Technical Note

Arthroscopic Biceps Tenodesis

Anthony A. Romeo, M.D., Augustus D. Mazzocca, M.D., and Joseph C. Tauro, M.D.

Abstract: Arthroscopic biceps tenodesis is indicated for the treatment of severe biceps tendonopathy, partial- or full-thickness tendon tears, or biceps instability typically associated with rotator cuff tear, although there has been considerable debate on tenotomy versus tenodesis. We advocate tenodesis, for the following reasons: to re-establish the resting muscle length so as to avoid scaring and spasm, to allow biceps use for complex elbow motion, and to avoid cosmetic defects in cases in which deformity can sometimes equal disability. This technical note provides illustrations and detailed descriptions of our arthroscopic tenodesis technique using an Arthrex (Naples, FL) biotenodesis system. Key Words: Shoulder—Upper extremity—Proximal biceps tendon—Tenodesis technique—Anterior shoulder disorder—Tendinosis.

Arthroscopic biceps tenodesis is indicated for the treatment of severe biceps tendonopathy, partial- or full-thickness biceps tendon tears, or biceps instability typically in association with a rotator cuff tear. Numerous methods for tenodesis of the long tendon of the biceps have been published.1-7 Most recently, the technique we use has been an open subpectoral biceps tenodesis. This approach avoids any injury to the deltoid musculature and provides a cosmetic incision at the anterior medial aspect of the arm below the level of the pectoralis major tendon. The integrity of this repair has been excellent based on clinical examination.

Arthroscopic techniques for biceps tenodesis have been developed to reduce soft tissue trauma. Initially, surgeons used single or multiple bone anchors with suture to secure the biceps tendon. This technique requires arthroscopic knot tying skills. Based on an experience with open bicep tenodesis using interference fit screw fixation, an arthroscopic technique has been developed using interference fit screw fixation.8 This technique uses a guide pin with an eyelet that passes through the bicipital groove anteriorly and then out the posterior aspect of the humerus. The angle of the guide pin is placed 1 cm below the rotator cuff insertion in the bicipital groove perpendicular to the axis of the humerus to the axillary nerve. Therefore, it avoids potential neurologic injury. However, passage of a guide pin through the posterior aspect of the humerus is a challenging technique and may be responsible for more complications in less experienced hands.

Recently, a new instrument, a biotenodesis driver, has been designed to allow a surgeon to place the tendon within a bone tunnel and then hold that tendon in place at the base of the bone tunnel while placing an interference fit screw over the top of the tendon (Fig 1). The key feature is a reverse screw mechanism on the distal segment that allows insertion of the interference screw while holding the tendon in the base of the bone socket to prevent the tendon from displacing from the socket. The expansion of this instrument to
allow for large tendon fixation has led to the development of an arthroscopic technique for biceps tenodesis using interference fixed screw fixation. In our opinion, this technique can be easily learned and allows for secure fixation of the tendon using an entirely arthroscopic approach.

**SURGICAL TECHNIQUE**

**Beach-Chair Position**

Patient position depends on the technique most familiar to the surgeon for subacromial surgery. The beach-chair position can be used for all aspects of subacromial surgery, including acromioplasty, rotator cuff repair, and distal clavicle resection. The patient is positioned in the beach-chair position with the arm in 30° to 60° of forward flexion, 30° of abduction, and 20° of internal rotation resting on a padded Mayo stand (Fig 2).

A standard 30° arthroscope is used for arthroscopic surgery of the shoulder. A pressure-sensing fluid pump is routinely used with a medium level of fluid flow and the pressure setting at 35 to 40 mm Hg. Standard arthroscopic portals are established for glenohumeral joint arthroscopy. Indications for biceps tenodesis include severe bicipital tendonitis or biceps tendon tear, as shown by clinical examination preoperatively or with intraoperative findings consistent with tendonitis or tear, and biceps instability, as shown during the arthroscopic examination of the glenohumeral joint. In particular, an injury to the subscapularis tendon requires a thorough evaluation of the biceps stability.

Commonly, the disruption of the superior lateral edge of the subscapularis from its insertion point on the lesser tuberosity will result in the loss of the normal restraint of the biceps tendon to medial translation (Fig 3). This restraint, which is primarily provided by the coracohumeral ligament and secondarily supported by the superior glenohumeral ligament and subscapularis origin, cannot be effectively reconstructed. In fact, should the surgeon choose to try this reconstruction, the typical consequence is postoperative shoulder stiffness with a loss of external rotation. This occurs because of a tightening of the capsular structures, including the coracohumeral ligament and superior glenohumeral ligament in this region, as well as a tethering of the biceps tendon that normally has some excursion through the bicipital groove. With the loss of the medial or lateral restraint to the biceps tendon stability, a biceps tenodesis effectively re-
solves symptoms related to the biceps. This will allow early range of motion and will not result in any consequences to shoulder function.

After the decision is made to perform a biceps tenodomy, an 18-gauge needle is passed from the anterior lateral corner of the acromion through the rotator cuff and into the biceps tendon itself. A No. 1 monofilament suture is then passed through the 18-gauge needle, captured with a grabber from the anterior portal and then extracted (Fig 4). After the tendon is marked with a suture, an arthroscopic basket is then used to release the tendon from its origin just lateral to the superior labrum (Fig 5). This completes the preparation for the biceps tenodesis during the glenohumeral joint arthroscopy.

The arthroscopic equipment is transferred to the subacromial space. The lateral portal is commonly placed at the mediolateral section of the acromion, which positions the cannula at the posterior aspect of the subacromial bursa. This allows an excellent view of the rotator cuff tendon as well as the subacromial space. It also prevents abutment of the instrumentation while an acromioplasty is being performed. However, visualization during the arthroscopic biceps tenodesis can sometimes be compromised so that a modification in the position of the lateral portal is present. The modified position of the lateral portal is a third posterior to the anterolateral edge of the acromion. A line can be drawn from the notch created by the posterior aspect of the clavicle and the anterior aspect of the scapular spine. This line goes directly lateral over the top of the humerus and marks the posterior aspect of the subacromial bursa. Another line can be drawn along the plane of the anterior aspect of the acromion.

By splitting the difference between the 2 lines, the surgeon has achieved a portal placement one third posterior to the anterior edge of the acromion (Fig 6). The portal is typically 2 to 3 cm below the palpable edge of the acromion. This portal can assist in arthroscopic acromioplasty, arthroscopic rotator cuff surgery, and distal clavicle resection. The standard lateral portal or the modified portal can both be used for visualization.

Although visualization is maintained through the
lateral portal, the anterior portal is the “working” portal. An arthroscopic shaver is placed in the anterior portal and all adventitial tissue is removed. Anatomic landmarks and the monofilament suture are used for localizing the tendon in the groove. The falciform ligament of the pectoralis tendon is a reproducible landmark. The biceps tendon is directly under this structure (Fig 7).

Using an arthroscopic basket, the sheath is identified and opened. An electrocautery can be used to clean surrounding tissues, and a probe can be used to free the tendon (Fig 8). The dissection is also extended proximally to the lateral aspect of the rotator interval. Care should be taken to avoid proceeding too far medially. Otherwise, the dissection to expose the biceps tendon from the biceps sheath may lead to a partial displacement of the superficial attachment of the subscapularis tendon.

Two options exist for retrieving the tendon. Option 1 involves retrieving the monofilament sutures with a crochet hook from the anterior portal and extracting the tendon from that portal (Fig 9). Option 2 involves localizing the biceps groove with a spinal needle in the anterolateral quadrant of the shoulder. After satisfactory angle and position is obtained, a portal incision can be made and a hemostat can be used to retrieve the tendon (Fig 10). The amount of excursion of the biceps tendon is relatively small but can be improved by flexing the arm more than 90°. Excessive distention of the soft tissues with fluid may also make the biceps tendon difficult to extract from the surgical wound. If this event occurs, the surgeon can transfer the arthroscope to the anterior portal and use the modified

---

**Figure 7.** Illustration of the falciform ligament of the pectoralis major muscle. The biceps tendon is consistently found under this structure.

**Figure 8.** (A) Using an arthroscopic basket, the sheath of the biceps tendon is identified and opened. (B) Electrocautery ablation device used to clean surrounding transverse humeral ligament tissue. (C) Extraction of the tendon close to the pectoralis major insertion allows for easier identification and withdrawal.

**Figure 9.** Option 1. A crochet hook retrieves the monofilament suture and tendon out the anterior portal.
lateral portal as the position to extract the tendon from the surgical wound.

After the tendon is extracted from the anterolateral portal, a hemostat is placed on the tendon at the level of the skin preventing the tendon from retracting underneath the skin (Fig 11).

The placement and tension of the tenodesis is important for anatomic repair. Anatomic dissection has revealed an average intra-articular biceps tendon distance $35 \pm 5$ mm with the arm adducted to the side. This tenodesis driver has a $20$-mm excursion with a $23$-mm screw. This goes to a $13$-mm driver length with $10$ mm of screw overhang. To approximate the intra-articular distance, $20$ mm of tendon is removed, and a “whip stitch” is placed in $15$ mm of tendon (Fig 12A). This will allow the tenodesis driver to “bury” the tendon with all of the suture in it to confirm correct placement in the bone tunnel.

A braided suture is placed on the end of the tendon using a tendon stitch technique as described by Krakow. Our preferred suture is a No. 2 Fiberwire (Arthrex, Naples, FL) 36 inches in overall length. After this is completed, a square knot is placed at the end of the suture. This allows the suture to maintain tension during insertion and allows the tenodesis driver ease in directing placement. The sutures and tendon are allowed to fall back into the subacromial space. Cannulas are placed into the anterior and anterolateral portal if removed, and the sutures can be shuttled into the anterior portal so they are out of the way for the bone tunnel preparation.

Visualization is established from the lateral portal. The bicipital groove is identified. The soft tissue is gently debrided so that the bicipital groove is easily visualized. The lateral edge of the bicipital groove should be avoided because the ascending branch of the anterior circumflex vessel traverses along this edge. Debridement of the sheath and surrounding tissue avoids soft tissue interposition with the placement of the drill, tendon insertion into the bone tunnel, and placement of the interference screw. The groove should be easily visualized before beginning the bone tunnel procedure.

Instrumentation can be performed through an 8.25-mm clear cannula in the anterior portal, enhanc-
ing visualization and minimizing soft tissue distention. Through the anterolateral portal, a cannulated reamer guide wire (2.4 mm) is inserted into the center of the bicipital groove 10 to 15 mm below the insertion of the supraspinatus, lateral to the subscapularis insertion, at the level of the transverse humeral ligament. The depth of insertion is 30 mm. Drilling beyond the posterior cortex of the humerus, which may increase the risk of complications during this surgical procedure is not necessary. For most patients, an 8-mm cannulated reamer is of adequate size to allow placement of the tendon into the bone tunnel and secure fixation with a 8-mm bioabsorbable interference fit screw.

The tendon diameter can be measured with sizing holes found on the thumb pad of the biotenodesis driver. The calibrated reamer is advanced over the guide pin to the 30-mm mark. The standard length of the proximal biceps biotenodesis screw is 23 mm. After the bone socket has been created, the reamer and the guide pin are removed. (Fig 13).

The biotenodesis driver and handle are assembled, and the bioabsorbable screw is placed over the distal end of the driver. Typically, an 8-mm screw is used for an 8-mm bone tunnel. The sutures are then retrieved through the anterolateral portal (Fig 14). With a wire loop suture passer through the driver, one limb of the suture is pulled through the driver and the screwdriver handle (Fig 15). The surgeon holds the other limb loosely. The limb that is passed through the driver is then pulled tightly, until the end of the tendon is securely placed against the tip of the driver. Having

The tendon diameter can be measured with sizing holes found on the thumb pad of the biotenodesis driver. The calibrated reamer is advanced over the guide pin to the 30-mm mark. The standard length of the proximal biceps biotenodesis screw is 23 mm. After the bone socket has been created, the reamer and the guide pin are removed. (Fig 13).

The biotenodesis driver and handle are assembled, and the bioabsorbable screw is placed over the distal end of the driver. Typically, an 8-mm screw is used for an 8-mm bone tunnel. The sutures are then retrieved through the anterolateral portal (Fig 14). With a wire loop suture passer through the driver, one limb of the suture is pulled through the driver and the screwdriver handle (Fig 15). The surgeon holds the other limb loosely. The limb that is passed through the driver is then pulled tightly, until the end of the tendon is securely placed against the tip of the driver. Having

the thumb pad against the driver handle so that it does not interfere with the insertion of the interference screw is important.

Visualization is through the lateral portal, and the tenodesis driver is placed through the anterolateral cannula. The tip of the driver and the tendon are visualized as they exit the cannula (Fig 16). The tip of the driver is placed at the superior aspect of the bone socket and manually inserted until the tendon reaches the base of the tunnel (Fig 17). The free suture limb inside of the cannulated driver is held tight against the driver with a hemostat. After the driver and tendon have seated to the bottom of the bone socket, the thumb pad is used to hold the tendon and suture against the base of the bone tunnel. The appropriate

the thumb pad against the driver handle so that it does not interfere with the insertion of the interference screw is important.

Visualization is through the lateral portal, and the tenodesis driver is placed through the anterolateral cannula. The tip of the driver and the tendon are visualized as they exit the cannula (Fig 16). The tip of the driver is placed at the superior aspect of the bone socket and manually inserted until the tendon reaches the base of the tunnel (Fig 17). The free suture limb inside of the cannulated driver is held tight against the driver with a hemostat. After the driver and tendon have seated to the bottom of the bone socket, the thumb pad is used to hold the tendon and suture against the base of the bone tunnel. The appropriate
insertion of the tendon is confirmed by the sight of the suture disappearing into the bone socket.

The bioabsorbable interference screw is placed directly over the top of the tendon until the head of the screw is below the level of the prominence of the medial and lateral intertubercular ridges. The head of the screw can be inserted until it is flush with the base of the bicipital groove. After the screw has been properly seated, the driver is removed from the anterolateral portal. A crochet hook is used to remove both limbs of the suture. One is through the center of the interference screw, and the other limb is now captured between the interference fit screw and the bone tunnel. A knot comprised of multiple half hitches is tied over the top of the interference screw, using arthroscopic knot-tying techniques (Fig 18). The tendon is now secured with 2 methods. The primary method is the interference screw, with secondary fixation accomplished by tying the suture to the anchor (suture anchor fixation). The subacromial space is irrigated, thoroughly removing any remaining soft tissue or debris. The arm is rotated from side to side to ensure that no prominence exists from the interference fit screw head and that no complications related to the surgical procedure have occurred. The arthroscopic portals are closed with suture.

**Lateral Decubitis Position**

The lateral decubitis position can also address all aspects of subacromial surgery, including arthroscopic biceps tenodesis. The arm is positioned in 30° to 45° of abduction with longitudinal traction. The advantage of this position is that the anatomy of the shoulder
stays relatively fixed during the surgical procedure. The disadvantage is that the traction is not easily removed. Therefore, the elbow is not flexed during the surgical procedure, which would provide a greater length of the biceps tendon available in the subacromial space. Therefore, in the lateral decubitus position, the biceps tendon length is inadequate to routinely extract from the anterior portal. We recommend a modification of the technique from the beach-chair procedure previously described, which allows the biceps tendon to remain in the subacromial space at all times.

After identifying the biceps tendon, either by palpation or visualization below the transverse humeral ligament, the surgeon removes the tendon from the groove. A single No. 2 Fiberwire is placed in the tendon 2 cm cephalad to the intended tenodesis hole using a Viper punch (Arthrex). Both suture limbs are retrieved out the anterior portal and then a sliding/locking knot is tied over the tendon. The bone socket is established and the tendon is delivered using the same methods described for the beach-chair position. Excess tendon can be trimmed at the conclusion of fixation.

**POSTOPERATIVE MANAGEMENT**

Postoperative management is typically dictated by the procedures that have been performed in conjunction with the biceps tenodesis. With a rotator cuff repair, passive range of motion of the shoulder is indicated for the first 6 weeks, followed by a gradual progression from active-assisted range of motion to active motion. Elbow range of motion and grip strengthening can progress as tolerated without concern for the bicep tenodesis. If the procedure includes only an acromioplasty, patients begin with passive range of motion but quickly progress to active-assisted and active range of motion, without concern of the integrity of the biceps tenodesis. Elbow range of motion and grip strengthening are also included.

Strengthening exercises are typically delayed until 6 weeks after the surgical procedure. If the surgical procedure is only a biceps tenodesis, then the postoperative management is the same as it is for an arthroscopic acromioplasty. Any strengthening activities related to elbow flexion or forward elevation of the arm with the elbow extended should be restricted until 6 weeks after the biceps tenodesis.

To date, we have performed 60 of these surgical procedures without any major complications. The testing of the repair using an arthroscopic probe at the completion of the procedure is extremely satisfying. The repair appears to be much more secure than any arthroscopic fixation that we could achieve using a variety of different techniques including suture anchor techniques. A short-term and long-term follow-up evaluation is in progress.

**REFERENCES**