Chapter 12
Avoiding and Managing Complications of Arthroscopic Biceps Tenodesis

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Top 10 Pearls

- Biceps pathology is a common and potentially underestimated source of shoulder pain, even without subacromial impingement or rotator cuff pathology.
- Tenotomy may be associated with cosmetic deformity, residual cramping and weakness, thus is often reserved for older, less active patients.
- Various biceps tenodesis techniques exist and can be tailored for the specific patient and associated pathologies present at the time of surgery.
- Subpectoral biceps tenodesis is the gold-standard for biceps tenodesis and removes the possibility of residual tendon pain within the biceps groove.
- For the subpectoral technique, careful marking of the natural resting tone of the biceps prior to tenotomy will prevent restriction of the biceps or under-tensioning. This is performed by tenotomizing 99% of the biceps tendon initially within the glenohumeral joint.
- If the tendon is prematurely released, a rough approximation we have noticed is that the biceps musculotendinous junction corresponds to the inferior border of the pectoralis muscle as it crosses the humerus.
- Carefully placed 90° bent Hohmann retractors are helpful for exposure in subpectoral tenodesis, allowing for a very small incision.
- A small Spectrum (Linvatec Inc, Largo, FL) crescent suture hook helps feed the PDS shuttle retrograde through the humeral canal in subpectoral tenodesis.
- Excision of rotator interval tissue and internal rotation of the arm will help visualize the bicipital groove opening for arthroscopic glenohumeral suture anchor fixation.
- A small push-in anchor along with a suture control cannula are helpful for all intraarticular biceps arthroscopic glenohumeral suture anchor fixation.

Introduction and Background

There have been a number of changes in the management of lesions of the tendon of the long head of the biceps brachii over the past century. Various biceps tenodesis techniques were popularized as a means of managing shoulder pain historically.2,3 Neer emphasized impingement syndrome and rotator cuff disease as a major source of shoulder pain in 1972. He recommended anterior acromioplasty and warned against blind biceps tenodesis.4,5 Preservation of the biceps for shoulder function was felt to be important.6,7 Recently, there has been increased recognition of the diseased biceps as a source of continued pain.8,9 However, there is some controversy in the literature as to the importance of the long head of the biceps in shoulder function. Currently, it is felt that the long head of the biceps does have some...
**Pertinent Biceps Anatomy**

The biceps brachii muscle has a long head and a short head. The short head tendon originates from the coracoid process, while the long head originates from the glenoid or superior labrum, travels intra-articularly and exits through the bicipital groove.

The tendon of the long head of the biceps is on average 102 mm in length (range 89-146 mm) and tends to be larger in males than females. It has a large cross sectional area proximally and tapers distally. Near its glenoid-labrum origin, the tendon has a cross-sectional area of 8.4 x 3.4 mm², tapers to 5.1 x 2.7 mm² at the proximal bicipital groove and is smallest at its exit the groove distally at 4.5 x 2.1 mm². The distal groove is also the narrowest portion of the bicipital groove. The tendon may appear to be flattened in shoulders with associated rotator cuff tears. A study of 104 cadaveric shoulders also found degenerative changes occurred primarily at the distal bicipital groove and near the glenoid-labrum origin. Tenodesis of the biceps proximal to the distal bicipital groove may retain diseased biceps tendon. However, it is unclear if this is clinically important.

**Important Clinical Source of Pain**

Especially in patients with associated shoulder pathology, biceps pathology may be an underestimated source of pain. Arthroscopic evaluation identifying diseased biceps tendons underestimated the extent of extra-articular disease lying within the bicipital groove distally in 49% of cases. In other words, the biceps tendon is an important source of pain that cannot be fully evaluated with standard arthroscopic technique and may be particularly overlooked in patients with additional shoulder pathology such as rotator cuff tear and glenohumeral arthritis. Walch noted that patients with chronic rotator cuff tears often experienced relief after spontaneous ruptures of the long head of the biceps. He subsequently reported that patients with irreparable rotator cuff tears who underwent biceps tenotomy had significant clinical improvement.

**The Biceps in Shoulder Function**

The significance of the biceps in shoulder function is controversial. A number of studies report that the long head of the biceps contributes significantly to glenohumeral stability, while others report little biceps activity with isolated shoulder motion. The long head of the biceps is reported to act as a humeral head depressor or as a counterbalance to proximal migration of the humeral head with biceps short head contraction. Other investigators report that biceps contraction in the abducted, externally rotated arm helps reduce anterior displacement of the humerus. Electromyography (EMG) studies also seem to suggest an anterior stabilizing function of the biceps. Cadaveric studies have reported increased suprascapular and anteroposterior translation with proximal biceps tenotomy. Surgeons have reported little biceps activity with shoulder motion when the elbow is controlled. Most likely, the biceps has some role in shoulder stability and function; however, a retained biceps may be more important clinically as a source of pain.

**Treating the Structurally Diseased Biceps Tendons**

With structural disease of the biceps tendon, definitive surgical management of the biceps tendon with tenotomy or tenodesis may have more positive clinical benefits than any negative functional loss caused by these procedures. Any significant tearing, hypertrophy, subluxation or intrasubstance degeneration of the tendon may be considered as a possible source of pain that requires tenodesis or tenotomy. Some authors have suggested that >25% partial tearing is significant. There is some controversy regarding the incidence and treatment of primary biceps tendonitis or simple inflammation of the tendon without structural changes. We feel that tenotomy and tenodesis should be considered in cases of chronic pain and weakness.

**Biceps Tenotomy**

Biceps tenotomy has the advantages of being technically easy to perform with clinical relief of pain. Some authors have reported no difference in residual pain, cosmetic, or strength between patients with tenotomy and tenodesis. However, tenotomy may have the disadvantages of cosmetic "popeye" deformity, residual cramping pain, and loss of elbow flexion and supination. A Popeye sign was present in 70% of tenotomy patients, while residual biceps fatigue weakness was reported in 38% of patients. Mariani et al. reported a 21% loss of supination strength and an 8% loss of elbow flexion strength in patients with proximal tendon rupture of the biceps tendon. Sixty-seven percent of these patients reported subjective weakness with 30% of patients reporting unable to return to work at full capacity because of weakness. In general, because of the possible functional and cosmetic disadvantages, most surgeons prefer to reserve biceps tenotomy for older, less active patients.

Tenotomy can be easily performed with a bitting basket or an electromechanical instrument. We prefer to tenotomize the tendon at its glenoid-labral origin leaving a normal appearing superior labrum with no residual stump. A shaver can be used to remove any remnant that may become a mechanical issue. If a tenotomy is performed, it is important to confirm full release and distalization of the tendon. A hypertrophic proximal biceps tendon may have an hourglass deformity and become incarcerated at the bicipital groove, becoming a mechanical block that has been reported to prevent a return of full shoulder motion. In these cases, excision of the hypertrophic tendon and release of the proximal groove may be necessary.

**Biceps Tenodesis**

Requires surgical intervention for biceps with otherwise normal intraarticular appearance.

**Arthroscopic Soft Tissue Suture Fixation**

If an arthroscopic biceps tenodesis is desired in a lower-demand patient, suture fixation of the biceps to the adjacent soft tissues can be performed. We prefer to use the rotator interval for fixation while other surgeons utilize the adjacent rotator cuff. This technique is relatively simple and quick and can be performed with an intact rotator cuff. The downside of this technique is the initial fixation of tenon to soft tissue and not to bone. However, some authors have reported only a 3% clinical failure of fixation and resultant biceps deformity with similar techniques.

After a full diagnostic arthroscopy of the shoulder, the biceps is pulled into the joint with a grasper and pierced in its midsubstance with a percutaneous spinal needle, and preserved normal cosmesis. There are a number of techniques in performing biceps tenodesis. It may be arthroscopically performed in the glenohumeral joint or within the subacromial space. These techniques can be performed with soft tissue suture fixation, suture anchor fixation, or with interference screws.
needle placed through the rotator interval (Fig. 12.1). A monofilament no. 1 suture is fed through the spinal needle and brought out the anterior midglenoid (AMG) cannula (Fig. 12.2). This suture is then used to pass a strong Mehalk Hitch around and through the biceps in the following fashion: through the anterior cannula a high-strength braided No. 2 suture is looped around the biceps and both ends are brought back out the cannula. We prefer to create a rosette of suture in the grasper such that it is easy to “dump” several inches of suture around the biceps at once (Fig. 12.3). If the suture “dump” is performed inferior to the biceps tendon, the grasper retrieves a suture end superior to the biceps, creating a loop (Fig. 12.4). Both braided suture ends are then tied to the monofilament suture end outside the anterior cannula. The percutaneous end of the monofilament suture is then used to shuttle the braided sutures through the biceps submusculature, then out the shoulder through the rotator interval. The Mehalk Hitch thus passes around and through the biceps, giving excellent hold (Fig. 12.5). To create a bridge of rotator interval tissue between braided sutures, one braided limb can then be brought out the anterior cannula and shuttled back through a different place in the rotator interval (~1 cm away) using another pass of the monofilament suture through a percutaneously placed spinal needle.

The tendon may then be released with an electro-surgical instrument or biting basket 5 mm proximal to the hitch. The remaining proximal biceps tendon may then be incised near the glenoid-labral origin with a biting basket or electrocautery device and then subsequently removed. The natural resting tension of the biceps is retained if the biceps and rotator interval are penetrated at their natural meeting point near the proximal bicipital groove. To stabilize the construct, the two ends of the braided suture are then identified in the subacromial space and tied together over the rotator interval soft tissue bridge.

**Arthroscopic Suture Anchor Fixation**

Suture anchor fixation of the biceps tendon may provide more secure fixation, tendon to bone healing, and can be easily performed with a rotator cuff repair in the subacromial space. We often perform this fixation technique when a rotator cuff tear is present and in the higher demand patient. It can also be performed in the glenohumeral joint when a rotator cuff tear is not present. We prefer the intra-articular glenohumeral technique in younger more active patients with an intact rotator cuff who may require stronger fixation than soft tissue suture fixation may provide.

**Subacromial Arthroscopic Suture Anchor Fixation**

A shaver is used to expose the rotator cuff footprint and prepare the proximal bicipital groove for tenodesis. We will usually use one suture from a multiple loaded suture anchor for additional biceps fixation and a second suture for rotator cuff fixation. Spectrum suture hooks (Linvatec Inc, Largo, FL) are typically used for tendon or rotator cuff purchase. Because of the biceps, there are a few important technical points. First, the anterior anchor may be more anterior than usual to accommodate for the biceps tendonosis portion of the case. This may require the anchor to be placed through the anterior cannula. Second, full visualization of the anterior shoulder should require the arm to be placed in more abduction and external rotation than the traditional bursal position. Third, performing the biceps tenodesis before the rotator cuff repair will allow better visualization of the biceps and bicipital groove.

If a separate anchor is used for biceps tenodesis, we prefer to use a push-in, smaller, double-loaded suture anchor such as a Mitek G4 anchor (Depuy Mitek, Raynham, MA) placed in the bicipital groove. This smaller anchor will prevent any hardware interference with the rotator cuff anchors. The Mehalk Hitch is not tied over a suture bridge but retrieved into the subacromial space through the cuff tear. Viewing from the lateral portal in the bursal position, the proximal bone of the bicipital groove is prepared with a shaver. A spinal needle is used to localize skin entry for the push-in anchor and the proper location of tenodesis near the bicipital groove opening. A small skin incision is made. A mini-Revo (Linvatec Inc, Largo, FL) punch is used to create a tract through the soft tissue and confirm proper access and location of the tenodesis anchor. A pinching grasper retrieves one limb of the Mehalk Hitch, which is passed through the Mitek G4 anchor eyelet (Depuy Mitek, Raynham, MA) outside the shoulder. These push-in anchors are typically double-loaded to approximate the corners from the anchor or it can be fixed with a rotator cuff repair anchor. If the tendon will be incorporated into the rotator cuff repair, the above soft tissue fixation technique is employed with a spinal needle creating a Mehalk Hitch over a soft tissue rotator cuff rotator interval bridge.
together, stabilizing the biceps to the anchor site. Backup fixation can be achieved with the second suture from the anchor. Using a suture hook and standard shuttling technique, the second suture can be passed through and then tied to the biceps.

**SCOI Arthroscopic Glenohumeral Suture Anchor Fixation**

For younger or more active patients and an intact rotator cuff, we have been performing an arthroscopic biceps tenodesis in the glenohumeral joint. It requires an AMG working portal, a posterior viewing portal, and a separate stab incision to pass the sutures.

**Rotator Interval and Bone Preparation**

After the biceps has been evaluated (Fig. 12.6), the rotator interval tissue is removed with a shaver to allow access to the proximal aspect of the bicipital groove (Fig. 12.7). The shaver or ball burr can then be used to abrade the bone in the proximal bicipital groove. Visualization of this fairly anterior area can be facilitated by internally rotating the arm or using a 70° scope (Fig. 12.8).

**Biceps Tendon Hitch**

A grasper or pinching instrument can then pull the biceps into the glenohumeral joint, exposing the tendon for a 17-gauge 6-in. epidural needle to puncture the biceps tendon. The needle is percutaneously placed off the anterolateral acromion, and the entry of the epidural needle roughly corresponds to the natural resting position of the intact biceps tendon (Fig. 12.9). Once the correct needle position has been identified, a small stab incision is made and a "suture control cannula" or SCC is passed into the glenohumeral joint (Fig. 12.10). This SCC cannula is a 5-in. thin metal cannulated tube that has a smooth beveled tip. The epidural needle passes freely within the suture control cannula, which protects and manages the sutures. A no. 1 PDS suture is passed through the biceps tendon and retrieved out the AMG portal. A Mehalik hitch is subsequently performed as described previously. A rosette of a no. 2 polyethylene braided suture is placed inferior to the tendon and retrieved superiorly placing a loop around the tendon (Fig. 12.11). The two free ends of the polyethylene braided suture are then tied with the PDS shuttle. The needle is removed, and the sutures are carried through the suture control cannula externally. A clamp is used to keep tension on the sutures on the end of the suture control cannula.

**Anchor Placement**

A small double loaded push-in anchor like the Mitek G4 (Deputy Mitek, Raynam, MA) will be used for suture anchor fixation. One suture from the anchor is removed to accept one suture from the previously prepared Mehalik hitch. The anterior glenoid cannula is directed toward or placed against the humeral bone near the bicipital groove. A pilot hole is drilled in the bone through the anterior cannula near the medial edge of the biceps groove (Figs. 12.12 and 12.13). A mini-Revo (Linvatec Inc, Largo, FL) punch painted with purple dye is then used to mark the hole to facilitate later identification. One end of the Mehalik hitch is carried out the AMG portal. The suture control cannula can help deliver the sutures into the joint for easier
Fig. 12.12 A drill is placed on the humerus at the bicipital groove opening for anchor preparation.

Fig. 12.13 The drilling is performed through the anterior cannula.

Fig. 12.14 The suture control cannula helps deliver the Mehalik hitch into the glenohumeral joint.

Fig. 12.15 The retrieved end is loaded into the anchor eyelet, and there are no twists. A nonsliding knot such as modified Revo knot is then tied, securing the biceps to the anchor (Fig. 12.16).

Second Biceps Tendon Hitch

Fig. 12.16 The anchor is placed over the predrilled humeral hole.

Fig. 12.17 The double loaded anchor is tapped into the humerus and tested.

Fig. 12.19 A nonsliding knot is tied securing the tendon to the humerus.

Fig. 12.18 The other end of the Mehalik hitch is retrieved with the aid of the suture control cannula.

Biceps Release and Labrum Final Preparation
Subpectoral Biceps Tenodesis

The subpectoral biceps techniques provide immediate secure fixation, tendon to bone apposition, excises all pathologic biceps tissue and avoids the possibility of any residual pain with bicipital groove involvement. It is also avoids the need for any additional hardware. We feel it is the gold standard for biceps tenodesis. However, it requires the conversion from an arthroscopic procedure to a small open procedure. The incision used is small, lies within Langer’s lines near the axilla and is nearly unnoticeable. In addition, it is the salvage procedure for any previous biceps surgery that needs to be revised. For a previously performed biceps tenodesis that continues to be painful, this technique can be easily performed to resolve the pain. For a tenodesis that failed to hold fixation or for a failed tenotomy, this technique can be performed for a salvage procedure. The retracted tendon can be often identified with this incision.

SCOI Subpectoral Biceps Tenodesis Technique

Arthroscopic Identification and Release

The patient is placed in the usual lateral decubitus position and a systematic glenohumeral arthroscopic examination is performed with the standard posterior and AMG portals. The biceps tendon is examined with a grasping tool and pulled into the glenohumeral joint to maximize visualization of the tendon. If significant pathology is present and the decision to perform a tenodesis is made, the biceps tendon is then partially released. Ninety-nine percent of the fibers are taken down with electrocautery or with a biting basket near the tendon labral origin (Fig. 12.23). A few fibers are left remaining to maintain normal biceps length-tension relationship, prevent distal retraction, and facilitate open identification. During the open part of the procedure, by pulling the tendon into the wound, the tenotomy will then be easily completed.

Repositioning

After the arthroscopic portion has been performed, the arm is taken out of the Shoulder Traction and Rotation (STAR) Sleeve (Arthrex, Inc, Naples, FL) and a sterile stockinette is placed over the arm. The beanbag is then deflated and the patient is tilted further posteriorly 30° to gain access to the arm and axilla. When adequate access has been determined with the surgeon standing between the abducted arm and the patient’s body, the beanbag is reinflated holding the position. We typically reposition the arm with betadine for the open portion of the procedure.

Incision and Tendon Preparation

With the arm abducted, the inferior border of the pectoralis major muscle can be palpated and outlined with a marking pen. Next the anterior axillary crease is marked out in Langer’s lines perpendicular to the inferior margin of the pectoralis major muscle (Fig. 12.24). The incision is approximately 3-4 cm in length. The skin is incised 1 cm above the inferior pectoralis major border and extended for 2-3 cm below the inferior border into the axilla. Small skin flaps are raised and the
overlying fascia of the pectoralis muscle is identified (Fig. 12.25). Blunt finger dissection deep to the pectoralis muscle will identify the humerus and the rolling edge of the biceps tendon. Right-angle Hohmann retractors are then placed medially and laterally on the humerus to expose the distal bicipital groove and biceps tendon (Fig. 12.26). An Army-Navy retractor can be used to provide additional retraction and exposure distally or proximally as necessary.

At this point with the elbow extended, the natural resting position of the biceps tendon within the groove can be noted. The tendon has not been fully tenotomized yet. Electrocautery is used to mark the bone at the distal bicipital groove, and a stitch of high-strength no. 2 or no. 5 suture is placed through the tendon at the same level (Fig. 12.27). The tendon is then pulled easily out of the wound completing the tenotomy (Fig. 12.28). The tendon is then sutured proximally for 1.5 cm with a locking stitch, and the excess proximal tendon is excised (Fig. 12.29). The tendon can then be sized and is typically 5 mm in diameter at this point. It is interesting to note that there is often significant pathological tendinopathy throughout the proximal tendon, particularly in the distal groove and near the origin.

If the natural resting position of the tendon cannot be identified, it can be approximated by noting that the biceps musculotendinous junction tends to correspond with the level of the inferior border of the pectoralis.
Fig. 12.32 The monofilament shuttle is retrieved with a grasper.

Fig. 12.33 The tendon suture is tied and shuttled with the monofilament

Fig. 12.34 The tendon has been fully delivered into the proximal drill hole and down the humeral canal.

Fig. 12.35 The sutures are tied around the biceps securing the tenodesis

Fig. 12.36 The tendon is now within the humerus, lying in the 1.5 cm between drill holes (Fig. 12.35). This measuring technique ensures restoration of the natural tendon length and tension. The sutures are then placed around or through the tendon and tied securely at the distal humeral drill hole (Fig. 12.36). The wound is irrigated and closed leaving a small incision that heals well within Langer’s lines and is typically out of sight (Fig. 12.37).

Conclusion

Important and common source of shoulder pain. Surgical treatment of the tendon usually includes either tenotomy or tenodesis. Good to excellent function can be maintained with either procedure, as has been shown in the literature. Various arthroscopic tenodesis techniques exist and can be technically more challenging. For experienced surgeons, however, the arthroscopic technique can be a relatively easy, cosmetic, and safe way of providing excellent fixation by detensioning and decreasing painful motion and friction of the biceps within the bicipital groove. A minimally invasive procedure can provide a stronger construct, increased bone-to-bone healing potential, and excision of all pathologic tissue within the bicipital groove. It does require a small incision located near the axilla, which may be at increased risk for infection or iatrogenic soft tissue injury. Tenotomy is certainly the easiest procedure to do, but does affect strength and cosmesis. Although the indications for one procedure vs. the other are still a subject of debate, the choice for either treatment should be tailored to each patient and especially to each surgeon’s comfort level.

References


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If one does not have the Arthrex Bionalization system set available, but wishes to utilize an interference screw tenodesis technique, it can easily be performed through an an infiltrated pin passed through the humerus out posteriorly, taking care to avoid the area of the axillary nerve. The sutures are passed through the eyelet of the Beath pin, and fixation is performed with a standard bioabsorbable interference screw.

Another easy technique for biceps tenodesis from a glenohumeral approach is to pass a screw into an anchor from an anterior cannula, directly through the tendon. This saves a step, since all sutures are thus already through the tendon with at least once pass, and additional passes can be made as desired. We have also found it useful when performing a
glenohumeral biceps tenodesis approach to reposition the arm in more forward flexion, and to occasionally utilize a medially placed portal posterior to allow improved visualization directly down the biceps groove.

When performing a tenodesis with the patient in the lateral decubitus position, we have found it easier to walk around the head of the patient standing anteriorly rather than repositioning the patient and standing in the axilla. This in effect puts the surgeon somewhat upside down, but in effect makes the approach quite simple without any need to adjust the bean bag or the arm traction.

Finally, we have had recent success using a knotless locking anchor for our tenodesis, which saves time and ensures proper suture tension.