

Complications of Proximal Biceps Tenotomy and Tenodesis



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KEYWORDS

• Biceps tenotomy • Biceps tenodesis • Complication

KEY POINTS

- Tenotomy of the LHBT tendon is a safe and quick procedure but can result in cosmetic deformity and cramping or soreness in the biceps muscle.
- Tenodesis of the LHBT provides a new, distal level of fixation for the tenotomized tendon and results in lower risk of cosmetic deformity or cramping in the biceps muscle.
- Tenodesis of the LHBT has an overall low complication rate but complications can be severe and include neurologic injuries, proximal humerus fracture, reflex sympathetic dystrophy, and infection.

INTRODUCTION

The long head of the biceps tendon (LHBT) has a unique anatomy, but with a less understood functional role in glenohumeral joint stability.¹ The proximal part of the LHBT is relatively fixed at its origin on the supraglenoid tubercle and the superior labrum. After a brief intra-articular course where it is mobile, the tendon makes a sharp turn into the bicipital groove. Within the bicipital groove, the tendon is again relatively anchored. This relative fixation of the proximal part of the LHBT at two sites in the setting of extensive mobility of the glenohumeral joint predisposes the LHBT to high stresses. The LHBT can be affected by inflammation, trauma, impingement, instability (typically associated with subscapularis tears), intrinsic degeneration, and fibrosis in the rotator interval.^{2,3}

The functional significance of the LHBT remains a topic of debate, but the LHBT is a recognized source of anterior shoulder pain.³ Pathologic involvement of the LHBT is

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usually seen in association with rotator cuff tears, shoulder arthritis, shoulder trauma, and labral pathology, which makes it challenging to determine the contribution or role of the LHBT in shoulder pain. The clinical tests for the LHBT pathology are neither sensitive nor specific.⁴

Tenotomy and tenodesis of the LHBT are two surgical treatment options for addressing the LHBT pathology.^{5–10} Tenotomy of the LHBT relieves pain by preventing traction insult to the inflamed, torn, or degenerated biceps tendon. Proponents of the biceps tenotomy believe that it is a simple and safe procedure that consistently relieves pain and allows quicker rehabilitation compared with biceps tenodesis.^{11,12} In contrast, tenodesis eliminates proximal tendon angulation, provides a new fixation anchor for the tenotomized tendon in the proximal humerus, and thus maintains the length-tension relationship of the LHBT musculotendinous unit.^{13,14} However, the tenodesis site has to be protected and requires an initial period of immobilization. Biceps tenotomy and tenodesis are associated with specific limitations and complications, which can affect the clinical outcome and influence patient satisfaction postoperatively.

COMPLICATIONS OF BICEPS TENOTOMY

Multiple studies have reported a high satisfaction rate after biceps tenotomy.^{5,11,12,15,16} Cosmetic deformity of the arm, cramping or soreness in the biceps muscle, and strength deficits in elbow flexion and supination are the three most commonly reported adverse events associated with the biceps tenotomy.^{5,11,12,16} Tenotomizing the LHBT results in variable degrees of distal migration of the biceps tendon, which can result in cosmetic deformity including the “Popeye” sign (**Fig. 1**). The severity of cosmetic deformity after biceps tenotomy varies and patient perception of the deformity is also variable. Elderly patients are less affected by the cosmetic outcome compared with younger patients.^{11,12} Cramping, soreness, or fatigue sensation in the biceps muscle can also occur after biceps tenotomy and is probably related to loss of proximal anchorage of the LHBT. However, not every biceps tenotomy is associated with a Popeye sign or biceps cramping and prevalence of these complications is variable in the reported literature.^{5,11,12,15,16} Biceps tenotomy can result in perception of weakness of elbow strength. Objective strength measurement studies have demonstrated loss of elbow flexion and supination strength in the operative arm compared with the contralateral arm or nonoperative control arms.^{17,18} However, the weakness in elbow strength after biceps tenotomy is more of a concern in the

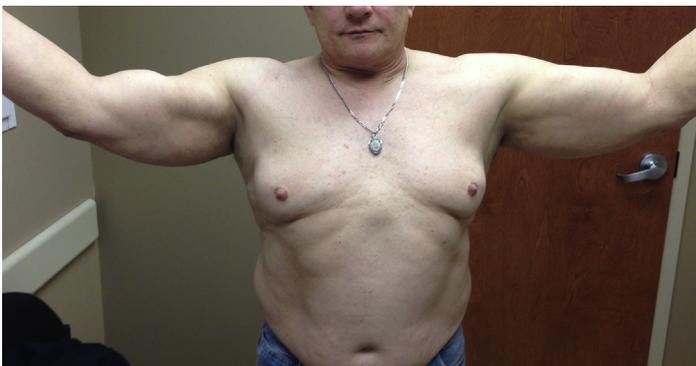


Fig. 1. Posttenotomy Popeye deformity in the arm.

young, active patient, such as a manual laborer, and is often inconsequential in older, sedentary patients.

Gill and colleagues¹⁵ reported a complication rate of approximately 13% in a retrospective cohort analysis of arthroscopic biceps tenotomy in 30 patients. Preoperative diagnosis in the cohort group included biceps tendinitis with or without impingement, partial tear of the LHBT, type IV SLAP lesion, anterior instability, and supraspinatus tear. Four patients had poor results after biceps tenotomy. One patient complained of cosmetic deformity and underwent biceps tenodesis, one patient continued to complain of persistent pain, and two other patients had loss of overhead function secondary to impingement syndrome. Kelly and colleagues¹² reported a Popeye sign in 70% of the patients (N = 40) that underwent arthroscopic biceps tenotomy for isolated LHBT tendinitis or LHBT involvement in the presence of concomitant pathology (rotator cuff tears, degenerative joint disease, impingement, shoulder instability, or adhesive capsulitis). There were clinically significant strength deficits in the operative arm compared with the contralateral arm in young patients but not in those age 60 years or greater. Thirty-two percent of people self-rated their outcome as fair or poor. All the patients with poor results had concomitant procedures performed (rotator cuff repair, joint debridement, and acromioplasty). Fatigue discomfort isolated to the biceps muscle after resisted elbow flexion was present in 37.5% of the patients. Interestingly, patients who were more than 60 years old did not have this complication.

In a retrospective cohort analysis of 117 patients that underwent biceps tenotomy, Duff and Campbell¹¹ reported a satisfaction rate of 95%. Twenty-seven percent of the patients noticed a cosmetic deformity and 19% patients had cramping sensation in the biceps. Thirty-one percent of patients reported weakness in their operative extremity, although there was no significant difference in the objective testing of elbow flexion and supination strength compared with the contralateral arm. In a large cohort of 307 patients that underwent arthroscopic biceps tenotomy as a part of the treatment of irreparable rotator cuff tears, Walch and colleagues¹⁶ reported an 87% satisfaction rate after this procedure. Approximately 50% of the patients noticed a cosmetic deformity. There were no complaints of weakness in elbow flexion or supination. However, no objective strength testing was performed. In a retrospective study of 39 patients that underwent arthroscopic biceps tenotomy for the treatment of irreparable rotator cuff tears, Boileau and colleagues⁵ reported a 72% satisfaction rate with the procedure. A Popeye sign was present in 62% of the shoulders. However, only 16 patients noticed the deformity and no patient was bothered by the cosmetic deformity. Twenty-one percent of the patients reported muscular cramping and 46% reported pain in the bicipital groove.

The previously mentioned retrospective case series and case control studies demonstrate that biceps tenotomy is an effective treatment option in a select patient population and has a low revision rate. The incidence of biceps cramping, loss of elbow flexion and supination strength, and concerns regarding cosmetic deformity are relatively less pronounced in the elderly patient population and seldom require revision surgery. However, cosmetic concerns can be important in young, thinner patients and loss of elbow strength, especially supination strength, may result in poor satisfaction in manual laborers.

COMPLICATIONS OF BICEPS TENODESIS

Biceps tenodesis provides a new fixation point for the tenotomized LHBT and thus maintains the length-tension relationship of the LHBT musculotendinous unit.^{14,19,20} Compared with biceps tenotomy, the advantages of tenodesis include a lower risk

of postoperative cramping or loss of elbow flexion and supination strength and improved cosmetic results. However, biceps tenodesis is a more complex operation that requires a period of postoperative immobilization and lengthier rehabilitation. There are numerous techniques and implants available for the tenodesis of the LHBT. Bone tunnels and key-hole techniques tenodese the tendon to the bone but do not require the use of implants.^{21,22} Similarly, soft tissue tenodesis to the conjoint tendon, pectoralis major, or rotator cuff does not require any special implant for fixation.²³ Alternately, the LHBT can be tenodesed to bone using an interference screw, an endobutton, or a suture anchor.^{24–26} Although considered a safe procedure, biceps tenodesis is associated with complications that are different than biceps tenotomy. The complications from biceps tenodesis are categorized into the following complications common to all types of tenodesis, and complications related to tenodesis technique (open vs arthroscopic; soft tissue vs bony tenodesis) or implant-specific complications.

Complications common to all types of tenodesis

- a. Length-tension mismatch
- b. Loss of fixation and occurrence of deformity
- c. Biceps pain
- d. Shoulder stiffness
- e. Infection
- f. Hematoma
- g. Neurologic injuries
- h. Vascular injuries
- i. Reflex sympathetic dystrophy

Tenodesis technique or implant-specific complications

- a. Proximal groove pain
- b. Proximal humerus fracture
- c. Implant failure
- d. Bioabsorbable screw reaction

There is debate regarding the optimal anatomic location for tenodesis, ideal implant for tenodesis, and open versus arthroscopic techniques for tenodesis.^{6,9,27–30} The LHBT tenodesis can be performed at a suprapectoral or subpectoral location. There is no consensus on the optimal level of tenodesis in the proximal humerus.^{28,29,31,32} Furthermore, there is no high-quality evidence to recommend one surgical technique over the other. The proponents of distal, subpectoral fixation believe that removal of the LHBT and tenosynovium from the bicipital groove allows the surgeon to avoid residual “groove pain,” which is believed to originate from the intertubercular part of the LHBT that may be scarred or inflamed. Retrospective case studies by Lutton and colleagues²⁸ and Sanders and colleagues³² have reported a higher complication rate and residual groove pain with proximal, suprapectoral biceps tenodesis. However, in a recently reported large series of arthroscopic proximal biceps tenodesis (1083 cases), Brady and colleagues¹³ reported a biceps tenodesis–specific complication rate of 0.4%, which included three symptomatic ruptures and one patient with biceps pain. All patients had an arthroscopic proximal biceps tenodesis using an interference screw at the most proximal part of the biceps groove but no patient had proximal biceps groove pain.¹³ Gombera and colleagues³¹ compared 23 patients that underwent arthroscopic suprapectoral tenodesis with 23 patients that underwent open subpectoral biceps tenodesis and found no significant difference in the pain relief or occurrence of Popeye deformity.

Proximal humerus fracture is a rare but recognized complication associated with tenodesis techniques that involve drilling bigger cortical tunnels (key hole, interference screw fixation), which can serve as a stress riser in the proximal humeral shaft.³³⁻³⁶ The fractures present within the first few months after surgery, and are oblique or spiral shaped in pattern. Sears and colleagues³³ reported two cases of proximal humerus shaft fracture in young, healthy subjects within 1 year after subpectoral biceps tenodesis with an interference screw fixation. Both patients required open reduction and internal fixation for management of their fractures. Proximal humerus fracture after open subpectoral biceps tenodesis or key-hole tenodesis has been reported by Dein and colleagues,³⁴ Reiff and colleagues,³⁵ and Friedel and colleagues³⁶ as single patient case reports.

Complications common to all types of biceps tenodesis procedure include loss of fixation, infection, hematoma, neurologic injuries, vascular injuries, and reflex sympathetic dystrophy.^{19,20,37} The incidence of these complications has been reported to be very low (<1%). Although not frequently reported, the authors believe that LHBT length-tension mismatch can result in a poor patient satisfaction after biceps tenodesis. Loss of fixation and biceps pain are the most commonly reported complication after biceps tenodesis. The failure of fixation can occur at the implant-bone interface or the implant-tendon interface.^{37,38} In our experience, the implant-tendon interface failure is more common. Although cadaveric biomechanical studies comparing different fixation methods demonstrate that interference screw fixation offers maximum pullout strength, no clinical studies have compared failure rates with different tenodesis devices.³⁹ It has been suggested that loss of fixation with occurrence of a Popeye deformity occurs more commonly than previously thought, although not all patients are bothered by it.²⁴ Biceps cramping and pain at the tenodesis site can occur but the incidence is low compared with the tenotomy. In a consecutive series of 84 arthroscopic biceps tenodesis using a suture anchor in the bicipital groove, Lee and colleagues²⁴ reported a 25% incidence of MRI-proved distal migration of the LHBT. Interestingly, only 11 patients (12.9%) were diagnosed with the deformity and only two patients noticed the deformity. Mazzocca and colleagues³⁹ studied 41 patients at approximately 1 year after open subpectoral biceps tenodesis. There was one fixation failure caused by rerupture of the tendon (2%). Nho and colleagues³⁷ reported the incidence of complications following open subpectoral biceps tenodesis in a cohort of 353 patients over a 3-year period. The overall complication rate was 2%. Complications included persistent bicipital pain (0.57%), failure of fixation (0.57%), infection (0.28%), musculocutaneous neuropathy (0.28%), and reflex sympathetic dystrophy (0.28%).

Neurovascular complications are rare but are seen more commonly with the open biceps tenodesis techniques.^{37,40} Anatomic cadaveric experiments have studied the relationship and proximity of various neurovascular structures including the musculocutaneous, radial, median, ulnar, and axillary nerves and brachial artery to the biceps tenodesis site.^{41,42} The relationship of neurovascular structures to the bicipital groove gets distorted with arm swelling secondary to arthroscopic fluid leaking in the subacromial and subdeltoid spaces during shoulder arthroscopy. This is especially true when biceps tenodesis is performed in conjunction with rotator cuff repair or labral repair because it is usually the final part of the procedure. The musculocutaneous nerve is the most commonly reported nerve injury in biceps tenodesis, especially with open subpectoral biceps tenodesis. Rhee and colleagues⁴³ reported four cases of brachial plexus injury in association with open subpectoral biceps tenodesis. Nho and colleagues³⁷ reported one case of musculocutaneous neuropathy in their series of 353 patients that underwent open subpectoral biceps tenodesis with an



Fig. 2. Deep infection after open biceps tenodesis.

interference screw. The authors recommend careful use of medial retractors and thorough identification of the LHBT before the retrieving the tendon and performing the tenodesis procedure.

Infection (**Fig. 2**), rupture at the LHBT musculotendinous junction when retrieving the tendon out of the groove, adverse reaction to the implant, and reflex sympathetic dystrophy are rare but reported complications in the literature.

SUMMARY

The LHBT is a recognized cause of anterior shoulder pain. Tenotomy and tenodesis of the LHBT are effective in relieving pain arising from the LHBT. Tenotomy is a quick and safe surgery but is limited by a high rate of postoperative cosmetic deformity, and cramping or soreness in the biceps muscle. Tenodesis of LHBT, however, has a lower risk of cosmetic deformity and cramping in the biceps muscle, but can result in more severe complications, such as neurologic injuries, proximal humerus fracture, reflex sympathetic dystrophy, and infection. Fortunately, these serious complications are uncommon and are minimized by improved understanding of regional anatomy, especially the medial neurovascular bundle, and careful placement of medial retractors in open tenodesis techniques.

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