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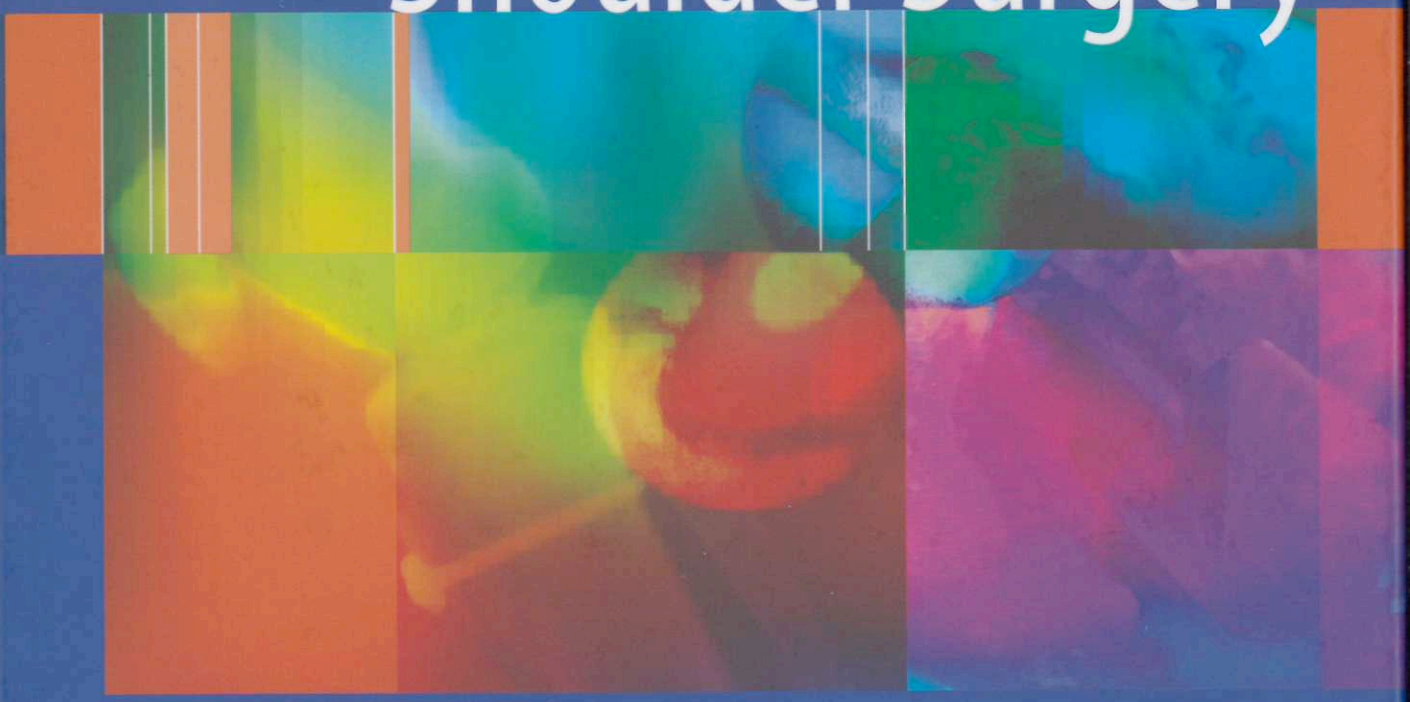
Complications in Knee and Shoulder Surgery



Management and Treatment Options for the Sports Medicine Orthopedist

Springer

Chapter 12
Avoiding and Managing Complications of Arthroscopic Biceps Tenodesis

Michael S. Bahk, Joseph P. Burns, and Stephen J. Snyder

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 undertensioning. 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.

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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.[1,2] Various biceps tenodesis techniques were popularized as a means of managing shoulder pain historically.[2–9] 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.[1,10] Preservation of the biceps for shoulder function was felt to be important.[3,10–12] Recently, there has been increased recognition of the diseased biceps as a source of continued pain.[13–15] 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,[16] 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.[17] It has a larger cross sectional area proximally and tapers distally. Near its glenoid-labrum origin, the tendon has a cross-sectional area of 8.4 × 3.4 mm^2, tapers to 5.1 × 2.7 mm^2 at the proximal bicipital groove and is smallest after it exits the groove distally at 4.5 × 2.1 mm^2.[17] The distal groove is also the narrowest portion of the bicipital groove.[17] The tendon may appear to be flattened in shoulders with associated rotator cuff tears.[17,18] A study of 104 cadaveric shoulders also found degenerative changes occurred primarily at the distal bicipital groove and near the glenoid-labrum origin.[17] Tenodesis of the biceps proximal to the distal bicipital groove may retain diseased biceps tendon. However, it is unclear if this is clinically important.

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,[19–25] while others report little biceps activity with isolated shoulder motion.[26,27] 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.[19] Other investigators report that biceps contraction in the abducted, externally rotated arm helps reduce anterior displacement of the humerus.[20] Electromyography (EMG) studies also seem to suggest an anterior stabilizing function of the biceps.[24,25] Cadaveric studies have reported increased superoinferior and anteroposterior translation with proximal

investigators have reported little biceps activity with shoulder motion when the elbow is controlled.[26,27] 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.

Important Clinical Source of Pain

Especially in patients with associated shoulder pathology, biceps pathology may be an underestimated source of pain.[28,29] Arthroscopic evaluation identifying diseased biceps tendons underestimated the extent of extra-articular disease lying within the bicipital groove distally in 49% of cases.[28] 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.[30] 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.[30]

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.[1,13,30–33] 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.[1,3,27] 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 tenodesis and tenotomy should be

requires surgical intervention for biceps with otherwise normal intraarticular appearance.

Biceps Tenotomy

Biceps tenotomy has the advantages of being technically easy to perform with clinical relief of pain.[32,34] Some authors have reported no difference in residual pain,[32] cosmesis,[35] or strength[36] between patients with tenodesis and tenotomy. However, tenotomy may have the disadvantages of cosmetic "popeye" deformity,[32,33,37,38] residual cramping pain,[33,38,39] and loss of elbow flexion and supination strength.[37] A Popeye sign was present in 70% of tenotomy patients, while residual biceps fatigue soreness was reported in 38% of patients.[38] 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.[37] Sixty-seven percent of these patients reported subjective weakness with 30% of patients reported being unable to return to work at full capacity because of weakness.[37] 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 biting basket or an electrosurgical 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.[40] In these cases, excision of the hypertrophic tendon and release of the proximal groove may be necessary.

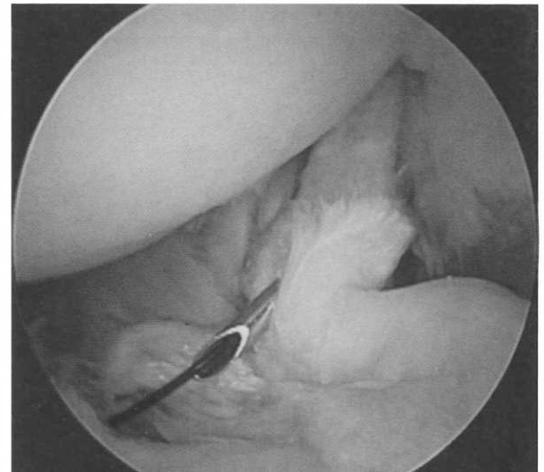
Biceps Tenodesis

strength, and preserve 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,[41,42] suture anchor fixation, or with interference screws.[43–47] Biceps tenodesis may also be performed in a mini-open fashion with a small subpectoral incision.[48–51]

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.[42,50,52] 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 tendon 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.[42,52]

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



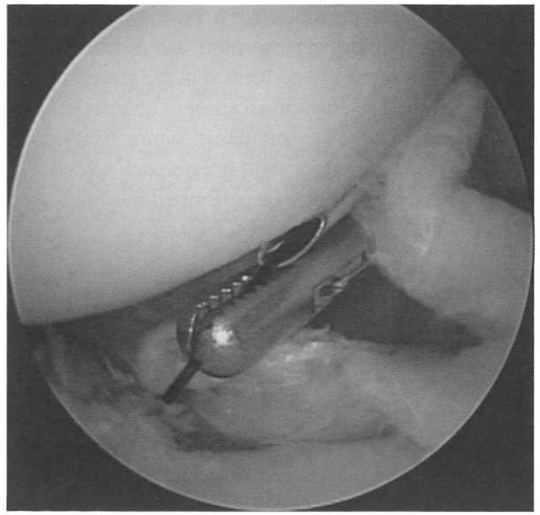
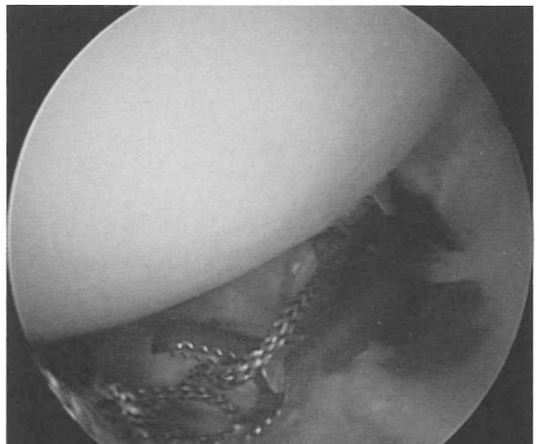


Fig. 12.2 A grasper retrieves the monofilament suture shuttle from the anterior cannula

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 Mehalik 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 midsubstance, then out the shoulder through the rotator interval. The Mehalik 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 electrosurgical 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



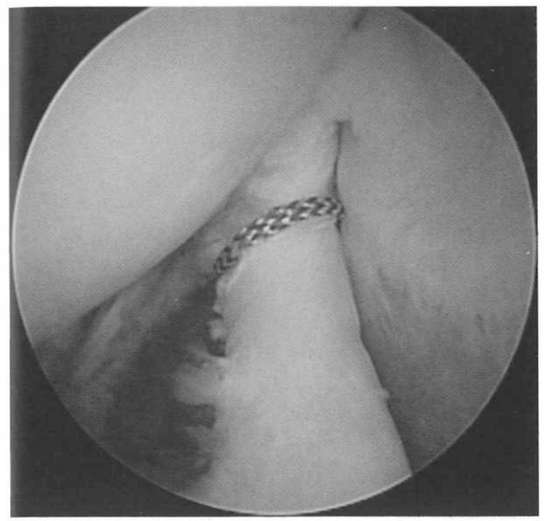


Fig. 12.5 The monofilament is tied around both ends of the high-strength braided suture which is then shuttled through the biceps tendon completing the Mehalik hitch

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 more 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

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 Mehalik hitch over a soft tissue rotator cuff/rotator interval bridge.

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 tendodesis portion of the case. This may require the anchor to be placed through the anterior cannula. Second, full visualization of the anterior shoulder may 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 Mehalik 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 Mehalik hitch, which is passed though the Mitek G4 anchor eyelet (Depuy Mitek, Raynham, MA) outside the shoulder. These push-in anchors are typically double-

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).

Fig. 12.6 Glenohumeral arthroscopy reveals a pathological biceps tendon

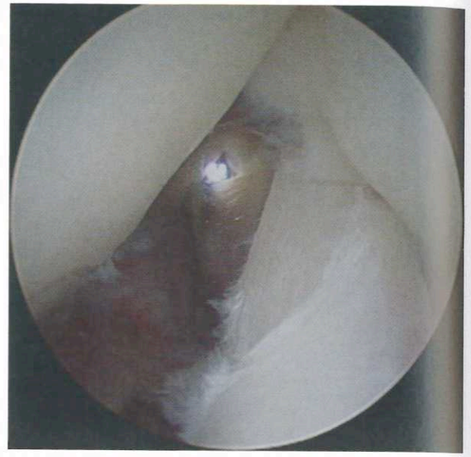


Fig. 12.7 A shaver through the anterior cannula removes rotator interval tissue allowing access to the bicipital groove opening

Fig. 12.8 Internal rotation of the arm aids in access to the anterior part of the humerus

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

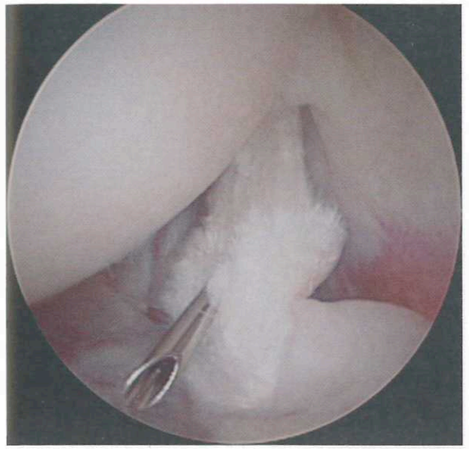


Fig. 12.9 An epidural needle percutaneously punctures the biceps tendon

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 shuttle suture is passed through the biceps tendon and retrieved

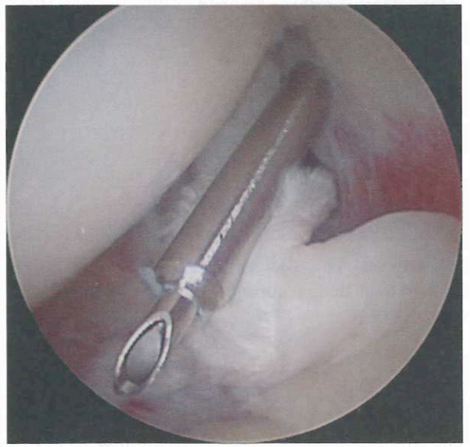


Fig. 12.10 A suture control cannula is percutaneously placed over the epidural needle and will aid in suture management and delivery

Fig. 12.11 A Mehalik hitch or a loop of suture is placed around and through the tendon

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 (Depuy Mitek, Raynham, 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 midglenoid 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

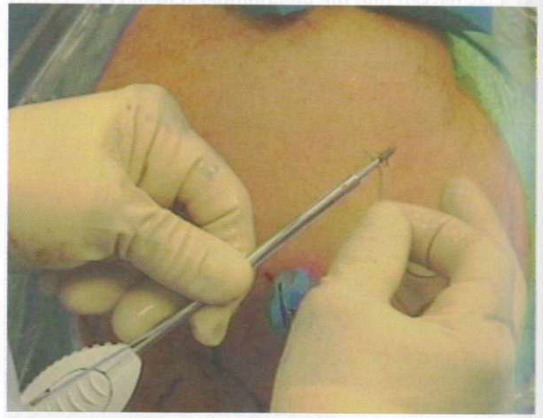


Fig. 12.15 The retrieved end is loaded into the anchor eyelet

retrieval (Fig. 12.14). The retrieved end of the Mehalik hitch is then placed through the eyelet of the anchor (Fig. 12.15). The anchor is then passed though the AMG cannula and subsequently tapped into the bone (Fig. 12.16). The anchor is tested for adequate fixation (Fig. 12.17). The second loaded suture is then retrieved with a crochet hook and placed outside the AMG can-

are no twists. A nonsliding knot such as modified Revo knot is then tied, securing the biceps to the anchor (Fig. 12.19).

Second Biceps Tendon Hitch

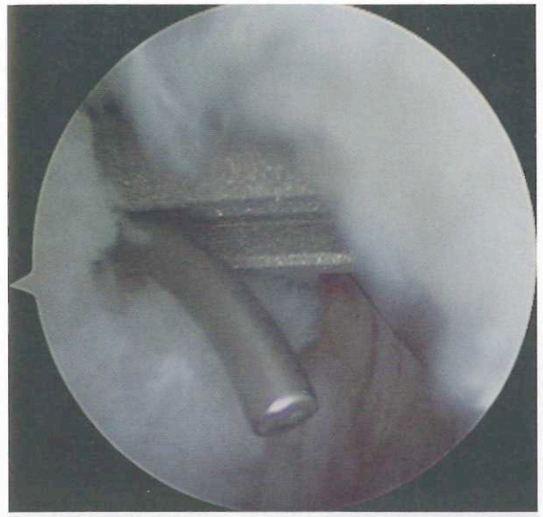


Fig. 12.16 The anchor is placed over the predrilled humeral hole

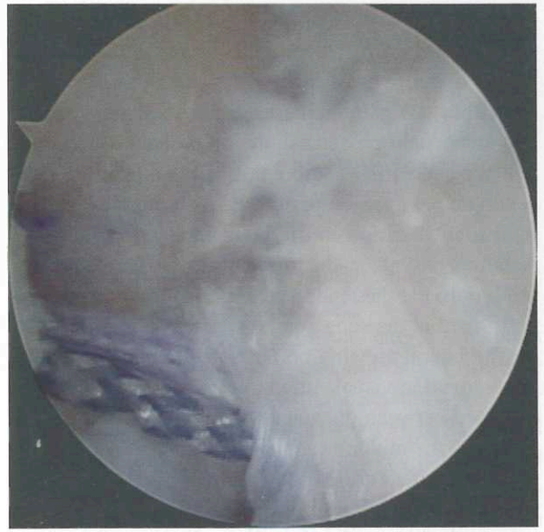


Fig. 12.17 The double loaded anchor is tapped into the humerus and tested

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

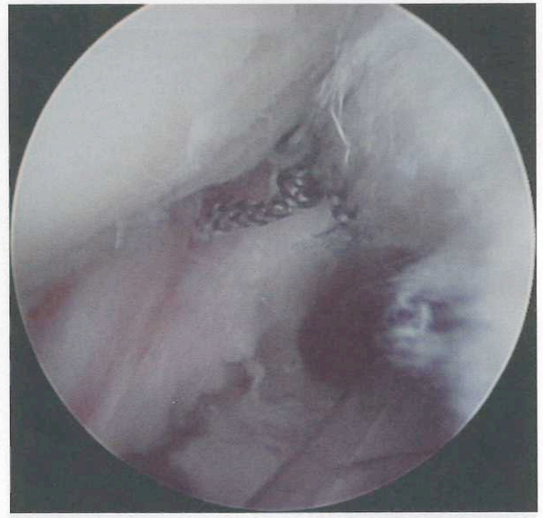


Fig. 12.19 A nonsliding knot is tied securing the tendon to the humerus

proximal to the first knot. A no. 1 PDS shuttle is passed and retrieved out the AMG as before fol-

Biceps Release and Labrum Final Preparation

Fig. 12.20 The Mehalik hitch is repeated and a second nonsliding knot is tied providing additional tenodesis security

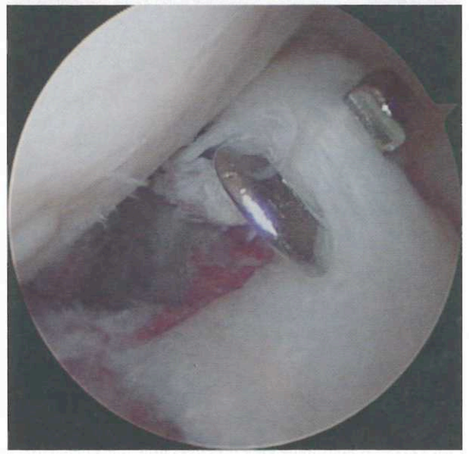


Fig. 12.21 The biceps is tenotomized with a biting basket

Arthroscopic Interference Screw Fixation

Another technique for biceps tendon is arthroscopic interference screw fixation. This has the advantage of more tendon to bone apposition with typically greater pull-out strength.[53] However, some authors have discontinued using this technique because of residual pain[51] either from the retained biceps in the bicipital groove or due to breakdown of the bioabsorbable screw.

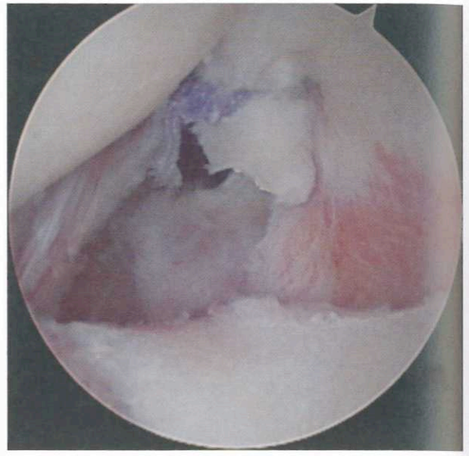


Fig. 12.22 An arthroscopic biceps tenodesis is performed within the glenohumeral joint with a push-in suture anchor and two suture hitches

Within the glenohumeral joint, a spinal needle is percutaneously passed off the anterolateral acromion to place a no. 1 PDS suture through the biceps tendon. A simple pass can be performed as it aids in subacromial identification in the later parts of the surgery. A biting basket or electrosurgical instrument can be used to divide the tendon. The rest of the procedure is performed in the subacromial space.

The lateral viewing portal is positioned more anteriorly to aid in visualization of the anterior shoulder. It is placed between the anterolateral corner of the acromion and the midpoint of the acromion.[54] The subacromial bursa is debrided with a shaver and the PDS is identified. An electrosurgical device can then be used to open the biceps sheath and expose the tendon. Once the tendon has been sufficiently released, an anterolateral incision can be made to externalize the tendon with a clamp. Twenty millimeter of tendon is excised and a running locking stitch is placed in 15 mm of tendon. These measurements will allow for proper tension restoration.[54] An anterolateral cannula can be placed in this incision and drilling can be performed through the cannula. Subsequently, a 7-8 mm bioabsorbable interference screw can be placed through the anterolateral skin incision to secure the tendon to bone.[47,54]

Subpectoral Biceps Tenodesis

The subpectoral biceps techniques provide immediate secure fixation, tendon to bone apposition, excises all pathological 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.

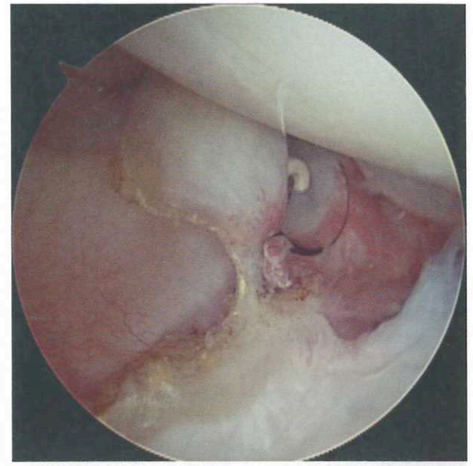


Fig. 12.23 The biceps tenotomy is nearly completed. A few fibers are left in place to hold biceps tension for the mini-open procedure

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 reprepare 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

Fig. 12.24 The inferior border of the pectoralis major muscle and the anterior axillary crease are marked out

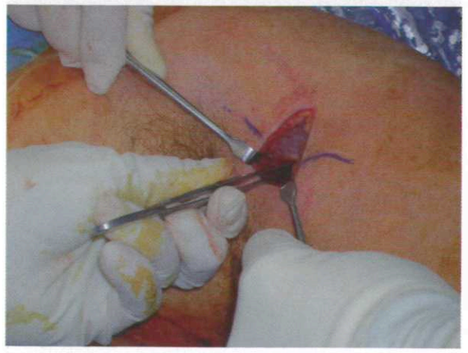


Fig. 12.25 The inferior border of the pectoralis major muscle is identified

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

Fig. 12.26 The biceps tendon is well visualized with the aid of bent human retractors

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.

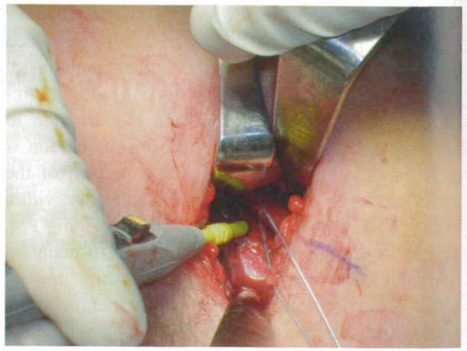


Fig. 12.27 An electrocautery mark on the humerus with a corresponding suture in the tendon helps to denote the natural position of the biceps

Fig. 12.28 The whole biceps is easily pulled into the wound completing the tenotomy

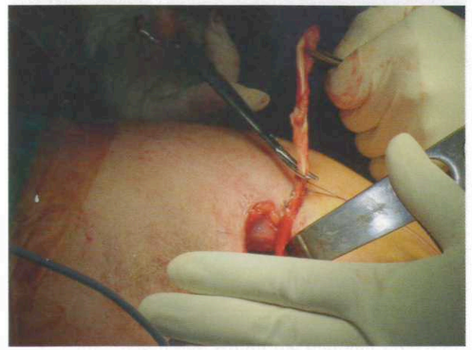


Fig. 12.29 After a running locking stitch is performed, the promixal diseased tendon is excised

Fig. 12.30 The proximal hole is drilled at the original electrocautery mark at the distal bicipital groove

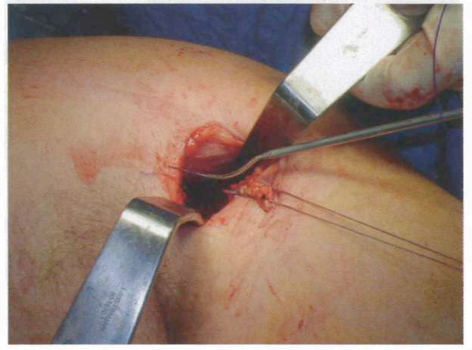


Fig. 12.31 A crescentic suture hook helps feed a monofilament shuttle retrograde through the humeral canal

Humeral Drilling and Tendon Passing

A guide pin is then placed at the electrocautery mark centered on the humerus. This marks the level of tendon fixation. The proximal drill site should be at the inferior edge of the biceps groove and not in the cortical bone. The pin is then overdrilled unicortically between 5 and 7 mm, depending on the size of the tendon (Fig. 12.30). Cannulated "acorn" type reamers are preferable. A second small unicortical hole approximately 2-3 mm in diameter is then placed 1.5 cm distally. The distance between drill holes should be equal to the length the tendon has been sutured proximally (1.5 cm). A small Spectrum (Linvatec Inc, Largo, FL) crescent suture passer is placed into the distal drill hole and a PDS suture acting as a shuttle is fed proximally up the canal of the humerus (Fig. 12.31). The shuttle is retrieved from the larger proximal hole with a clamp (Fig. 12.32). The PDS stitch is then tied around the composite suture, which is then shuttled out the distal humeral hole (Fig. 12.33).

Final Fixation and Closure

With the arm fully extended and the forearm supinated, the sutures are pulled, reducing the tendon into the humeral drill hole (Fig. 12.34), and stopping at the natural resting point: the 1.5 cm of proximal sutured

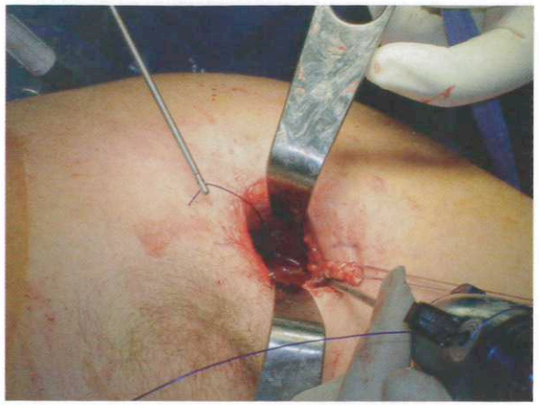


Fig. 12.32 The monofilament shuttle is retrieved with a grasper

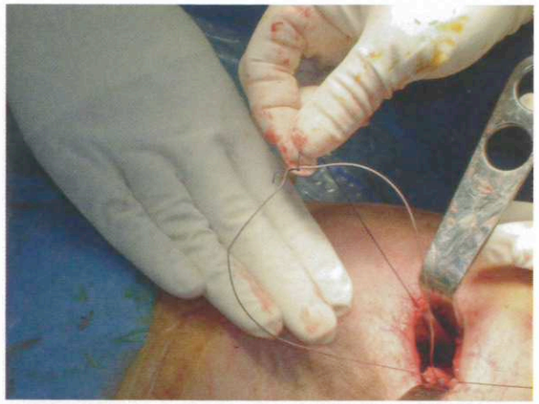


Fig. 12.33 The tendon suture is tied and shuttled with the monofilament

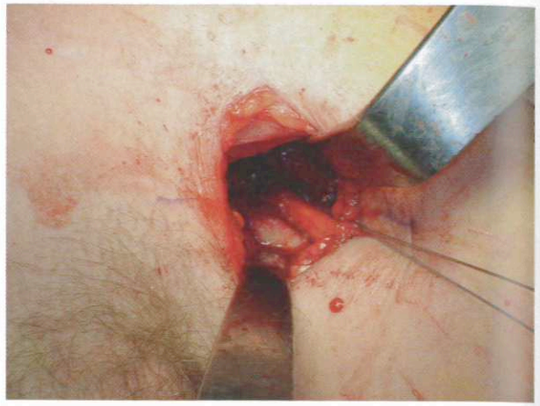


Fig. 12.35 The tendon has been fully delivered into the proximal drill hole and down the humeral canal

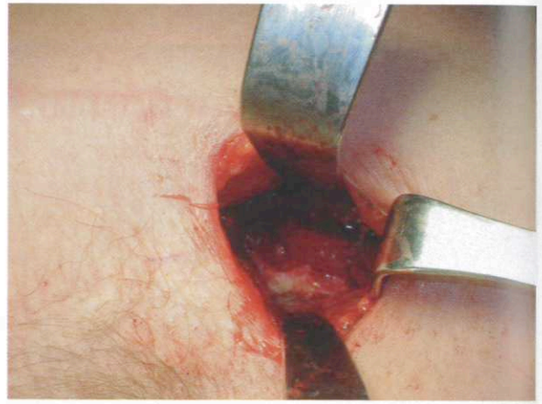


Fig. 12.36 The sutures are tied around the biceps securing the tenodesis

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

Fig. 12.37 The final wound is small, lies within Langer's lines and heals well

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 mini-open procedure may 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.

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Editors' Comments (Biceps Tenodesis)

Interference Screw Technique

There are many potential pitfalls to this technique. Patients who are obese, very muscular, or if there has been fluid extravasation present a challenge to the surgeon as there may be very little working tendon length once the tendon is retrieved through the working anterolateral portal. If this occurs, one can consider either an arthroscopic suture anchor technique or an open approach. Another alternative is to

If one does not have the Arthrex Biotenodesis set available, but wishes to utilize an interference screw tenodesis technique, it can easily be performed with a Beath 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-in 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 occassionally utilize a medially placed posterior portal 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 easy 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.