

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

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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.¹ With the shoulder in neutral or internal rotation, the LHBT courses in an oblique direction from its origin toward the intertubercular groove.² The tendon is stabilized by the medial sling, which is formed by the coracohumeral and superior glenohumeral ligaments.³⁻⁵ The role of the transverse humeral ligament as a medial restraint is less established.⁴ 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.^{2,6,7} 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

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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.^{8,9} 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).^{1,9-12} 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.^{13,14}

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.¹⁰ Usually the patient reports hearing a snap during a common activity or during mildly strenuous activity. Patients often report relief of shoulder pain

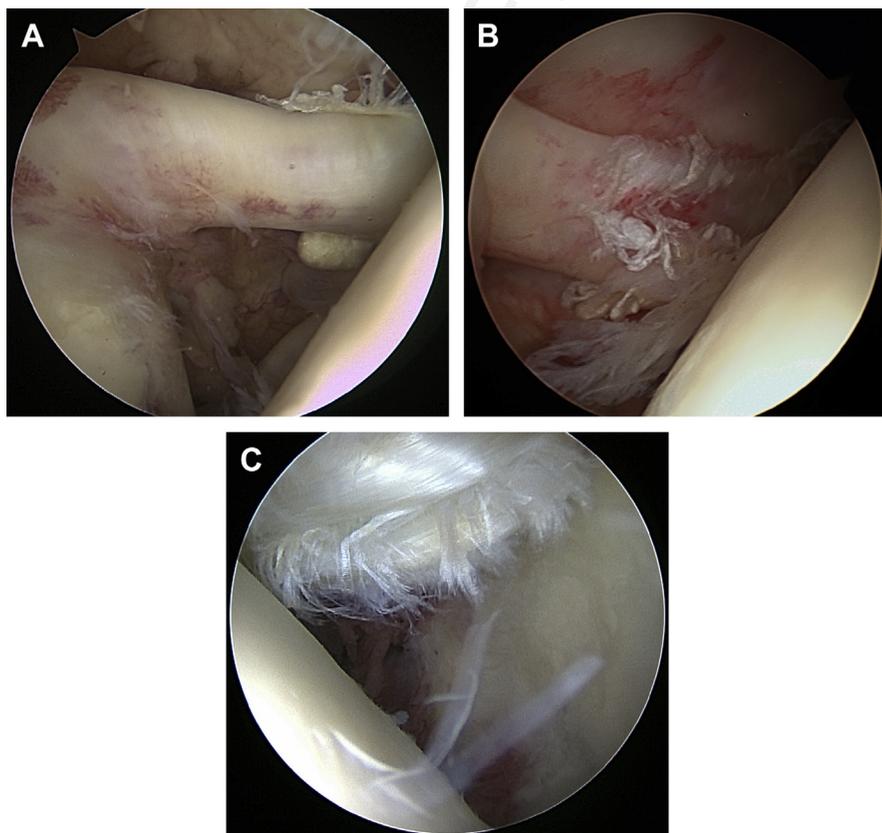


Fig. 1. Arthroscopic images (viewing from the posterior portal) showing synovitis (A), partial tear (B), and delamination (C) of the long head of the biceps concomitant with rotator cuff tear.

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

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

111 In rotator cuff tears, the LHBT can be mechanically entrapped intra-articularly or in the
112 bicipital groove. Boileau and colleagues¹¹ described the hourglass biceps, which is
113 hypertrophy of the intra-articular portion of the LHBT, which then gets trapped in
114 the joint during elevation of the arm, resulting in pain and restriction of shoulder eleva-
115 tion. The intertubercular portion of the LHBT can be scarred in this location because of
116 synovial adhesions. In our experience performing open subpectoral biceps tenodesis,
117 an LHBT that is scarred in the groove often does not drop after tenotomy, and often
118 requires more force to retrieve during tenodesis. Furthermore, in these cases the
119 retrieved tendon often shows synovial bands and inflammation.¹⁷

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

123 Medial instability of the LHBT is caused by failure of the medial sling of the biceps,
124 which is composed of the superior glenohumeral ligament and the coracohumeral
125 ligament.¹⁸ Medial instability of the LHBT is characteristically seen with anterosu-
126 perior rotator cuff tears (subscapularis and supraspinatus). Walch and colleagues¹⁸
127 reported a detailed description of instability of biceps tendon in association with
128 rotator cuff tears. In their retrospective review of 446 shoulders with rotator cuff
129 tears, they found instability in 71 cases. The LHBT was subluxated in 25 shoulders
130 and dislocated in 46 shoulders. Dislocation of the LHBT was seen in association
131 with complete tears of subscapularis in 23 cases, partial tears of subscapularis
132 in 21 cases, and with an intact subscapularis in 2 cases. The tendon subluxation
133 was either in the form of slippage along the superior part of the lesser tuberosity
134 or over the medial rim of the groove. Medial dislocation of the LHBT was present
135 in the form of intra-articular dislocation in 23 cases, dislocation into the substance
136 of subscapularis in 21 cases, and over the intact subscapularis tendon in 2 cases.
137 Note that the LHBT was fairly normal in appearance with minimal damage when the
138 tendon was dislocated intra-articularly but had variable degrees of damage when
139 the tendon was subluxated into the subscapularis. Although posterior dislocation
140 of the LHBT is uncommon and is seen in association with acute posttraumatic
141 posterosuperior rotator cuff tears, Lafosse and colleagues⁶ reported a higher inci-
142 dence of LHBT instability in a prospective series of 200 patients who underwent
143 arthroscopic rotator cuff repair. The LHBT stability was tested statically and
144 dynamically in the anterior-posterior direction during diagnostic shoulder arthro-
145 scopic examination. Instability of LHBT was present in 89 of 200 shoulders (45%)
146 with the instability pattern of 37% in the anterior direction, 42% in the posterior
147 direction, and 21% in both the anterior and posterior direction. Anterior instability
148 of the LHBT was in the form of subluxation or dislocation of the tendon, but poster-
149 ior and combined anterior and posterior instability was always a subluxation event,
150 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.^{19,20} 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.^{20,21} 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.^{22,23} Arthroscopic evaluation is considered the gold standard for evaluation of the LHBT.²² It is critical to evaluate the intertubercular portion of the proximal biceps for signs of disorder (synovitis, dynamic instability) during diagnostic arthroscopy (Fig. 2).¹⁴

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.^{14,24} Biceps tenotomy and biceps tenodesis are surgical treatment options for addressing LHBT disorder.²⁴

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

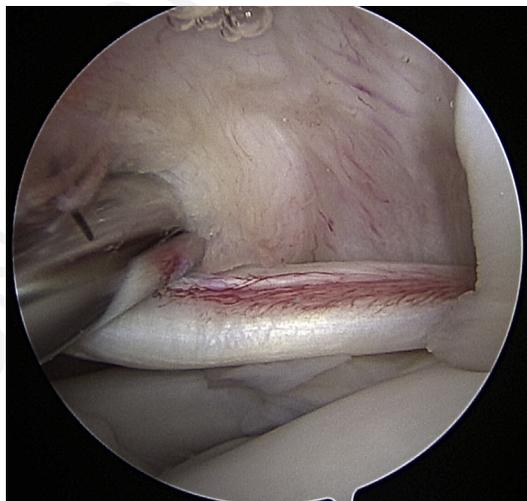


Fig. 2. Arthroscopic examination of the intertubercular portion of the long head of the biceps showing synovitis (lip stick lesion).



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).^{15,16,25,26} 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.^{14,27-29} 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.

253 Failure to address LHBT disorder in the setting of rotator cuff repair can result
254 in persistent shoulder pain and poor patient satisfaction. The role of biceps tenotomy
255 or tenodesis as a treatment of LHBT disorder along with concomitant rotator cuff repair
256 has been extensively studied.^{15,16,27,30-34} In a prospective, randomized controlled
257 study, Zhang and colleagues³⁴ reported no significant differences in the clinical results,
258 outcome scores, cosmetic deformity, biceps cramping, and satisfaction level between
259 arthroscopic biceps tenotomy and tenodesis in patients older than 55 years with repara-
260 ble rotator cuff tears. In a prospective cohort study comparing biceps tenotomy with
261 tenodesis in the setting of rotator cuff repairs, Koh and colleagues²⁷ reported a signifi-
262 cantly higher rate of Popeye deformity and higher rate of biceps cramping with tenot-
263 omy. There were no differences between the two groups with respect to outcome
264 scores (Constant and American Shoulder and Elbow Surgeons scores). De Carli and
265 colleagues³¹ reported similar findings in a retrospective study comparing arthroscopic
266 tenotomy (n = 30) with arthroscopic tenodesis (n = 35) in patients with reparable rota-
267 tor cuff tears and LHBT disorder. The investigators found no significant differences be-
268 tween the two groups with respect to pain relief and functional outcome. A recent
269 meta-analysis by Leroux and colleagues³³ comparing outcomes after biceps tenotomy
270 or tenodesis performed with rotator cuff repair showed significant improvement in
271 postoperative Constant scores. However, the difference in Constant scores between
272 the two groups was lower than the reported minimal clinically important difference.
273 Similarly, biceps deformity was significantly less in the tenodesis group compared
274 with the tenotomy group but most of the patients were not concerned with the cosmetic
275 deformity. There was no significant difference between the two groups with respect to
276 satisfaction rate and rate of biceps cramping.

277 Tenotomy of the LHBT in massive rotator cuff tears was first proposed by Gilles
278 Walch to relieve pain and improve function (see Fig. 3). In a retrospective case series,
279 Walch and colleagues¹⁶ reported their long-term results of arthroscopic tenotomy in
280 307 cases with an average follow-up of 57 months (range, 24–168 months). Arthro-
281 scopic tenotomy was offered as a surgical treatment to patients with irreparable rota-
282 tor cuff tears and to patients who were not willing to participate in the rehabilitation
283 required after rotator cuff repair. There was a significant improvement in postoperative
284 mean Constant scores and 87% of patients were satisfied or very satisfied with the
285 result. The investigators described the biceps tenotomy as a purely palliative proce-
286 dure, which does not protect against the progressive radiographic changes that occur
287 with long-standing rotator cuff disease. Small retrospective case series have shown
288 favorable results with arthroscopic biceps tenotomy for concomitant LHBT disorder
289 in the presence of rotator cuff tears. In another retrospective case study, Boileau
290 and colleagues¹⁵ compared arthroscopic biceps tenotomy (n = 39) with biceps tenod-
291 esis (n = 33) for treatment of persistent shoulder pain and dysfunction caused by irrepa-
292 rable rotator cuff tears with proximal biceps lesion. Postoperatively, there was
293 significant improvement in the mean Constant score and 78% of the patients were
294 satisfied with the procedure. There were no significant differences between the tenot-
295 omy and tenodesis groups with satisfaction rate and mean Constant scores. Sixty-two
296 percent of the shoulders in the tenotomy group had a Popeye sign, although none
297 were bothered by it.

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

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

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

321 SUMMARY

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

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