Technical Note

Rotator Cuff Anterior Cable Reconstruction With Long Head of Biceps Tendon Autograft

Raymond E. Chen, M.D., Wajeeh R. Bakhsh, M.D., Jason S. Lipof, M.D., Zachary G. McVicker, M.D., and Ilya Voloshin, M.D.

Abstract: Rotator cuff tears with anterior cable disruption show a more detrimental natural history than tears with an intact cable. Anterior cable reconstruction in the setting of such tears provides a potential avenue to improve tissue quality of the repaired construct and enhance repair longevity. Cadaveric studies investigating anterior cable reconstruction have shown biomechanical advantages. We present an arthroscopic surgical technique for rotator cuff anterior cable reconstruction using long head of the biceps tendon autograft in the setting of repairable large-to-massive rotator cuff tears with poor anterior cable tissue quality.

The rotator cuff anterior cable (RCAC) has been shown to be the primary load-bearing structure during supraspinatus force transmission to the humerus. Injuries to the RCAC have devastating effects on rotator cuff function and tear propagation. Cadaveric studies show that rotator cuff tears involving the anterior cable result in greater tear displacement, decreased tendon stiffness, and increased tendon strain in comparison with tears involving the rotator crescent. Rotator cuff tears involving the anterior cable follow a more progressive natural history than those with an intact anterior cable, with accelerated tendon retraction and fatty degeneration. Disruption of the anterior rotator cable has also been associated with increased retear rates after repair. Because of these findings, it has been suggested that anterior cable involvement should be viewed as a relative indication to perform earlier rotator cuff repair surgery.

Given the biomechanical importance of the anterior rotator cable, restoration of the anterior cable construct is a potential area of improvement in rotator cuff repair surgery. The development of a RCAC reconstruction technique would potentially help prevent the previously discussed complications and could yield an overall stronger biomechanical repair construct. Therefore, we present an arthroscopic RCAC reconstruction technique using long head of the biceps (LHB) tendon autograft in the setting of repairable large-to-massive rotator cuff tears, with geometry and location indicative of anterior cable involvement.

Surgical Technique

Patients can be positioned in the operating room as per surgeon preference for arthroscopic rotator cuff repair; either the lateral decubitus or the beach chair position can be used. A diagnostic shoulder arthroscopy of the glenohumeral joint is performed with standard anterior, posterior, and lateral portal placement, visualizing the extent of the rotator cuff tear and anterior cable disruption, as well as the integrity of the LHB. Attention is then paid to the subacromial space, with initial bursectomy to achieve necessary visualization of the rotator cuff. Rotator cuff mobilization is then performed. Adhesions are divided to maximize the ability of the rotator cuff to mobilize enough to reach, at minimum, the medial aspect of the greater tuberosity without undue tension (Figure 1). A disrupted LHB tendon or a retracted rotator cuff tear with inability to adequately mobilize would preclude proceeding with the proposed surgical technique.
Next, the greater tuberosity, in addition to the superior bicipital groove, is debrided to bleeding bone with an arthroscopic shaver (Arthrex, Naples, FL) in preparation for anchor placement. Biceps tenodesis is then performed at the superior aspect of the bicipital groove. This is achieved by percutaneously placing a double-loaded suture anchor (5.5-mm BioComposite cork-screw anchor loaded with 2 SutureTape sutures, Arthrex) just superior to the biceps groove, anterior to the greater tuberosity. A suture limb of 1 of the SutureTape sutures is then passed through the LHB at the level of the anchor using a modified Mason-Allen stitch. The opposite limb of the same suture is then passed through the anterior leaflet of the rotator interval tissue, and these limbs are tied arthroscopically in standard fashion. A remaining suture limb of the other SutureTape suture is then passed through the biceps tendon first, then through the remaining anterior rotator interval tissue, if present, and the suture is tied arthroscopically. This achieves biceps tenodesis, with the proximal portion of the biceps tendon available for anterior cable reconstruction. The biceps tendon is still attached to the glenoid at this point, and will now serve as a scaffold for reduction of the rotator cuff (Figure 2; see also Figure 5A).

Next, near the origin of the long head of the biceps tendon, ~5 mm distal to the superior glenoid tubercle, a limb of a free SutureTape suture is passed through the biceps tendon from deep to superficial. The other limb of the suture is also passed through the tendon just adjacent to the first limb in a similar fashion. Then, in a “pants-over-vest” fashion, the suture limbs are passed through the anteromedial margin of the supraspinatus tendon (site of the anterior rotator cable) (Figure 3A; see also Figure 5B). With the suture limbs passed through both the biceps tendon and the supraspinatus tendon, the proximal biceps origin is then released using a RF (radiofrequency) probe (Smith & Nephew, Andover, MA) (Figure 3B). The suture limbs are then tied arthroscopically, advancing the cuff tissue along the scaffold provided by the LHB tendon (Figure 3C; see also Figure 5C, D). Using ≥2 free SutureTape sutures, the process is then repeated at more distal locations along the LHB tendon, marching the remainder of the anterior rotator cuff tissue along the LHB tendon, toward the greater tuberosity (Figure 3D; see also Figure 5E–G). This constitutes rotator cuff anterior cable reconstruction using the LHB tendon autograft, as the LHB acts as the previous bundle of cables transferring stress to the greater tuberosity (Table 1).

After RCAC reconstruction is accomplished, a standard, double-row, transosseous equivalent technique (SpeedBridge, Arthrex), with medial row knot-tying, is performed to achieve rotator cuff repair and footprint compression of the remaining tendon tissue (Figure 4). If mobility of the tissue precludes transosseous equivalent repair over the greater tuberosity, single-row repair to the medial edge of the greater tuberosity can be performed. All patients undergo a final subacromial decompression, including acromioplasty.

Postoperative restrictions and rehabilitation are similar to standard rotator cuff repair protocols. The protocol at the authors’ institution focuses on
progressive range of motion in supine position and pendulum exercises for the first 6 weeks, active assisted range of motion and gentle isometrics at 6 to 12 weeks, and gentle progressive resistive exercises after 12 weeks. The return to sport phase is usually initiated after 6 months.

Discussion

Rotator cuff tears have been shown to progress more quickly and result in significantly worse rotator cuff function when they involve the rotator cable. Anterior tears of the supraspinatus are associated with more rapid tear enlargement and more advanced fatty degeneration, even after surgical repair and higher retear rates. Therefore, development of a reliable technique to reconstruct and augment the RCAC has the potential to improve patient outcomes after rotator cuff repair surgery.

The choice of LHB tendon as an autograft source to reconstruct the RCAC is logical and adds minimal patient morbidity, given the close proximity of the LHB tendon to the rotator cuff. Furthermore, concomitant LHB pathology is quite common in the setting of rotator cuff tears, and tendon sacrifice via tenotomy or tenodesis is routinely performed. Prior clinical studies have described using the LHB tendon to augment rotator cuff repair. However, previous techniques used the LHB as an interposition graft with transection of the tendon on the humeral and glenoid side, interposing/augmenting the
rotator cuff with the transected tendon. Our proposed anterior cable reconstruction technique is distinct from these prior descriptions, as we use the LHB tendon to reconstruct and augment the anterior rotator cable, leaving the tendon in continuity on the humeral side, rather than using the tendon as a bridge to connect

**Table 1. Pearls and Pitfalls**

| Pearls                                                                 | Pitfalls                                                                 |
|----------------------------------------------------------------------|--------------------------------------------------------------------------|
| Incorporation of rotator interval tissue into the biceps tenodesis provides a sealing effect | Care must be taken during rotator cuff tendon adhesiolysis to ensure that the torn tendon can be mobilized to, at minimum, the medial aspect of the greater tuberosity footprint |
| Medial row anchors for later transosseous equivalent rotator cuff repair can be placed before anterior cable reconstruction (ACR) for better visualization of anchor position | The biceps tendon should not be tenotomized until the initial free suture has been passed through the LHB and anterior cable tissue |
| Multiple free sutures can be used during the ACR process, using the long head of the biceps (LHB) tendon as a scaffold to march the anterior supraspinatus tissue laterally |                                                                                        |
retracted rotator cuff tissue to the greater tuberosity of the humerus.

RCAC reconstruction has recently been investigated in the cadaveric setting. Park et al.\(^5\) proposed using LHB tendon to reconstruct the RCAC in massive rotator cuff tears and, through cadaveric biomechanical testing, found that such a technique normalized superior migration and subacromial contact pressure. This recent cadaveric study provides biomechanical proof that RCAC reconstruction can potentially provide a more robust repair construct and help to prevent the known complications of rotator cuff tears with anterior cable disruption. Our proposed technique is translational and applies the RCAC reconstruction hypothesis clinically. Our arthroscopic anterior rotator cable reconstruction technique is similar to that proposed by Park et al.,\(^5\) using the LHB tendon to reconstruct the disrupted RCAC. Our technique differs in that we release the LHB tendon from its proximal attachment and we perform a pants-over-vest suture fixation technique to overlap the anterior supraspinatus tissue and the LHB tendon (Figure 5). This avoids potential for development of an hourglass biceps lesion, which creates stiffness and impingement in the glenohumeral joint. It also allows for direct transmission of anterior rotator cuff forces through the reconstructed anterior cable to the greater tuberosity (Table 2).

The proposed rotator cuff anterior cable reconstruction technique provides a potential avenue to improve tissue quality of the repaired construct and enhance repair longevity (Video 1). Further investigation of this novel technique is required, but we hope that reconstruction of the RCAC in repairable large-to-massive rotator cuff tears with anterior rotator cable disruption may help alter the progressive natural history of this tear pattern and decrease chances of repair failure.

### References

1. Burkhart SS, Esch JC, Jolson RS. The rotator crescent and rotator cable: An anatomic description of the shoulder’s “suspension bridge.” *Arthroscopy* 1993;9:611-616.
2. Mesiha MM, Derwin KA, Sibole SC, Erdemir A, McCarron JA. The biomechanical relevance of anterior rotator cuff cable tears in a cadaveric shoulder model. *J Bone Joint Surg Am* 2013;95:1817-1824.
3. Namdari S, Donegan RP, Dahiya N, Galatz LM, Yamaguchi K, Keener JD. Characteristics of small to medium-sized rotator cuff tears with and without disruption of the anterior supraspinatus tendon. *J Shoulder Elbow Surg* 2014;23:20-27.
4. Petersen SA, Murphy TP. The timing of rotator cuff repair for the restoration of function. *J Shoulder Elbow Surg* 2011;20:62-68.
5. Park MC, Itami Y, Lin CC, et al. Anterior cable reconstruction using the proximal biceps tendon for large rotator cuff defects limits superior migration and subacromial contact without inhibiting range of motion: A biomechanical analysis. *Arthroscopy* 2018;34:2590-2600.
6. Cho NS, Yi JW, Rhee YG. Arthroscopic biceps augmentation for avoiding undue tension in repair of massive rotator cuff tears. *Arthroscopy* 2009;25:183-191.
7. Park SR, Sun DH, Kim J, Lee HJ, Kim JB, Kim YS. Is augmentation with the long head of the biceps tendon helpful in arthroscopic treatment of irreparable rotator cuff tears? *J Shoulder Elbow Surg* 2018;27:1969-1977.

| Table 2. Advantages and Disadvantages |                      |
|---------------------------------------|----------------------|
| **Advantages**                        | **Disadvantages**    |
| Utilization of long head of the biceps (LHB) autograft yields minimal morbidity and risk | The LHB tendon must be intact to perform this reconstruction |
| Reconstruction of the anterior cable adds biomechanical strength to the overall repair construct | This reconstruction technique cannot be performed on chronically retracted rotator cuff tears with minimal mobility |
| The LHB tendon acts as a scaffold for controlled lateral advancement of the rotator cuff tendon, reducing tension on the transosseous equivalent repair construct | |
| Standard rehabilitation rotator cuff repair protocols can be used | |

\(^{e715}\)