

Revision Open Subpectoral Biceps Tenodesis With Allograft Tendon Reconstruction for Symptomatic Failed Biceps Tenodesis



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Abstract: Biceps tenodesis and tenotomy are both effective surgical procedures for management of shoulder pain and dysfunction secondary to SLAP tears, biceps tendinitis, rotator interval pulley lesions, and failed SLAP repairs. These procedures are generally safe with low complication rates. However, failure of a proximal biceps tenodesis or tenotomy can rarely lead to symptomatic Popeye deformity with pain and cramping with repetitive forearm supination and elbow flexion. Surgical revision is indicated in young active patients to restore the length tension relationship of the biceps brachii to improve supination and flexion strength, as well as to provide symptomatic relief and improved endurance. Failed biceps tenodesis can be a challenging surgical scenario, as oftentimes there is limited available proximal biceps tendon tissue, especially in the setting of prior subpectoral biceps tenodesis. We report a technique of revision open subpectoral biceps tenodesis with allograft tendon augmentation for the management of symptomatic Popeye deformity in young active patients with little to no remaining proximal biceps tendon.

Introduction

Biceps tenodesis and tenotomy are effective surgical procedures with a low complication rate and a high rate of patient satisfaction for the management of symptomatic superior labrum anterior to posterior (SLAP) tears, biceps tendinitis, rotator interval pulley lesions, and failed SLAP repairs.^{1,2} A recent systemic

review and meta-analysis found the incidence of proximal failure resulting in Popeye deformity following arthroscopic suprapectoral tenodesis and open subpectoral biceps tenodesis to be as low as 1.7% versus 1.0%, respectively.³ However, in the general population, this deformity is well tolerated with no change in overall clinical outcome or need for surgical revision.⁴ However, cramping pain with flexion and repetitive supination of the forearm in young active patients is a relative indication for surgical revision. Several authors have demonstrated encouraging outcomes following revision biceps tenodesis after proximal failure leading to a Popeye deformity.⁵⁻⁹

The challenge of surgical management of a failed biceps tenodesis is there may be minimal to no remaining proximal biceps tendon available. This is especially true if the index procedure was an open subpectoral technique in which the tenodesis is performed more distal near the musculotendinous junction. The purpose of this article is to describe our technique with revision biceps tenodesis with tibialis anterior allograft augmentation to specifically address the surgical scenario of no remaining biceps tendon and only the tissue of the musculotendinous junction and biceps muscle belly available for reconstruction (Video 1).

Informed verbal consent was obtained from the patients in all of the figures and videos in this technique article.

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Surgical Technique

Patient Positioning

After general anesthesia, the patient is positioned in the beach chair position with all bony prominences well padded (Fig 1). We prefer not to use a regional interscalene nerve block so that we can examine the musculocutaneous nerve postoperatively in the recovery room. The patient then undergoes sterile preparation and draping, a timeout is performed, and perioperative antibiotics are confirmed.

Exposure

The prior open subpectoral biceps tenodesis incision is extended distally for 12 to 15 centimeters (Fig 1). If the prior biceps tenodesis was performed arthroscopically, the proximal aspect of the incision is 1-2 cm proximal to the distal border of the pectoralis major tendon. Proximally, the distal aspect of the deltopectoral interval is identified by the cephalic vein. The distal portion of the pectoralis major tendon is identified and dissected with the conjoint tendon of the coracobrachialis and short head of the biceps tendon deep to it. The biceps tendon is absent from the groove and undersurface of the pectoralis major, as it is retracted distally. Next, the biceps muscle belly is identified and retracted distally in



Fig 1. Patient positioned in the beach chair position for a left shoulder revision subpectoral biceps tenodesis. Red arrow denotes the prior open subpectoral biceps tenodesis incision.

the mid aspect of the arm. The next step requires identification of the musculocutaneous nerve, which traverses through the conjoint tendon, 3-5 cm distal to the tip of the coracoid and then passes in the interval between the biceps and brachialis. By reflecting the retracted biceps muscle belly distally, the musculocutaneous nerve is easily identified as it exits through the anterior surface of the conjoint tendon (Fig 2). This is a critical step of the procedure to ensure that the nerve is not incorporated into the allograft reconstruction.

The biceps muscle and residual musculotendinous junction is inspected. For cases such as this, where there is a chronic rupture after a prior biceps tenodesis, there is likely to be little to no remaining tendon. However, there may be a palpable firmness and bulbous nature to the musculotendinous junction, where the remaining tendon has scarred in. The musculotendinous junction is then secured with a no. 2 nonabsorbable suture, and the biceps muscle is circumferentially mobilized with blunt dissection with care taken to protect the musculocutaneous nerve.

Allograft Reconstruction

While visualizing the musculocutaneous nerve on the deep surface of the biceps muscle in the interval between biceps and brachialis, the tibialis anterior tendon allograft is pulvertaft weaved horizontally from medial to lateral across the musculotendinous junction (Fig 3). Then, it is pulvertaft weaved in an orthogonal direction (from superficial to deep, proximal to the initial horizontal weave), so that the tendon exits the deep aspect of the biceps muscle as it ascends proximally (Fig 4). The initial horizontal weave can be either medial to lateral or lateral to medial, and it is the surgeon's preference. The junction of the allograft, biceps muscle belly, and musculotendinous junction are then sutured together with multiple no. 2 nonabsorbable sutures in a figure-of-8 fashion (Fig 3).

Revision Biceps Tenodesis Fixation Technique

The allograft reconstruction is then brought proximally under sufficient tension, and a subpectoral biceps tenodesis location is selected. We prefer to use a tenodesis screw for fixation. The graft is sized to fit into a 6-mm tunnel. A unicortical 6-mm tunnel is drilled 1 cm proximal to the inferior border of the pectoralis major. If there is already a suture anchor or tenodesis hole in this location, this hole can be reused, or a separate hole can be drilled more proximally. Next, the tendon is opposed to the hole and 10-15 mm of tendon is templated to fit into the tenodesis hole. The tendon is trimmed as needed to achieve satisfactory tension. The tendon is then inserted into the tunnel, and a 5.5-mm Arthrex (Naples, FL) biotenodesis screw is inserted to achieve interference fixation (Fig 5). The elbow is then

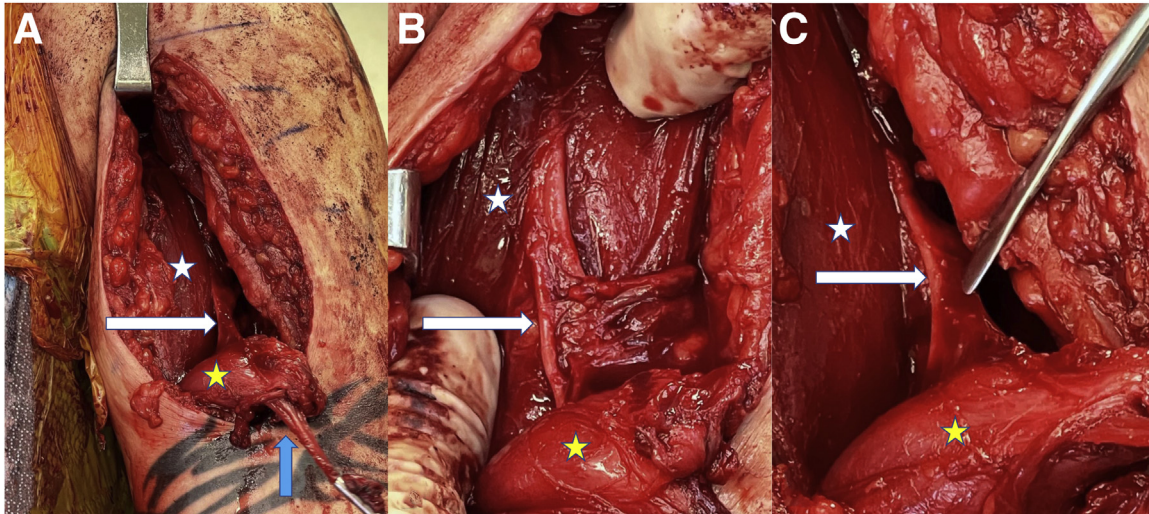


Fig 2. Left shoulder in the beach chair position after initial deep dissection. White arrow denotes the musculocutaneous nerve is identified (A, B, C). White star denotes the conjoined tendon (coracobrachialis, short head of the biceps) (A, B, C). Yellow star denotes the biceps muscle belly retracted and reflected distally (A, B, C). Blue arrow denotes the remnant biceps fascial sheath without any tendon (A).

ranged gently with confirmation that the biceps muscle belly is appropriately retensioned. The musculocutaneous nerve is palpated and noted to be free of any undue tension. The wound is then irrigated and closed in a layered fashion.

Postoperative Rehabilitation Protocol

The postoperative rehabilitation protocol consists of sling immobilization for 4 weeks. Immediately following surgery, the patient should begin a structured physical therapy protocol, which consists of 3 weeks of passive range of motion from 90° of flexion up to full flexion, and passive extension from maximum flexion

back to 90° of flexion. The purpose of this is to allow gliding and prevent scarring of the biceps allograft construct deep into the pectoralis major tendon. After the first 3 weeks, the patient is gradually allowed more extension, so that by 6 weeks postoperative, they are reaching full extension. Active strengthening of the biceps is initiated 4 months after surgery. Return to heavy lifting and sport is allowed at 6 months after surgery.

Discussion

Numerous studies have documented good surgical outcomes with biceps tenodesis and tenotomy for the

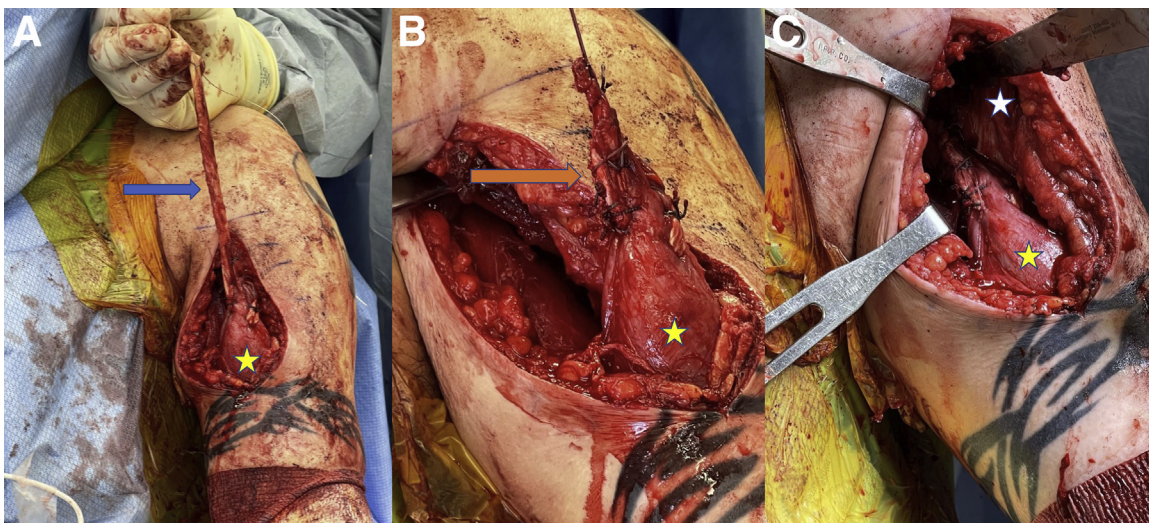


Fig 3. Left shoulder in the beach chair position. Yellow star denotes the biceps muscle belly (A, B, C). (A) Blue arrow denotes the tibialis anterior allograft tendon pulvertaft weaved and secured to the biceps muscle belly. (B) Orange arrow denotes the final length of the biceps allograft augmentation showing no. 2 nonabsorbable sutures in a figure-of-8 fashion securing the junction. (C) White star denotes the pectoralis major tendon.

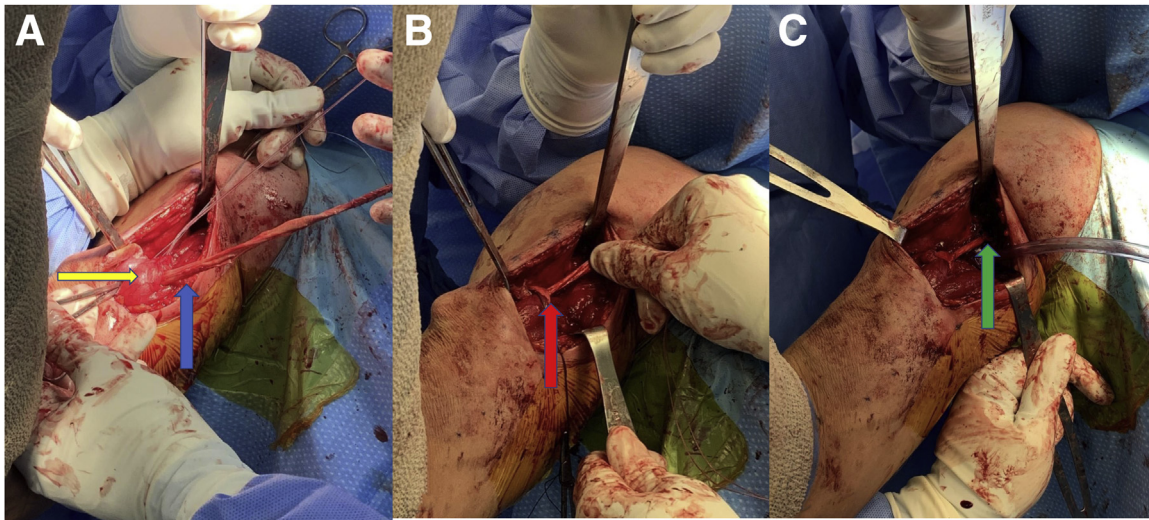


Fig 4. Right shoulder in the beach chair position. (A) Yellow arrow denotes the biceps muscle belly. Blue arrow denotes the tibialis anterior allograft tendon pulvertaft weaved horizontally from lateral to medial. (B) Red arrow denotes the tibialis anterior allograft tendon pulvertaft weaved orthogonally from superficial to deep so it is exiting dorsally (posteriorly) and proximally. (C) Green arrow denotes the biceps allograft augmentation is tenodesed subpectorally and restores the resting tension of the biceps muscle belly.

treatment of symptomatic SLAP tears, proximal biceps tendinopathy, biceps instability secondary to rotator interval pathology, and failed SLAP repairs.^{1,2} Controversy exists as to the ideal surgical management, as both tenodesis and tenotomy reliably relieve pain and

improve shoulder function; however, several studies have shown increased rates of Popeye deformity with arthroscopic biceps tenotomy.^{10,11} Studies have also demonstrated that failure after biceps tenodesis can lead to pain, cramping, and dysfunction. Revision biceps tenodesis leads to high patient satisfaction and significant improvement in functional outcomes.^{5,9} The challenge with revision biceps tenodesis is that, often-times, there is little to no remaining tendon for suture fixation, especially if the initial surgery was an open suprapectoral or subpectoral tenodesis technique. This creates a difficult surgical scenario as the biceps muscle belly does not provide substantial tissue for direct suture repair, and there is limited musculotendinous junction remaining. For this reason, we developed a technique for revision biceps tenodesis with tibialis anterior allograft augmentation. We selected tibialis anterior allograft for the following reasons: 1) limit morbidity of autograft harvest, 2) known diameter of tendon that closely matches native biceps tendon, and 3) avoids having to suture hamstrings together, which may lead to asymmetric tension on graft limbs after pulvertaft weave. We have used this technique on 2

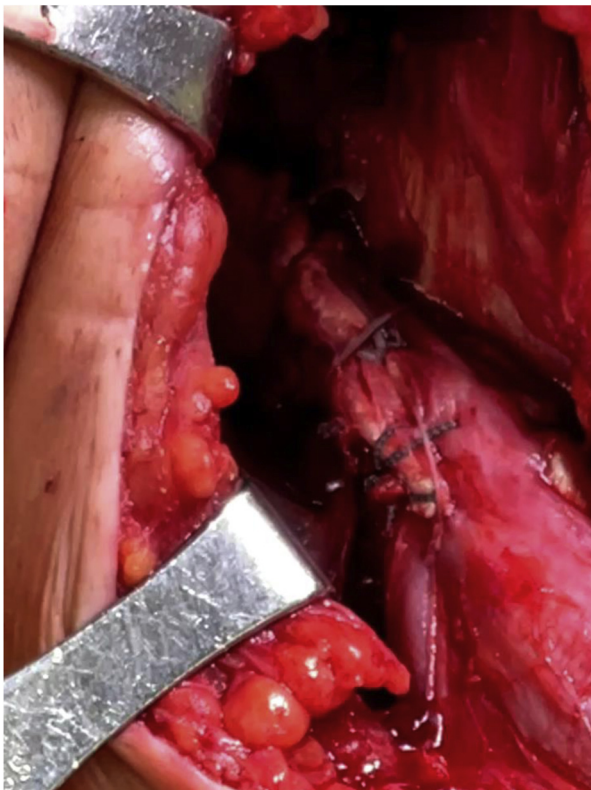


Fig 5. Left shoulder with the patient in the beach chair position. Demonstration of the final revision subpectoral biceps tenodesis construct with tibialis anterior allograft tendon.

Table 1. Pearls and Pitfalls

- Visualization of the musculocutaneous nerve is critical to avoid iatrogenic injury.
- When performing Pulvertaft weave, the vertical limb should be as dorsal (posterior) as possible as opposed to ventral (anterior) to reapproximate the normal anatomy.
- Tensioning of the graft should be performed slightly more flexed than neutral to avoid a lag, as the muscle tendon unit can still stretch over time. However, avoid maximum flexion while performing tension to avoid loss of extension.
- Slowly allow extension in the rehabilitation protocol.

Table 2. Advantages and Disadvantages

Advantages
Can lead to improved functional outcomes
Restores the biceps brachii length/tension relationship
Allograft avoids donor site morbidity.
Optimize elbow flexion and supination
Improves cosmesis of previous "Popeye" deformity
Can be performed in acute or chronic setting of failed prior tenodesis
Risks
Potential for injury to the musculocutaneous nerve
Disease transmission with allograft use
Infection
Limitations
Rarely performed surgery
Narrow indications in young active patients
Only short-term follow-up available

young active patients after failed biceps tenodesis with improvement in pain, function, and cosmesis. Tibialis anterior allograft has also been used to reconstruct the distal biceps tendon after tendon rupture.¹²

Revision biceps tenodesis with tibialis anterior allograft tendon augmentation is an effective surgical technique for the rare case of symptomatic failed biceps tenodesis in a young active patient. Most cases of failed biceps tenodesis can be successfully treated non-operatively with acceptable outcomes. However, this technique is ideal for the revision scenario where there is little to no remaining biceps tendon, which is typical of chronically failed open subpectoral or suprapectoral biceps tenodesis in a patient with persistent pain and cramping (Tables 1 and 2).

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