(Fig. 3)



(Fig. 2)

INTERFERENCE SCREW FIXATION OF GRAFT TO CLAVICLE

The two limbs of the biologic graft are taken and placed through the posterior bone tunnel, recreating the conoid ligament, and one from the more anterior and medial bone tunnel, recreating the trapezoid ligament. At the same time that the graft is brought through, each limb of the #2 FiberWire should be brought through the respective bone tunnels as well (Fig. 2).

Upper displacement of the scapulohumeral complex by the assistant reduces the acromioclavicular joint. A large point-of-reduction forceps placed on the coracoid process and the clavicle can assist while securing the tendon grafts. The acromioclavicular joint should be over reduced during initial fixation due to an inevitable amount of creep in the tendon graft. With complete upper displacement on the graft ensuring its tautness, a 5.5 mm x 15 mm Bio-Tenodesis Screw is placed in either the posterior or midline bone tunnels. The #2 FiberWire is brought up through the cannulated process of this screw and cannulation of the driver. After assessment that this is done successfully, the second screw is placed in the bone tunnel (Fig. 2).

The remaining portions of the tendon graft are sewn to each other as a tissue bridge between the screw heads using a #2 FiberWire (Fig. 3).

Once both grafts have been secured, the #2 FiberWire is tied over the top. (Fig. 3).

CLOSURE

One of the most important concepts with acromioclavicular or coracoclavicular joint reconstruction is the closure of the deltotrapezial fascial flaps that were made previously. A nonabsorbable suture in a modified Mason-Allen type interrupted manner is placed through the deltoid fascia. Six or seven are used at this point and these are tied at the end. The knots are tied on the posterior aspect of the trapezius. This should completely obscure the grafts as well as the clavicle.

If there is any concern that this is not a secure repair, the deltoid should be repaired through small drill holes in the anterior cortex of the clavicle. Some worry exists, based on two 6-mm bone tunnels in the clavicle with further small defects in the clavicle that this could lead to an iatrogenic fracture. In unpublished three-point bending data accomplished in the University of Connecticut biomechanics laboratory, as long as screws were in these holes there was not a significant difference in the load-to-failure between the modified Weaver-Dunn and the interference screw fixation methods.

The subdermal skin is closed with 2–0 or 3–0 absorbable sutures. The skin itself is closed with either running 2–0 Prolene or interrupted nylon everting the edge of the skin. A compression dressing is placed and the patient is placed in a supportive sling with external rotation to 0° and an upward force on the arm.

POSTOPERATIVE COURSE

Zanca as well as axillary radiographs are taken immediately postoperatively and compared with those taken 6 weeks postoperatively. Pendulum exercises three times a day are started immediately. The patient is told that he will be in a sling for 6 weeks and can come out of it only during supervised therapy, which involves active assisted range of motion in all planes. However, the use of sling support is critical. From 6 to 12 weeks, the sling is generally discontinued; however, no strengthening or lifting can be done as the graft is still maturing. From 12 to 24 weeks, isometric exercises are begun. Contact athletics are allowed 6 months postoperatively.

COMPLICATIONS

Although none have been reported so far, potential complications involve infection, clavicle fracture, or osteolysis of the distal clavicle. Of course, complete failure due to nonhealing of the ligament grafts is always a potential consequence.

CONCLUSIONS

The biomechanical analysis of the acromioclavicular and coracoclavicular ligaments and their influence on the acromioclavicular joint have aided and directed the proposed operative technique.[1, 2, 3, 4 and 5] The use of autogenous semitendinosus graft for reconstruction of the acromioclavicular joint has been reported by Jones and coworkers[6] and Lee and coworkers.[7] These studies, along with the development of the Bio-Tenodesis system, led to this eventual technique.

The anatomic coracoclavicular joint reconstruction technique is designed to place tendon grafts in the exact anatomic location. It also attempts to provide and reconstruct any remnants of the acromioclavicular joint capsule ligaments, specifically the superior and posterior portions. This procedure does not purport to be the “best,” but it does allow anatomic recreation of damaged anatomy. It does this with the previously described interference screw fixation to bone, which has worked successfully in other applications.

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Instruments:

Bio-Tenodesis Screw System Instrumentation Set	AR-1675S

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Chronic AC Repair Kit (AR-2256) contains the following:

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