# Subpectoral Biceps Tenodesis Using an Expanding PEEK Device

Joseph C. Tauro, M.D., Matthew Moralle, M.D., and Stephen Iacono, M.D.

**Abstract:** In this Technical Note, we describe a method of mini-open long head biceps subpectoral tenodesis. The implant used is a threadless expanding PEEK (polyether ether ketone) interference device that fixes the biceps tendon in a drill hole in the humerus under the inferior border of the pectoralis major tendon. The diameter of the drill hole varies between 6 and 8 mm depending on the width of the tendon. The procedure can be performed through a 3-cm incision centered on the inferior border of the pectoralis tendon. Based on our experience, it is a quick, safe, and reliable tenodesis procedure.

Pathology of the long head of the biceps (LHB) is a common cause of shoulder pain.[1-3] Initial management of LHB pathologies usually includes rest, nonsteroidal anti-inflammatory drugs, physical therapy, and corticosteroid injections into the subacromial space, bicipital groove, or glenohumeral joint. If conservative measures fail, the main surgical options employed are tenotomy and tenodesis.[4] Tenodesis has been shown to have similar relief of pain as tenotomy and better functional performance in some studies.[4,5] The most definitive advantage of tenodesis over tenotomy is a much lower incidence of inferior migration of the biceps, the "Popeye" deformity.[2,6] Furthermore, tenodesis may improve long-term function because it better restores normal anatomy.[7]

Indications for tenodesis include chronic tendonitis, partial or complete tears of the LHB, SLAP lesions, and tendon subluxation out of the bicipital groove in patients who have failed conservative management.[3] Several techniques have been described for performing tenodesis. Abraham et al.'s[1] systematic review of Level III and IV studies concluded that both open and arthroscopic biceps tenodesis provided satisfactory outcomes in most patients, and there were no identifiable differences. Open subpectoral tenodesis is a commonly performed surgical option. The tendon can be fixed onto or into the humerus using a variety of


**Fig 1.** TenoLok Anchor undeployed. The biceps tendon is secured to the tendon with the suture loop.

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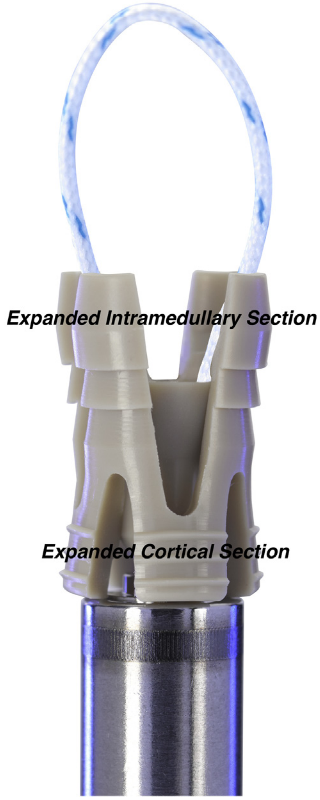


**Fig 2.** TenoLok Anchor in the deployed configuration, showing the expanded intramedullary and cortical fixation sections.

implants or anchors. Soft tissue fixation alone has also been reported to be successful.[8] Arthroscopic suprapectoral techniques have also been described, the most common technique being high or low suprapectoral tenodesis. Both techniques have significant clinical improvement in functionality as well as pain.

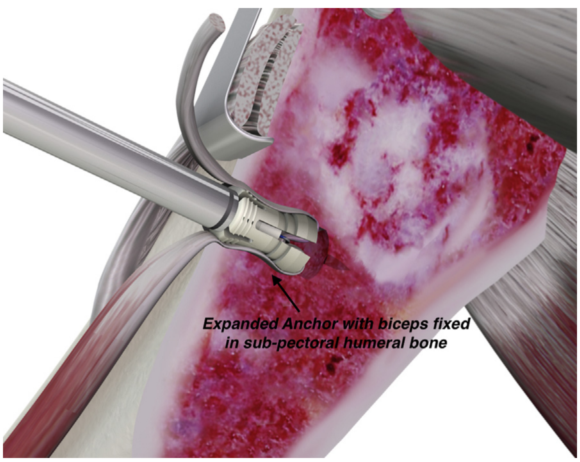


**Fig 3.** TenoLok Anchor with the attached biceps tendon inserted in the drill hole under the inferior border of the pectoralis tendon. It has been deployed, showing expanded intramedullary and cortical fixation.

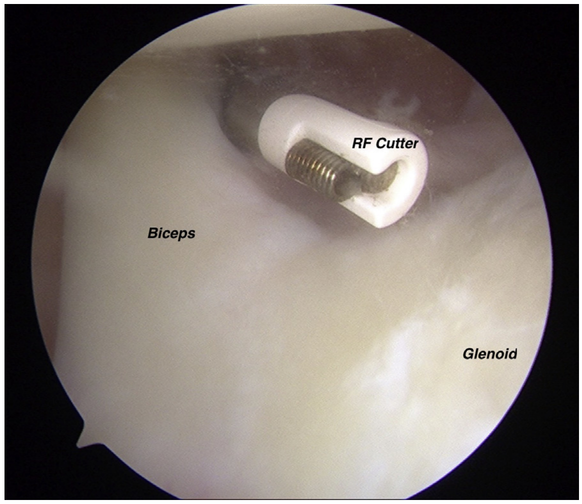


**Fig 4.** Right shoulder in the lateral decubitus position. Arthroscopic view from the posterior portal. A radiofrequency (RF) cutter is inserted percutaneously through the rotator interval immediately inferior to the biceps tendon in preparation for tenotomy.

However, recent ex vivo models have suggested that the suprapectoral technique may have a reduced load to failure in comparison with the open subpectoral procedure.[9] Interference screws have been shown to have higher ultimate load to failure and improved stiffness; however, these devices may have a higher revision rate due to failure caused by rupture of the tendon at the site of tenodesis. It is believed that the failures of these devices are due in part to trauma to the tendon during fixation. It is postulated that screw threads can cause rotation of the graft, decreased restored tension, and a reduced load to failure. Recent ex vivo models have shown that the use of sheathed

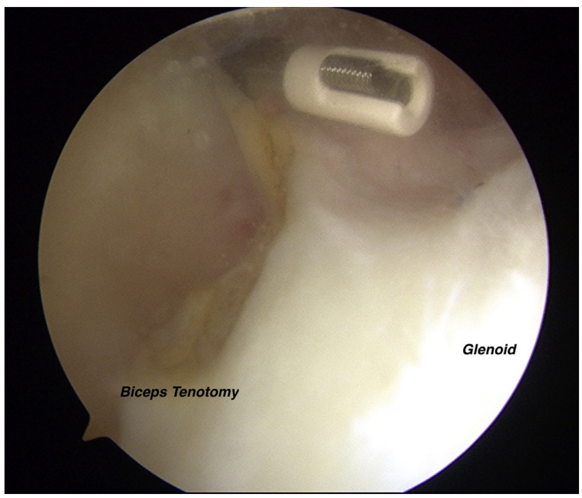


**Fig 5.** Right shoulder in the lateral decubitus position. Arthroscopic view from the posterior portal. Biceps tenotomy has been completed using the radiofrequency probe as a cutting device. The biceps has retracted into the bicipital groove.

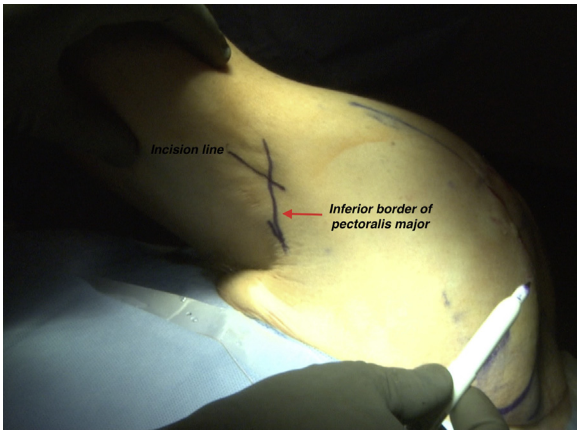


**Fig 6.** Right shoulder in the lateral decubitus position. The incision line for the tenodesis is centered over the humeral shaft. It extends 1 cm above and 2 cm below the inferior border of the pectoralis major.

screws can decrease malrotation of screws and trauma to tendon during tenodesis.[10]

The technique described in this report uses a threadless expanding PEEK (polyether ether ketone) interference device (TenoLok Anchor, ConMed, Largo, FL) that fixes the biceps tendon in a drill hole in the humerus under the inferior border of the pectoralis major (PM) tendon. The device has a suture loop through the foot of the implant that holds the biceps in place during insertion. Undeployed, the implant diameter is 5 or 6 mm (Fig 1). When deployed, this implant expands radially to provide an interference fit in the humerus (Figs 2 and 3). We believe that this represents an improvement over threaded devices, especially in the subpectoral area where the bone is harder and damage to the tendon from a threaded device is more of a possibility.

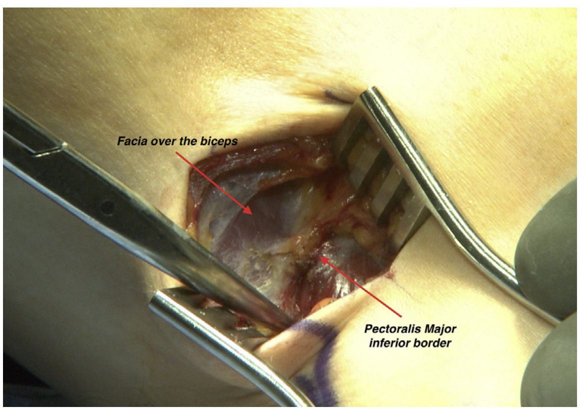


**Fig 7.** Right shoulder in the lateral decubitus position. After the skin has been incised, a self-retaining retractor is placed. Superficial dissection is performed to expose the inferior border of the pectoralis major and the facia over the biceps.

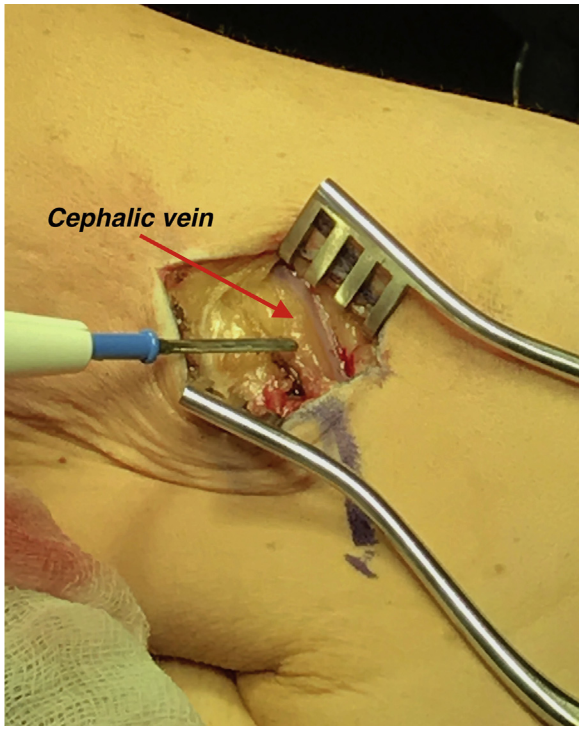


**Fig 8.** Right shoulder in the lateral decubitus position. During the initial superficial dissection, the cephalic vein may be encountered. It is located over the lateral edge of the pectoralis tendon and should be protected by retracting it laterally with the self-retainer.

## Surgical Technique

### Patient Positioning, Diagnostic Arthroscopy, and Tenotomy

We perform a diagnostic arthroscopy in the lateral position using an adjustable arm holder (AssistArm Limb Positioner, ConMed) (Video 1).

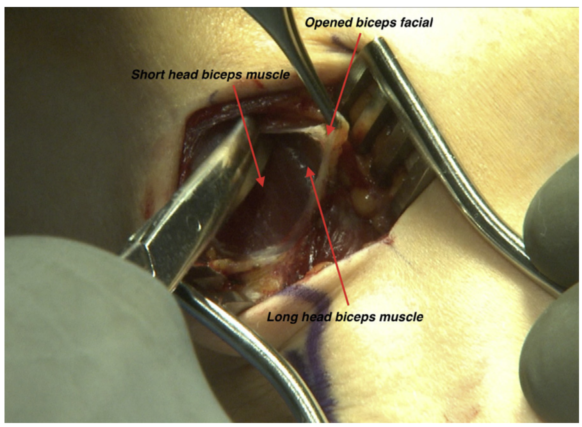


**Fig 9.** Right shoulder in the lateral decubitus position. The fascia over the biceps is incised, exposing the muscle of the short head of the biceps medially and the muscle of the long head of the biceps laterally.

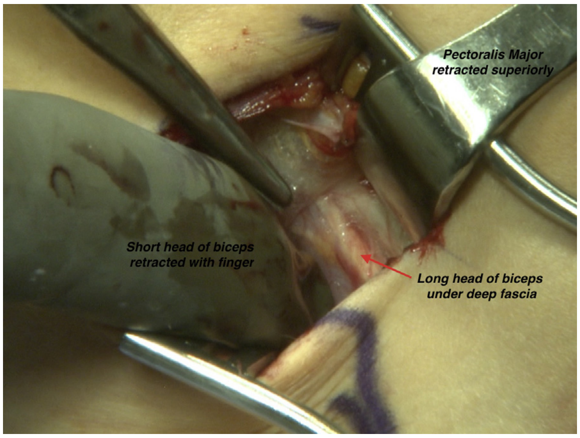


**Fig 10.** Right shoulder in the lateral decubitus position. The short head of the biceps is retracted medially with a finger; the pectoralis is retracted superiorly with an army/navy retractor, exposing the long head of the biceps.

Biceps pathology is confirmed and a tenotomy is performed. If there is an anterior superior rotator cuff tear or a rotator interval tear, a radiofrequency (RF) cutter is inserted percutaneously and directed through the tear to the biceps insertion and then the tenotomy is performed. If there is no cuff or interval tear, the RF cutter is inserted through an anterior portal. Alternatively, the RF device is inserted through a small percutaneous incision and then, using a small amount of cutting energy, directly through the superior rotator interval to the biceps (Figs 4 and 5).

## Incision and Superficial Dissection

After any other associated pathology is addressed (for instance, a rotator cuff repair), we close the arthroscopic incisions and move around to the front of the patient. The arm is placed in 20° of abduction to relax the PM, 10° of external rotation and 0° of flexion to help with incision and dissection visualization. The inferior border of the PM is marked. The incision is based on the central axis of the humeral shaft, beginning 1 cm above and ending 2 cm below the inferior margin of the PM (Fig 6).

Superficial dissection is performed until the inferior border of the PM and the fascia over the short head muscle belly of the biceps is identified (Fig 7). The cephalic vein is not always visualized but is located over the lateral edge of the pectoralis tendon and must be avoided (Fig 8).

## Deep Surgical Dissection

Just deep to the PM, the facia over the biceps is identified and incised (Fig 9). The PM is retracted superiorly. The short head of the biceps muscle belly is

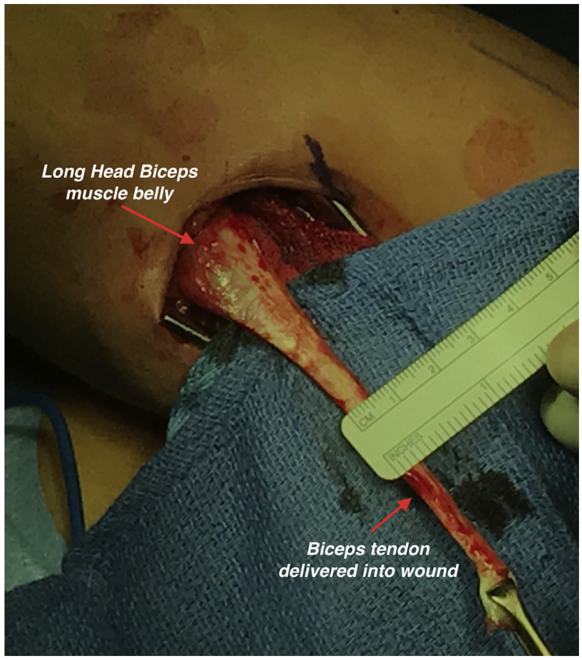


**Fig 11.** Right shoulder in the lateral decubitus position. The biceps tendon is delivered into the wound. Then the width of the tendon is measured 15 mm proximal to the musculotendinous junction to select implant size and drill size (see Table 2).

**Table 1.** Surgical Procedure Pearls and Pitfalls

| Pearls | Pitfalls |
|---|---|
| • Use your index finger to palpate the LHB tendon before placing the Hohmann retractor laterally. Make sure that the retractor goes in lateral to the tendon, not medially or through it by using your finger to protect the tendon | • Avoid the cephalic vein. It runs along the pectoralis major insertion laterally and can be injured especially at the inferior border of the tendon (Fig 21) |
| • Rehearse the tendon reduction to confirm that tenodesis tension is anatomic (Fig 16) | • Avoid the musculocutaneous nerve. Never dissect or drill blindly. Be sure to place the small Hohmann retractors directly on the bone |
| • Maintain the position of the tendon under the implant during insertion. Proximal tension on the tendon can be helpful (Fig 22) | • The anchor is designed for both intramedullary and cortical fixation (Fig 2). Avoid inserting the anchor below the cortical surface of the humerus because this reduces pullout strength |

LHB, long head of the biceps.

**Table 2.** Implant and Drill Hole Size Based on the Tendon Width

| Tendon Size, mm | Implant Size, mm | Drill Size, mm |
|---|---|---|
| 4 | 5 | 6 |
| 4.5-5 | 5 | 6.5 |
| 5.5 | 5 | 7 |
| 6 | 6 | 7.5 |
| >6 | 6 | 8 |

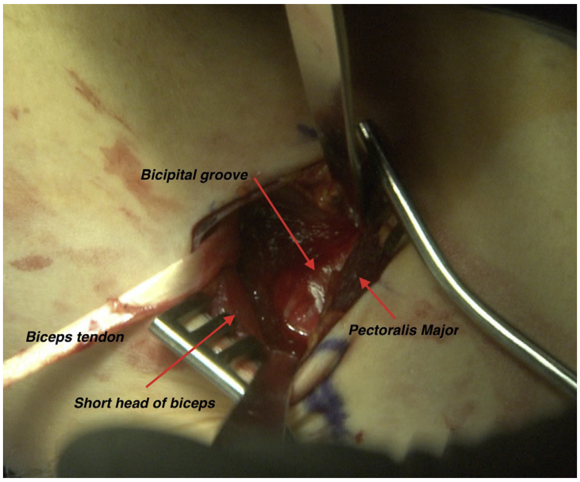


**Fig 12.** Right shoulder in the lateral decubitus position. Small Hohmann retractors are placed directly on bone, retracting the pectoralis major superior laterally and the short head of the biceps medially, exposing the bicipital groove.

exposed and retracted medially with a finger. The LHB can be palpated and visualized lateral to the short head (Fig 10, Table 1). Using an Allis clamp, the LHB is grasped and delivered into the wound.

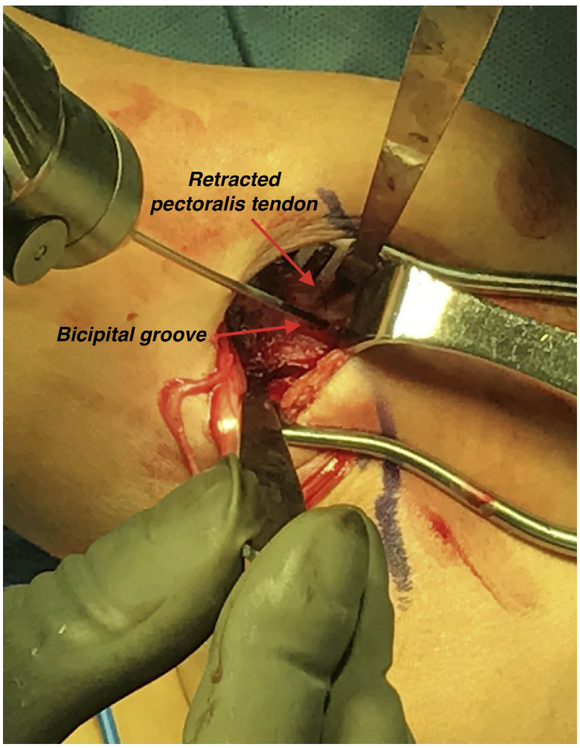


**Fig 13.** Right shoulder in the lateral decubitus position. Guidewire placement is under the inferior border of the pectoralis major tendon, in the biciptal groove, and directed centrally into the humeral shaft. The guidewire is inserted through the anterior cortex of the humerus and to the posterior cortex but not through it.

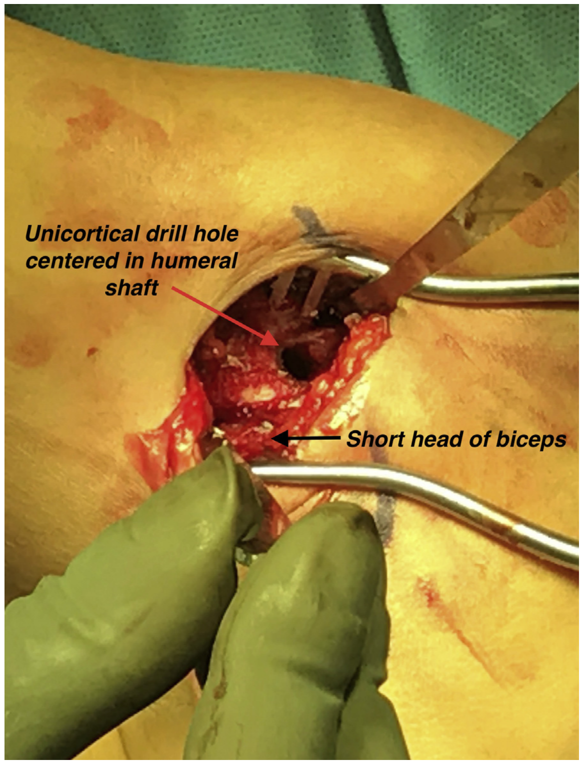


**Fig 14.** Right shoulder in the lateral decubitus position. Completed unicortical drill hole after using a cannulated drill over the guidewire. Soft tissue should be removed from the drill hole opening with a bovie or knife to facilitate anchor and tendon insertion.

### Tendon Preparation and Making the Drill Hole

Tendon diameter is measured (Fig 11). Based on tendon size and patient bone quality, an implant and drill hole size is selected (Table 2). Under direct vision, a small Hohmann retractor is placed laterally to retract the PM tendon and another is placed medially to retract the short head of the biceps muscle belly. The distal bicipital groove is identified (Fig 12, Table 1).

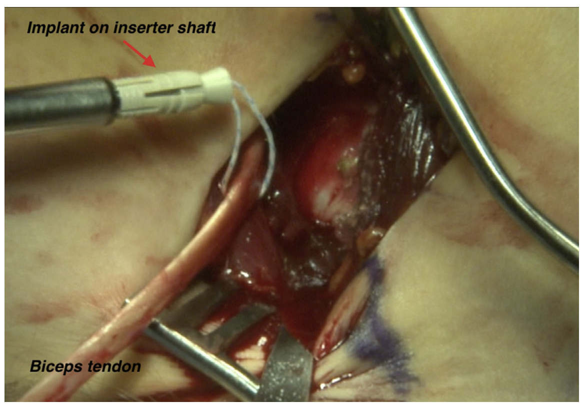


**Fig 15.** Right shoulder in the lateral decubitus position. The biceps tendon is pulled through the suture loop at the end of the implant.

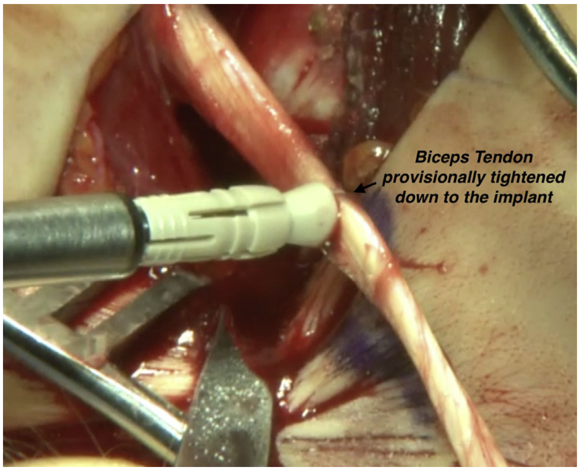


**Fig 16.** Right shoulder in the lateral decubitus position. The implant suture loop is provisionally tightened around the biceps tendon to secure it to the foot of the implant.

The guidewire is placed 5 mm proximal to the inferior border of the PM tendon, in the bicipital groove. It is very important that the guidewire be drilled into the center of the humeral shaft to minimize the postoperative fracture risk[10] (Fig 13). A unicortical hole in the humeral shaft is made using a cannulated drill over the guidewire (Fig 14).

## Fixing the Tendon to the Implant

The LHB is pulled through the suture loop at the foot of the TenoLok implant and provisionally tightened 17 mm proximal to the musculotendinous junction (Figs 15 and 16). The tenodesis position is rehearsed by laying the implant over the LHB distally with the head of the implant over the drill hole. This will confirm the position of the tenodesis once completed that should be at the musculotendinous junction (Fig 17, Table 1).

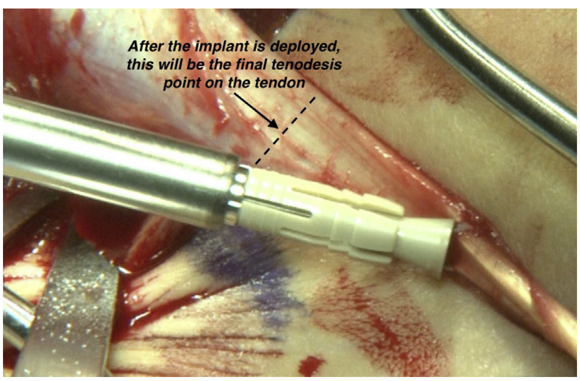


**Fig 17.** Right shoulder in the lateral decubitus position. The implant is laid over the long head tendon distally. The top of the implant is where the final position of the biceps tenodesis will be located. The desired position is the musculotendinous junction.

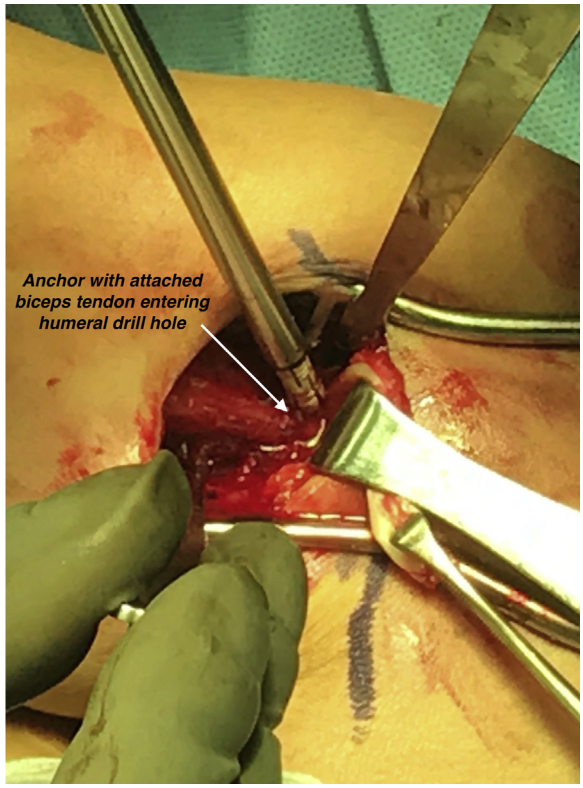


**Fig 18.** Right shoulder in the lateral decubitus position. The anchor with the biceps tendon attached is then inserted into the drill hole.

## Inserting and Deploying the Implant

The anchor and the attached tendon are directed into the drill hole (Fig 18) and tapped into the bone until the

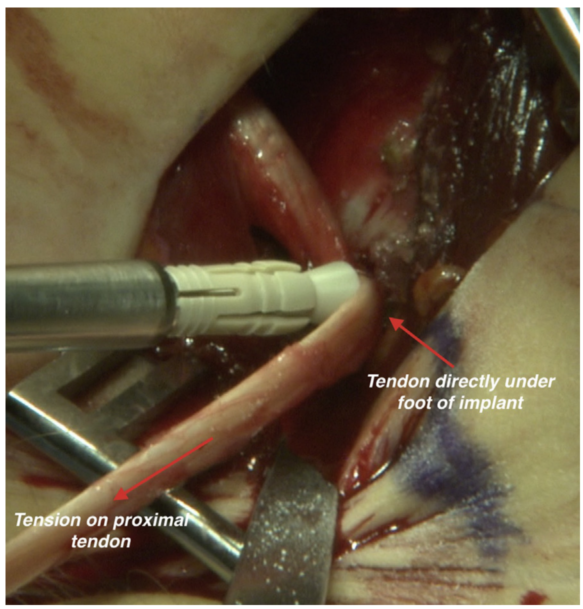


**Fig 19.** Right shoulder in the lateral decubitus position. The biceps tendon must remain centered under the foot of the implant during insertion. Tensioning and gently guiding the proximal tendon can be helpful.

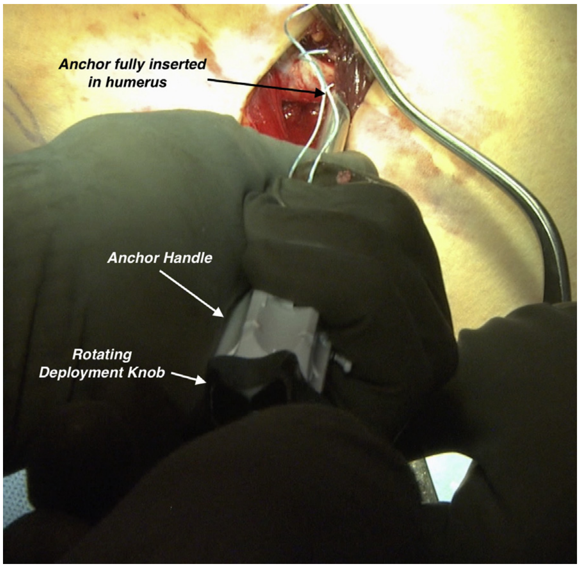


**Fig 20.** Right shoulder in the lateral decubitus position. While maintaining a gentle insertion force on the handle, the implant is expanded by grasping the white handle to prevent rotation of the device, and then turning the black knob clockwise until a click is heard and felt.

top of the implant is flush with the outer cortical surface of the humerus. Note that it is important to maintain the position of the LHB tendon under the foot of the implant during insertion so that it does not slide to the side of the implant, compromising fixation. Although it is not usually necessary, a clamp can be used on the tendon on the proximal side of the implant to assist with this (Fig 19, Table 1).

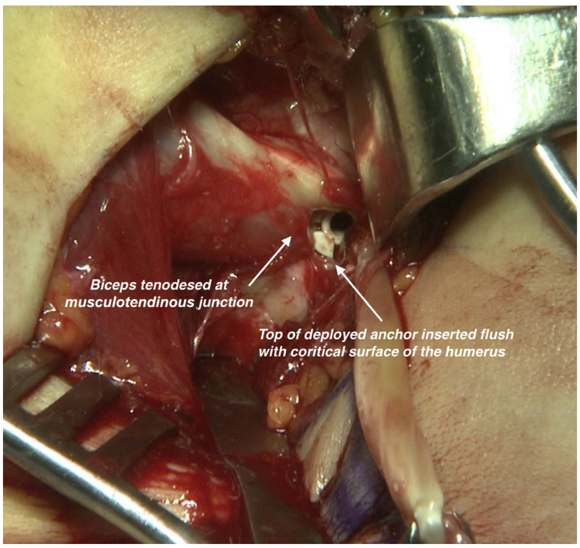


**Fig 21.** Right shoulder in the lateral decubitus position. The handle and suture have been removed, showing the completed repair before tendon trimming. Note that the head of the implant is flush with the cortical surface of the humerus. This provides the strongest fixation.

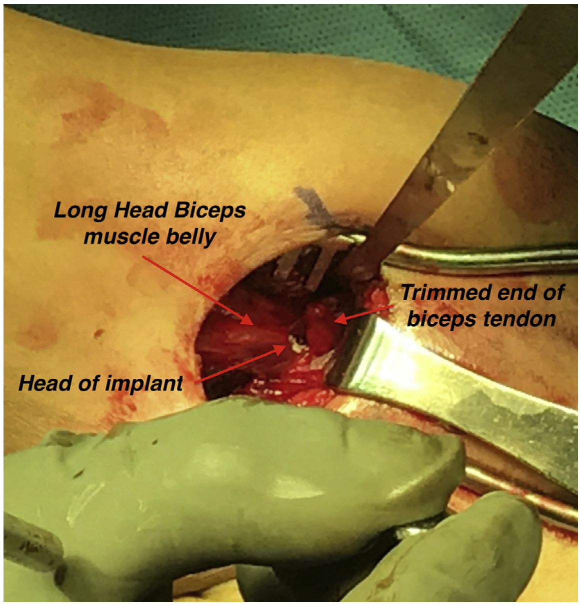


**Fig 22.** Right shoulder in the lateral decubitus position. Completed repair after tendon is trimmed, leaving a 1-cm stump proximally.

The device is deployed by grasping the white section of the handle to prevent rotation and then turning the black knob clockwise until a loud click is felt and heard, indicating that the implant has fully expanded (Fig 20). The retaining suture loop is unwound from the cleats on the inserter and the handle is removed. The suture can then be removed from the anchor (Fig 21).

### Closure

Excess tendon is removed with a scalpel or a scissor, leaving a 1-cm stump of tendon proximally (Fig 22). The wound is irrigated and the skin is closed with absorbable sutures and skin glue.

## Discussion

The technique presented has been in use for more than 3 years and has been reliable and reproducible in our hands. Once experience is gained with the technique, it can usually be completed within 15 minutes.

**Table 3.** Advantages and Disadvantages of Open Subpectoral Biceps Tenodesis

| Advantages | Disadvantages |
|---|---|
| • The anatomic length of the LHB can be accurately reproduced | • Fracture risk from the drill hole in the humerus |
| • All sites that can produce proximal LHB pain are addressed | • 3-cm scar from the open procedure |
| • Damage to the tendon from threads is eliminated | • Potential for injury to the musculocutaneous nerve and cephalic vein |
| • Very secure fixation | • Additional cost of the anchor |

LHB, long head of the biceps.

The small scar is cosmetic. Postoperative pain is typically mild. Outcomes in general after biceps tenodesis have been good. Tenodesis has been shown to have similar relief of pain as tenotomy and better functional performance in some studies.[4,5] The most definitive advantage of tenodesis over tenotomy is a much lower incidence of inferior migration of the biceps, the "Popeye" deformity.[2,6] The advantage of subpectoral biceps tenodesis in general is that the anatomic length of the LHB can be accurately reproduced and all sites that can produce proximal LHB pain are addressed. Compared with other subpectoral techniques, the main advantages of this specific technique are that fixation strength is higher than soft tissue fixation alone and damage to the tendon from threads is eliminated (Table 3). We perform this technique commonly in patients with proximal biciptal pain who have failed conservative management for all of the above reasons. There are, however, risks involved with this procedure as in any surgical procedure compared with nonoperative care or tenotomy such as surgical site infection, pain at the surgical site, or failure of fixation. The disadvantages compared with arthroscopic suprapectoral techniques are that an open incision is needed for the tenodesis and that a drill hole into the humeral shaft is necessary, as opposed to more proximal metaphyseal bone. Although no outcome study has reported fractures from this drill hole, there have been fracture case reports[11] and torsional strength of the humerus at time zero for the tenodesis has been shown to be reduced in some studies.[12] Drill hole position centrally in the humeral shaft has been shown to minimize the reduction in torsional strength of the humerus and is thus critical to avoid this complication.[13] There is also a possible risk to the cephalic vein or the musculocutaneous nerve[14] and axillary nerve if a bicortical drill hole is used.[15]

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