

# Proximal Biceps Tendon and Rotator Cuff Tears



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## KEYWORDS

- Biceps tenotomy • Biceps tenodesis • Rotator cuff tears

## KEY POINTS

- Long head of the biceps is commonly involved in rotator cuff tears.
- Both tenotomy and tenodesis are effective in relieving pain from biceps tendon disorder in the presence of rotator cuff tears.
- Tenotomy of the proximal biceps is a safe and quick procedure, but can be associated with a clinically significant Popeye sign and cramps in the biceps muscle.
- Tenodesis of the LHBT establishes the length-tension relationship and minimizes the risk of Popeye deformity.

## INTRODUCTION

The functional role of the long head of the biceps tendon (LHBT) in glenohumeral joint stability is poorly understood and remains controversial. From the anatomic perspective, the LHBT is fixed at its origin on the supraglenoid tubercle and the superior labrum.<sup>1</sup> With the shoulder in neutral or internal rotation, the LHBT courses in an oblique direction from its origin toward the intertubercular groove.<sup>2</sup> The tendon is stabilized by the medial sling, which is formed by the coracohumeral and superior glenohumeral ligaments.<sup>3–5</sup> The role of the transverse humeral ligament as a medial restraint is less established.<sup>4</sup> In external rotation and abduction of shoulder, the LHBT is prevented from posterior subluxation by the posterior sling formed by the posterior part of the coracohumeral ligament and the anterior fibers of the supraspinatus tendon.<sup>2,6,7</sup> This unique anatomy of the proximal biceps places it at high risk for abrasive wear and injury. Furthermore, its close proximity to the anterior and superior rotator cuff predisposes the LHBT to injury in the setting of rotator cuff tears.

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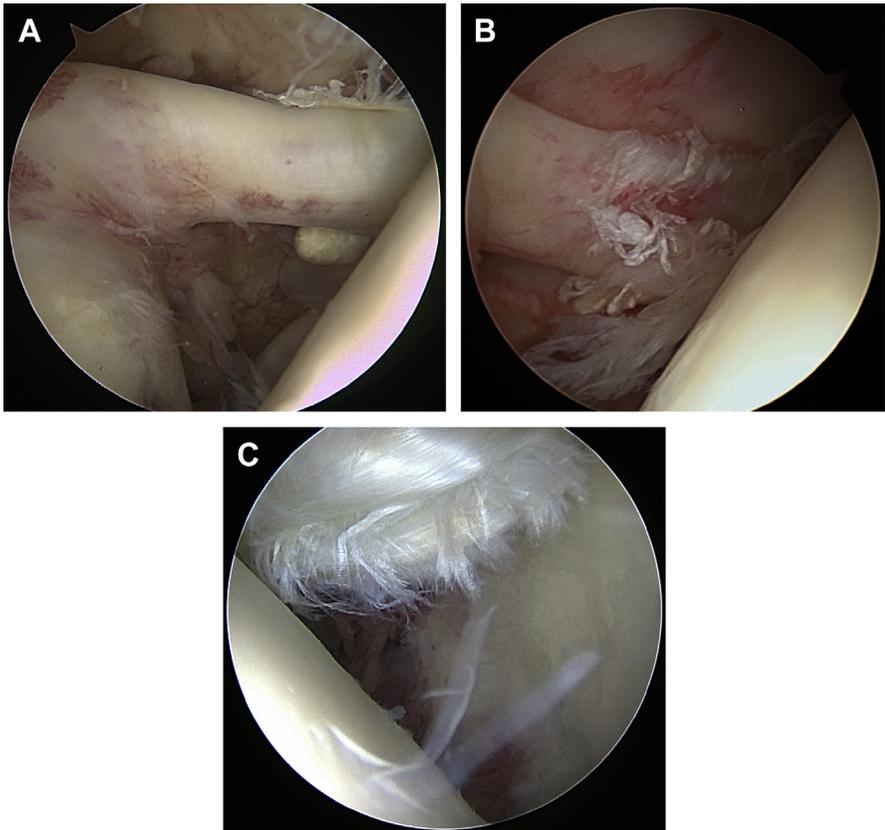
## PROXIMAL BICEPS AND ROTATOR CUFF TEARS

### Disorders

The LHBT lies in close anatomic proximity to the subscapularis and supraspinatus tendons. Rotator cuff tears have a high incidence of concomitant LHBT disorder, and this disorder is directly correlated with the extent of rotator cuff disease.<sup>8,9</sup> Tendon hypertrophy, hourglass contracture, delamination, partial and complete tears, and tendon instability in the bicipital groove are common macroscopic pathologic findings affecting the LHBT in the presence of rotator cuff tears (Fig. 1).<sup>1,9-12</sup> Early on in the rotator cuff degenerative process, LHBT disorder may present as purely microscopic or may show mild thickening of the intra-articular part of the tendon, synovitis, or dynamic subluxation. Some of these findings are more pronounced in the intertubercular part of the LHBT and can easily be missed during arthroscopy if the tendon is not pulled into the joint with a probe to examine the intertubercular part of the tendon.<sup>13,14</sup>

### SPONTANEOUS RUPTURE OF THE LONG HEAD OF THE BICEPS TENDON

Spontaneous complete rupture of the LHBT can occur in the presence of chronic rotator cuff tears.<sup>10</sup> Usually the patient reports hearing a snap during a common activity or during mildly strenuous activity. Patients often report relief of shoulder pain



**Fig. 1.** Arthroscopic images (viewing from the posterior portal) showing synovitis (A), partial tear (B), and delamination (C) of the long head of the biceps concomitant with rotator cuff tear.

following complete ruptures.<sup>15,16</sup> Complete rupture of the LHBT can result in loss of normal arm contour caused by distal migration of the biceps muscle belly, which is popularly described as the Popeye sign. However, not all patients complain of a Popeye deformity or have biceps cramping following complete ruptures of the LHBT. Absence of a Popeye deformity after complete biceps rupture is thought to be caused by scarring of the tendon in the bicipital groove, rotator interval, or by the subscapularis tendon. In older patients, this deformity may be less noticeable because of muscle atrophy.<sup>11</sup>

### **MECHANICAL ENTRAPMENT OF THE DISEASED LONG HEAD OF THE BICEPS TENDON**

In rotator cuff tears, the LHBT can be mechanically entrapped intra-articularly or in the bicipital groove. Boileau and colleagues<sup>11</sup> described the hourglass biceps, which is hypertrophy of the intra-articular portion of the LHBT, which then gets trapped in the joint during elevation of the arm, resulting in pain and restriction of shoulder elevation. The intertubercular portion of the LHBT can be scarred in this location because of synovial adhesions. In our experience performing open subpectoral biceps tenodesis, an LHBT that is scarred in the groove often does not drop after tenotomy, and often requires more force to retrieve during tenodesis. Furthermore, in these cases the retrieved tendon often shows synovial bands and inflammation.<sup>17</sup>

### **INSTABILITY OF THE LONG HEAD OF THE BICEPS TENDON**

Medial instability of the LHBT is caused by failure of the medial sling of the biceps, which is composed of the superior glenohumeral ligament and the coracohumeral ligament.<sup>18</sup> Medial instability of the LHBT is characteristically seen with anterosuperior rotator cuff tears (subscapularis and supraspinatus). Walch and colleagues<sup>18</sup> reported a detailed description of instability of biceps tendon in association with rotator cuff tears. In their retrospective review of 446 shoulders with rotator cuff tears, they found instability in 71 cases. The LHBT was subluxated in 25 shoulders and dislocated in 46 shoulders. Dislocation of the LHBT was seen in association with complete tears of subscapularis in 23 cases, partial tears of subscapularis in 21 cases, and with an intact subscapularis in 2 cases. The tendon subluxation was either in the form of slippage along the superior part of the lesser tuberosity or over the medial rim of the groove. Medial dislocation of the LHBT was present in the form of intra-articular dislocation in 23 cases, dislocation into the substance of subscapularis in 21 cases, and over the intact subscapularis tendon in 2 cases. Note that the LHBT was fairly normal in appearance with minimal damage when the tendon was dislocated intra-articularly but had variable degrees of damage when the tendon was subluxated into the subscapularis. Although posterior dislocation of the LHBT is uncommon and is seen in association with acute posttraumatic posterosuperior rotator cuff tears, Lafosse and colleagues<sup>6</sup> reported a higher incidence of LHBT instability in a prospective series of 200 patients who underwent arthroscopic rotator cuff repair. The LHBT stability was tested statically and dynamically in the anterior-posterior direction during diagnostic shoulder arthroscopic examination. Instability of LHBT was present in 89 of 200 shoulders (45%) with the instability pattern of 37% in the anterior direction, 42% in the posterior direction, and 21% in both the anterior and posterior direction. Anterior instability of the LHBT was in the form of subluxation or dislocation of the tendon, but posterior and combined anterior and posterior instability was always a subluxation event, which was reducible.

## DIAGNOSIS AND IMAGING

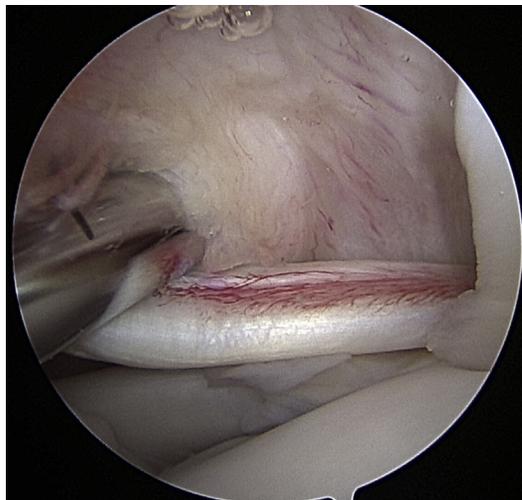
Proximal biceps (LHBT) disorder usually results in anterior shoulder pain with radiation into the arm along the muscle belly in some cases.<sup>19,20</sup> However, there is no discrete pain pattern or distribution that is specific to LHBT disorders. It may be difficult to isolate signs and symptoms specific to proximal biceps tendon disorder in the presence of rotator cuff disorder during physical examination. Although multiple physical examination signs and special tests have been described for the diagnosis of biceps tendon disorder in the setting of rotator cuff tears, there is no single test that is 100% sensitive and specific.<sup>20,21</sup> Tenderness to palpation directly over the upper part of the bicipital groove or in the subpectoral location is a sensitive test but lacks specificity. The Popeye sign is diagnostic of a drooping biceps but not all LHBT ruptures result in this deformity. An anteriorly dislocated LHBT can be palpated and rolled under the finger in thin individuals.

Plain radiographs are not helpful in the diagnosis of LHBT disorder. MRI, computed tomography arthrography, and ultrasonography are widely used but sensitivities are low.<sup>22,23</sup> Arthroscopic evaluation is considered the gold standard for evaluation of the LHBT.<sup>22</sup> It is critical to evaluate the intertubercular portion of the proximal biceps for signs of disorder (synovitis, dynamic instability) during diagnostic arthroscopy (**Fig. 2**).<sup>14</sup>

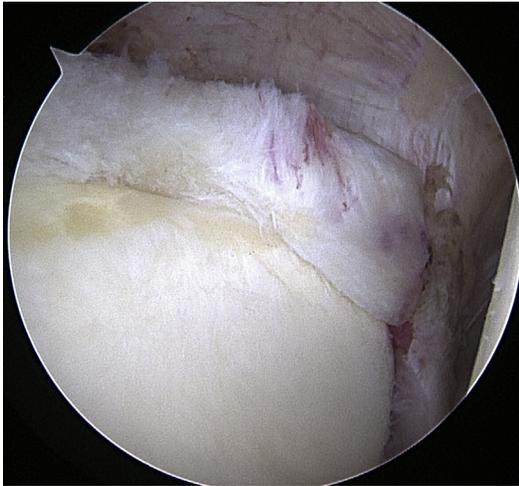
## TREATMENT

Nonsurgical management of proximal biceps tendinopathy has traditionally included activity modification, physical therapy, antiinflammatory medications, and corticosteroid injections into the glenohumeral joint, subacromial space, or into the biceps tendon sheath in the groove.<sup>14,24</sup> Biceps tenotomy and biceps tenodesis are surgical treatment options for addressing LHBT disorder.<sup>24</sup>

Tenotomy of the LHBT relieves pain by preventing traction insult to the inflamed or degenerated biceps tendon (**Fig. 3**). Proponents of biceps tenotomy consider it a simple and safe procedure that consistently relieves pain and allows quicker



**Fig. 2.** Arthroscopic examination of the intertubercular portion of the long head of the biceps showing synovitis (lip stick lesion).



**Fig. 3.** Arthroscopic image (viewing from the posterior portal) of superior labrum after biceps tenotomy.

rehabilitation. Tenotomy of the LHBT can be associated with Popeye deformity and biceps cramping, which can result in poor satisfaction in young patients (**Fig. 4**).<sup>15,16,25,26</sup> Biceps tenodesis provides a new fixation point for the tenotomized tendon in the proximal humerus, and thus maintains the length-tension relationship of the musculotendinous unit. However, the tenodesis has to be protected and requires an initial period of immobilization.<sup>14,27-29</sup> Patients who cannot comply with the initial period of immobilization and slower rehabilitation are more appropriately treated with tenotomy. Many surgical techniques have been described for arthroscopic and open biceps tenodesis and description is beyond the scope of this article. Debate remains regarding the ideal location, ideal implant, and ideal technique for biceps tenodesis.



**Fig. 4.** Popeye deformity after arthroscopic tenotomy.

Failure to address LHBT disorder in the setting of rotator cuff repair can result in persistent shoulder pain and poor patient satisfaction. The role of biceps tenotomy or tenodesis as a treatment of LHBT disorder along with concomitant rotator cuff repair has been extensively studied.<sup>15,16,27,30–34</sup> In a prospective, randomized controlled study, Zhang and colleagues<sup>34</sup> reported no significant differences in the clinical results, outcome scores, cosmetic deformity, biceps cramping, and satisfaction level between arthroscopic biceps tenotomy and tenodesis in patients older than 55 years with reparable rotator cuff tears. In a prospective cohort study comparing biceps tenotomy with tenodesis in the setting of rotator cuff repairs, Koh and colleagues<sup>27</sup> reported a significantly higher rate of Popeye deformity and higher rate of biceps cramping with tenotomy. There were no differences between the two groups with respect to outcome scores (Constant and American Shoulder and Elbow Surgeons scores). De Carli and colleagues<sup>31</sup> reported similar findings in a retrospective study comparing arthroscopic tenotomy (n = 30) with arthroscopic tenodesis (n = 35) in patients with reparable rotator cuff tears and LHBT disorder. The investigators found no significant differences between the two groups with respect to pain relief and functional outcome. A recent meta-analysis by Leroux and colleagues<sup>33</sup> comparing outcomes after biceps tenotomy or tenodesis performed with rotator cuff repair showed significant improvement in postoperative Constant scores. However, the difference in Constant scores between the two groups was lower than the reported minimal clinically important difference. Similarly, biceps deformity was significantly less in the tenodesis group compared with the tenotomy group but most of the patients were not concerned with the cosmetic deformity. There was no significant difference between the two groups with respect to satisfaction rate and rate of biceps cramping.

Tenotomy of the LHBT in massive rotator cuff tears was first proposed by Gilles Walch to relieve pain and improve function (see [Fig. 3](#)). In a retrospective case series, Walch and colleagues<sup>16</sup> reported their long-term results of arthroscopic tenotomy in 307 cases with an average follow-up of 57 months (range, 24–168 months). Arthroscopic tenotomy was offered as a surgical treatment to patients with irreparable rotator cuff tears and to patients who were not willing to participate in the rehabilitation required after rotator cuff repair. There was a significant improvement in postoperative mean Constant scores and 87% of patients were satisfied or very satisfied with the result. The investigators described the biceps tenotomy as a purely palliative procedure, which does not protect against the progressive radiographic changes that occur with long-standing rotator cuff disease. Small retrospective case series have shown favorable results with arthroscopic biceps tenotomy for concomitant LHBT disorder in the presence of rotator cuff tears. In another retrospective case study, Boileau and colleagues<sup>15</sup> compared arthroscopic biceps tenotomy (n = 39) with biceps tenodesis (n = 33) for treatment of persistent shoulder pain and dysfunction caused by irreparable rotator cuff tears with proximal biceps lesion. Postoperatively, there was significant improvement in the mean Constant score and 78% of the patients were satisfied with the procedure. There were no significant differences between the tenotomy and tenodesis groups with satisfaction rate and mean Constant scores. Sixty-two percent of the shoulders in the tenotomy group had a Popeye sign, although none were bothered by it.

The aforementioned studies show that biceps tenotomy and biceps tenodesis are both effective treatment options for addressing LHBT disorder in the setting of rotator cuff tears. Cosmetic deformity, muscle cramps, and strength deficits are three of the most common adverse events associated with biceps tenotomy. The incidence of biceps cramping, and concern regarding cosmetic deformity, are less pronounced in the elderly patient population and these conditions seldom require revision surgery.

However, cosmetic concerns can be important in young, thin patients. Further, loss of elbow strength, especially supination strength, may result in poor satisfaction in manual laborers. Compared with the biceps tenotomy, the advantages of tenodesis include less risk of postoperative cramping and an improved cosmetic result. However, biceps tenodesis is a more complex operation that requires a period of postoperative immobilization and lengthier rehabilitation.

As per the senior author's protocol, we maintain a low threshold to treat the biceps tendon in the setting of a surgically managed rotator cuff tear. Any pathologic abnormalities of the tendon generally lead to concomitant treatment of the biceps, especially in a revision setting or following occupational injuries in an effort to eradicate all potential pain generators. We prefer to perform biceps tenodesis in young and active patients, patients with heavy physical recreational or occupational demands, and thin muscular patients. Biceps tenotomy is reserved for the older patient population with sedentary demands, in situations in which cosmesis is not a concern, and in patients who cannot comply with the initial protective rehabilitation protocol.

## SUMMARY

The LHBT lies in the rotator interval between the subscapularis and supraspinatus tendons and is commonly pathologic in the setting of rotator cuff tears. Failure to address LHBT disorder in reparable rotator cuff tears can result in residual postoperative pain and poor outcomes. There is controversy regarding whether biceps tenotomy or tenodesis is superior for surgical treatment of biceps disorder in the setting of rotator cuff tears. Tenotomy is a simple, quick, and safe procedure, but carries a risk of biceps cramping and deformity. Tenodesis restores the length-tension relationship of the biceps and minimizes the risk of biceps cramping and Popeye deformity. However, comparative retrospective studies do not show any significant improvement in shoulder outcome measures and pain relief with biceps tenodesis compared with tenotomy in the setting of rotator cuff tears.

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