Tendinopathy of the Long Head of the Biceps
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Abstract
Tendinopathy of the long head of the biceps is a common cause of anterior shoulder pain. As such, the anatomy and function of the tendon as well as its pathophysiology and different treatment methods have been studied extensively. The pathophysiology is a spectrum beginning with inflammation and leading to tendon degeneration. Different clinical tests and imaging modalities may all be employed to help aid in diagnosis. Conservative management is the first-line treatment, but surgical intervention may be warranted. In general, tenotomy or tenodesis is performed depending, among other things, on the age and activity level of the patient. There are several different methods for tenodesis, each with certain advantages and disadvantages. Patient factors must be considered when choosing the optimal treatment.

Biceps tendinopathy is a common cause of anterior shoulder pain. As such, its pathophysiology and treatment options have been studied extensively. Despite this research, much controversy still remains about the tendon’s function in the shoulder and the best methods of treating associated pathology. This chapter will provide a brief review of the function of the long head of the biceps tendon (LHBT), as well as the pathophysiology, evaluation, and management of LHBT disorders.

Anatomy/Function

The origin of the LHBT is the supraglenoid tubercle of the scapula and the superior glenoid labrum [1]. It receives its blood supply from branches of the anterior humeral circumflex artery [1]. Both sensory and sympathetic nerve fibers have been identified in the LHBT with the highest concentration found proximally [2]. It is roughly 9 cm long and 5 cm in diameter with the proximal portion being flatter and larger [1]. It has both intra- and extra-articular components. The intra-articular portion is found...
Tendinopathy of the Long Head of the Biceps in the rotator interval [3] and is considered extrasynovial because it is contained within an invaginated envelope of synovial membrane [4]. It becomes extra-articular once in the bicipital groove.

The bicipital groove exists between the greater and lesser tuberosities of the proximal humerus. It is teardrop shaped with its apex directed medially [5]. Secondary to the orientation of the humeral head, the LHBT makes a 30–40° turn and resides on the medial wall of the groove against the lesser tuberosity [1, 6], which makes it susceptible to irritation at this site from repetitive or overuse. It is contained within this groove by a tendoligamentous sling that consists of the subscapularis tendon, the supraspinatus tendon, the coracohumeral ligament, and the superior glenohumeral ligament [7] (fig. 1). Although the existence of a transverse humeral ligament was once thought to stabilize LHBT in its groove, recent anatomical dissection has shown that no such discrete structure exists [5]. Furthermore, the fibers of the subscapularis have been demonstrated to continue over the roof and floor of the groove [5].

The biomechanical function of the LHBT at the shoulder remains a controversial subject. It has been considered a vestigial structure [8], a humeral head depressor during abduction [9], an anterior stabilizer [10], and as a flexor and abductor of the shoulder [11]. Its primary role, however, is as a flexor and supinator of the elbow [1].

**Pathophysiology**

Inflammatory conditions of the LHBT lead to a continuum of progressive degeneration. Tenosynovitis/tendinitis evolving into tendinosis, delamination, pre-rupture, and finally rupture is the usual progression of events [1]. Tenosynovitis/tendinitis may cause the LHBT to initially appear hemorrhagic and if it persists, tendinosis (tendon degeneration) occurs [7]. Histologically, tendinosis is characterized by cellular infiltration, edema, fibrosis [4, 7]. Ruptured tendons have been shown to have one or more of the following: hypoxic degeneration, mucoid degeneration,
tendolipomatosis, calcifying tendinopathy, and disordered arrangement of collagen fibers [12, 41].

Tendinitis of the LHBT can be divided into primary and secondary causes. Primary tendinitis is the existence of isolated tendinitis in the bicipital groove without associated shoulder pathology [4]. It is most commonly observed in young athletes and is the result of mechanical stresses on the tendon [1, 7]. Participants in sports involving repetitive overhead activities, such as throwing athletes, swimmers and volleyball players are particularly susceptible [1, 6, 7]. Secondary tendinitis occurs with associated shoulder pathology (i.e. impingement syndrome, rotator cuff disease) and is more common than primary tendinitis [4, 13]. The biceps tendon sheath is an extension of the synovial lining of the shoulder and thus is affected by inflammation of the rotator cuff [6, 7].

Mechanical causes of LHBT problems include entrapment, instability and spontaneous rupture [1]. Entrapment occurs when the intra-articular component of the LHBT becomes hypertrophied and is unable to slide into the bicipital groove. This condition is referred to as an ‘hourglass biceps’ [1]. Instability can manifest as either subluxation or dislocation. Partial- or full-thickness tears of the subscapularis tendon are commonly associated with LHBT subluxation and almost always associated with dislocation [7, 14]. Furthermore, rotator cuff tears may cause biceps sling incompetence which can lead to subluxation/dislocation [1]. Traumatic rupture of a normal LHBT is rare, and rupture is usually the result of chronic tendinopathy [1, 15]. Rupture usually occurs with an associated rotator cuff tear [13].

Symptoms

Symptoms of LHBT pathology are variable which can make its diagnosis elusive. The insidious onset of anterior shoulder pain localized to the bicipital groove is the most common symptom [1, 6, 7, 16]. This pain may occur at night, and may radiate into the biceps muscle and down to the radial aspect of the hand [1]. It is exacerbated by repetitive overhead activities [6]. An unstable tendon may present with a clunk during shoulder rotation, particularly with abduction [1, 6]. Rupture of the LHBT is usually noticed as an audible pop with immediate resolution of previous anterior shoulder pain [6].

Physical Examination Findings

One of the most common and reproducible findings in patients with LHBT pathology is point tenderness upon palpation of the tendon in the bicipital groove [4, 7]. The groove is directly anterior, and can be palpated easily, when the arm is internally rotated 10° [1, 6]. Two commonly used provocative tests to evaluate for LHBT
pathology are Speed’s test and Yergason’s test. Speed’s test is positive with reproduction of bicipital groove pain with resisted forward flexion of the shoulder with the elbow fully extended, and the forearm fully supinated. A positive Yergason’s test is when pain is reproduced with resisted supination of the forearm with elbow flexed at 90°. In a study by Holtby and Razmjou [17], both tests have been shown to have a low sensitivity but high specificity for detecting LHBT pathology and superior labrum anterior/posterior (SLAP) lesions. Yergason’s test was found to have a sensitivity and specificity of 43 and 79% respectively. Speed’s test was found to have a sensitivity and specificity of 32 and 75% respectively. Their usefulness in detecting one versus the other, however, has not been shown. An ‘hourglass biceps’ may limit the terminal 10–20° of arm elevation as it becomes entrapped in the bicipital groove [1]. A Popeye sign may be observed in cases of LHBT rupture. This presents as an abnormal contour of the muscle as it retracts distally.

Injections may be utilized to help differentiate LHBT pathology from other causes of shoulder pain. If the underlying cause is impingement, a subacromial injection may relieve pain [7]. Injection directly into the bicipital groove may also be done but can be difficult to perform. Ultrasound guidance may be used to improve accuracy [1].

**Imaging**

Plain radiographs may be useful in evaluating LHBT pathology. Calcifications or osteophytes may be seen within the bicipital groove [1] (fig. 2). The Fisk view is a described technique to visualize groove anatomy [18]. Tendinosis or a subscapularis tear may present as cystic change in the lesser tuberosity [1]. Impingement syndrome may be detected by visualization of a subacromial spur on an outlet view [6].

Ultrasound is a dynamic study that may be used to diagnose biceps rupture, subluxation or dislocation. Its usefulness, however, in detecting inflammation is unknown [7]. Furthermore, its accuracy is very operator-dependent.
Magnetic resonance imaging (MRI) is commonly used to visualize the LHBT. It also provides valuable information with respect to the surrounding structures and rotator cuff. It may be performed with or without arthrography. Increased fluid around the tendon is a sign of tendinopathy (fig. 3) and may be falsely positive with an arthrogram. Diameter change of the tendon is one of the primary criteria for diagnosing degeneration of the LHBT [19]. Signal change within the tendon is also an indication of degeneration and is best visualized on proton density-weighted fat-saturated sequences [19]. Poor correlation has been found, however, between MRI and arthroscopic findings [20].

Arthroscopic evaluation provides the definitive diagnosis of LHBT pathology [1]. The tendon should be brought into the joint so that the portion that lies in the bicipital groove may be visualized (fig. 4). An active compression test may be performed.
under arthroscopic visualization as described by Verma et al. [21]. The arm is forward flexed to 90° with the elbow extended, adducted 10–15°, and internally rotated. The LHBT may be observed displacing inferior and medially and may become entrapped in the joint. Correlation with clinical findings should then be used to determine treatment.

Non-Operative Management

Conservative management is usually the first-line treatment of LHBT pathology and is usually successful [6]. Activity modification and NSAID therapy are the initial interventions. Avoidance of biceps and repetitive overhead activities is helpful. Physical therapy may be utilized for implementation of modalities and iontophoresis to target inflammation. Injections, while previously mentioned for aid in diagnosis, may also prove useful for treatment. Subacromial and glenohumeral corticosteroid injections may alleviate biceps pain by addressing commonly associated shoulder inflammation [7]. The tendon sheath may also be injected within the bicipital groove. One should take care, however, not to inject the tendon itself as this may predispose to rupture [22].

Operative Management

Surgical management of LHBT pathology has been shown to be beneficial in certain scenarios and generally involves either tenotomy or tenodesis. One indication for surgery is for chronic refractory tendinitis manifested as persistent pain and with intraoperative findings of severe inflammation or hypertrophy [23, 24] (fig. 5). As previously mentioned, the biceps tendon should be pulled into the joint during arthroscopy to evaluate the part that lies in the intertubercular groove as this a common site of pathology [7]. Another indication for operative intervention is LHBT instability with or without a subscapularis tear [25] (fig. 6, 7). Arthroscopic findings of a partial tear of 25–50% are criteria that may also be used as guidelines for surgically treating the LHBT [25, 26] (fig. 8). Performing a tenotomy or tenodesis of the LHBT in the setting of an elderly person with a massive irreparable rotator cuff tear and LHBT lesion has been shown to alleviate pain and improve range of motion [27]. Symptomatic SLAP tears in patients over 50 years of age are also an indication for LHBT surgery [7, 42].

Tenotomy of the LHBT involves cutting the tendon at its proximal insertion at the superior labrum and letting the tendon retract through the groove. The patient may be placed in the lateral decubitus or beach-chair position. A standard posterior viewing portal is established and the camera is placed in the glenohumeral joint. An anterior portal is then established through the rotator interval and an arthroscopic
basket forceps is used to cut the tendon as close as possible to the labrum (fig. 9). If, secondary to hypertrophy, the tendon does not retract, it should be debrided until it does so as this may remain a source of pain [7, 24]. This procedure has been effective in relieving pain, but patients can develop a Popeye deformity and fatigue discomfort during resisted elbow flexion [28]. A Popeye deformity occurs more frequently in
this procedure and may not be desirable in thin patients who are concerned about cosmesis [29]. Furthermore, young, heavy laborers may be affected by the muscle fatigue and cramping [28]. An advantage of a tenotomy is that there are no postoperative restrictions on activity afterward and patients quickly return to baseline activity level [29].

Tenodesis of the LHBT is preferred in young patients, laborers, and patients concerned about developing a cosmetic deformity [7]. Controversy still remains as to whether or not it is the preferred technique in athletes who present with recurrent biceps or labral pathology. There has been a wide variety of techniques for performing a tenodesis described. These techniques involve fixation either proximal to or distal to the bicipital groove. Proximal techniques are usually performed arthroscopically (table 1). The LHBT can be tenodesed into bone or soft tissue. One such soft tissue procedure is the percutaneous intra-articular transtendon (PITT) technique [30] (fig. 10). This technique has been shown to have similar fixation strength when compared with suture anchors [31]. It is a relatively easy procedure to perform and there is little associated cost since no hardware is used. Another soft tissue procedure with similar characteristics involves incorporating the LHBT into a rotator cuff repair.
With any proximal fixation procedure, there is the potential for continued pain if there is pathology in the bicipital groove. Distal procedures eliminate this potential. An open subpectoral tenodesis can be performed with rare postoperative complications [32]. With the patient in the beach-chair position, a routine arthroscopy and LHBT tenotomy as previously described is performed. A 4-cm incision is then made in the axilla over the site of the musculotendinous junction of the LHBT (fig. 11). The subcutaneous tissues are dissected bluntly and the insertion of the pectoralis major tendon is palpated. Blunt dissection is again used to palpate the LHBT on the humerus by going underneath the inferior edge of the pectoralis major tendon. The surgeon’s finger is then used to pull the tendon into the wound (fig. 12). Starting 1 cm proximal to the musculotendinous junction, the tendon is whip-stitched with a #2 non-absorbable suture. The excess tendon is then cut (fig. 13). A blunt and sharp Homan retractor is then placed around the medial and lateral aspects of the humerus respectively and the periosteum is elevated exposing the bicipital groove (fig. 14). A Steinman pin is then drilled unicortically into the center of the groove. Next, a 5-mm acorn drill is passed over the Steinman pin and a unicortical hole is drilled. The Steinman pin is removed and a 2.5-mm drill is

**Table 1. Proximal fixation**

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<td>PITT Roman bridge</td>
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<td>conjoint tendon [38]</td>
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Fig. 11. Photograph of incision site for open subpectoral tenodesis.

Fig. 12. Photograph of LHBT pulled through wound. Note transition zone (arrow) of extra-articular inflamed tendon and intra-articular normal tendon.
used to drill two holes inferior to the 5-mm hole just medial and lateral to it aiming at the 5-mm hole (fig. 15). A suture-pass is then inserted into one of the inferior drill holes and retrieved out of the 5-mm drill hole. One limb of the previously whip-stitched tendon is then placed in the suture-pass and passed through the 5-mm hole and out one of the drill holes. These steps are repeated for the other suture limb. The tendon is then docked into the 5-mm hole and the suture limbs are tied over a bone bridge (fig. 16). This mode of fixation is known as the bone tunnel technique. Tendon fixation with an interference screw or the bone tunnel technique has been
shown to be the strongest and second strongest modes of fixation respectively with no statistically significant difference between the two [33]. The bone tunnel technique, however, has the advantage of being cost-saving since no hardware is used.

**Postoperative Rehabilitation**

Rehabilitation after tenotomy can generally be aggressive. There is no immobilization, and return to activities is limited only by their symptoms [34, 35]. Heavy lifting however should be delayed in order to try and avoid a Popeye deformity [36].

Tendon-to-bone healing after a tenodesis may take up to 12 weeks with the greatest gains in strength occurring over the first 4 weeks [36, 37]. A sling is used for 4 weeks postoperatively. Pendulum exercises of the shoulder as well as passive range of
motion of the elbow are allowed. Wrist and hand strengthening may be initiated early. Resisted range of motion may begin at 6 weeks postoperatively as may active elbow flexion and forearm supination [7]. Athletes may begin throwing at 3 months, can pitch at 4.5 months and can return to contact sports at 6 months out.

Conclusion

Tendinopathy is a spectrum of diseases and is a common cause of anterior shoulder pain. Different clinical tests and imaging modalities should be employed to help aid in diagnosis. Conservative management is the first-line treatment, but surgical intervention may be warranted. In general, tenotomy or tenodesis is performed depending, among other things, on the age and activity level of the patient. There are several different methods for tenodesis, each with certain advantages and disadvantages. Patient factors must be considered when choosing the optimal treatment.

References


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