

Biceps Tendon Disorders in Athletes

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Abstract

It has been proposed that the long head of the biceps functions as a humeral head depressor and stabilizer. In addition, in many overhead sports, the biceps helps to accelerate and decelerate the arm. With improper training or fatigue, inordinate stresses can be placed on the biceps as it attempts to compensate for other muscles. This can lead to attrition and failure, either within the tendon substance or at its origin. Bicipital problems in athletes usually occur in conjunction with other types of shoulder disorders, such as rotator cuff impingement and glenohumeral instability, making determination of the role and degree of biceps involvement difficult. Conditions affecting the biceps tendon in athletes can be generally classified as degeneration, instability, and disorders of the origin. Because of the close association of biceps lesions with other abnormalities, a thorough evaluation of the shoulder with a suspected biceps disorder is essential. Treatment of bicipital problems in athletes must often be accompanied by treatment of associated shoulder conditions.

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Many athletes involved in overhead activities place extreme stress and biomechanical demand on their shoulders, exposing their biceps tendons to pathologic changes and the possibility of rupture. Because of the close association of biceps lesions with other shoulder problems, diagnosis of the underlying cause of pathologic changes in the biceps can be challenging.

Although the anatomy of the biceps and the pathologic processes that can affect it have been well documented,¹⁻⁸ the function of this structure and the proper treatment of the diseased tendon remain incompletely understood. However, there has been a recent resurgence of interest in the biceps tendon as it relates to anterior-to-posterior superior labrum (SLAP) lesions, subscapularis lesions, and "hidden" lesions of the

rotator interval, which affect the coracohumeral ligament, the superior glenohumeral ligament, and the superior portion of the subscapularis tendon.⁹

Anatomy

The biceps muscle has two separate heads. The short head and the coracobrachialis originate from the coracoid process and combine to form the conjoined tendon. The long head originates within the glenohumeral joint and, after coursing through the bicipital groove between the greater and lesser tuberosities, joins with the short head at the level of the deltoid insertion to form the muscle proper.

The origin of the long head of the biceps has recently been stud-

ied.^{1,2,10} In one study, Habermeyer et al¹ found that the tendon originated from the posterior labrum in 48% of cases and from the supraglenoid tubercle in 20%. Twenty-eight percent of the shoulders had an origin from both sites.¹ In an anatomic study of 105 cadavers, Vangsness et al² found that approximately 50% of the tendon originated from the superior glenoid labrum, with the remaining tendon fibers attached to the supraglenoid tubercle. Cooper et al¹⁰ recommended caution in assessing the superior labrum at the biceps origin, suggesting that some looseness and mobility of the labrum in this region may be normal, and that debridement may not be indicated as treatment for a presumed SLAP lesion.

Within the glenohumeral joint, the tendon is intra-articular but extrasynovial, ensheathed by a continuation of the synovial lining of the articular capsule. The synovium is reflected on itself, forming a pouch

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that extends to the inferiormost extent of the bicipital groove.³ This sheath may fill with contrast material and be visualized on arthrography, but it prevents extravasation of contrast material to surrounding tissues.

As the tendon leaves the glenohumeral joint, it passes deep to the coracohumeral ligament and through the rotator interval, entering the bicipital groove (Fig. 1). Here the tendon travels beneath the transverse humeral ligament, which spans the area between the greater and lesser tuberosities, and the falxiform process, which is the aponeurotic expansion of the pectoralis major. The groove itself has an average depth of just over 4 mm and an average medial wall angle of 56 degrees.⁴ Anatomic variation in groove dimensions has been implicated as a cause of tendon instability by several authors,^{1,5} although Cone et al⁴ found no correlation between medial wall angle and incidence of subluxation.

Function of the Biceps Tendon

The function of the biceps tendon as it relates to shoulder biomechanics is not entirely understood. It has been postulated to act as both a humeral head depressor and a stabilizer of the glenohumeral joint. The relative motion between the biceps and the humeral head in elevation of the shoulder is best visualized as rotation of the humeral head in relation to a seemingly static biceps tendon.^{5,7,8} Superior migration of the head with loss of this static structure has been noted by several authors. Kumar et al¹¹ found upward migration of the humeral head in 15 cadavers in which the long head had been released intra-articularly. Dynamic depression of the humeral head was demonstrated by Warner and

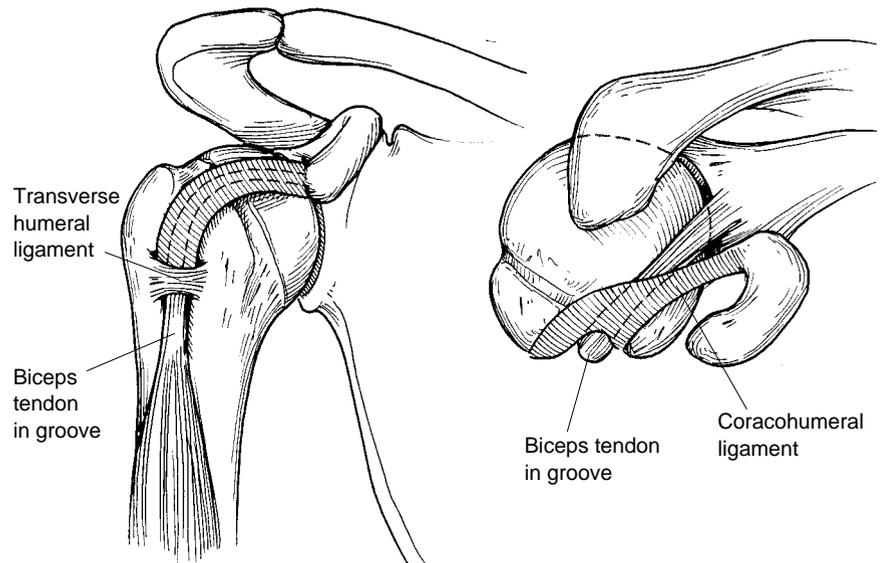


Fig. 1 As the long head of the biceps tendon exits the glenohumeral joint, it proceeds through the rotator interval beneath the coracohumeral ligament. This structure helps to provide stability to the tendon through its thick attachments on either side of the bicipital groove.

McMahon,¹² who showed superior migration of the humeral head relative to the contralateral (control) shoulder in seven patients with isolated loss of the proximal attachment of the long head of the biceps. However, it has been demonstrated that no significant superior migration of the humeral head occurs at all with arthroscopic release of the biceps tendon in the presence of irreparable massive rotator cuff tears.

In addition, both the long head and the short head of the biceps contribute to anterior stability of the shoulder, with greater input occurring as the degree of instability increases.¹³ Pagnani et al¹⁴ applied forces to the biceps tendon in 10 cadavers and found significantly less translation of the humeral head in the superior, anterior, and inferior directions when these forces were applied. Rodosky et al¹⁵ have suggested that contraction of the biceps with the shoulder in the abducted, externally rotated position produces an increase in torsion-

al rigidity of the anterior capsule and may diminish the force transmitted to the inferior glenohumeral ligament. Detachment of the biceps anchor at the superior labrum has been associated with increased strain on the inferior glenohumeral ligament¹⁵ and allows significantly increased anterior and inferior translation of the glenohumeral joint.¹⁶ Electromyographic evaluation of athletes with a diagnosis of glenohumeral instability revealed increased biceps activity (compared with normal subjects) during arm acceleration.¹⁷ This may represent a compensatory mechanism for stabilization of the humeral head. The biceps-labrum complex, therefore, has some role in stability with the shoulder in the vulnerable position of abduction and external rotation.

The athlete's shoulder is often under greatest stress during overhead activities. Understanding the muscle activation patterns of the biceps during the overhand pitch allows a better appreciation of biceps disorders and biceps func-

tion in shoulders with pathologic changes. Electromyographic analysis of the biceps during throwing has shown that in the normal shoulder the biceps functions predominantly as an elbow flexor during pitching, with the activity paralleling that of the brachialis.^{17,18} Moderate biceps activity occurs in the cocking phase, accompanied by elbow flexion. Decreased activity is seen during the acceleration phase, when the elbow is static. Peak activity of the biceps is noted during follow-through, when controlled deceleration of the arm is required to avoid a hyperextension snap at the elbow. Andrews et al¹⁹ have suggested that this peak level of activity with deceleration is a cause of SLAP lesions.¹⁹

In a study comparing amateur and professional throwing athletes, the amateurs required considerably more biceps activity to accelerate the arm than the professionals, who were able to selectively recruit the subscapularis for this purpose.¹⁸ In addition, the amateur athletes required greater activity of the biceps to decelerate the arm during follow-through. Perhaps those individuals with the greatest skill or control in the throwing motion are able to lessen the demands placed on the tendon.

Pathology and Pathogenesis

Biceps Tendon Degeneration

Deterioration of the biceps tendon has commonly been referred to as tendinitis. However, the disorder lacks a true inflammatory component; consequently, the term "tendinosis" or "tendon degeneration" is more appropriate. The microscopic changes include atrophy of collagen fibers, irregular collagen fiber patterns with fissuring of the tendon, fibrinoid necrosis, and fibrocyte proliferation.²⁰ Eventually, the ten-

don may rupture, with retraction of the distal portion through the bicipital groove.

Because of the intimate association of the biceps tendon with the rotator cuff, the principal cause of biceps degeneration is thought to be mechanical irritation of the tendon against the coracoacromial arch. Neer²¹ noted that biceps tendon ruptures rarely occur without a concomitant tear of the supraspinatus tendon, and postulated that biceps degeneration virtually always results from subacromial impingement.

The degree of impingement in athletes is determined on the basis of multiple factors.⁶ Morrison and Bigliani²² reported the association of rotator cuff disorders with a type III (hooked) acromion; theoretically, bicipital disorders would also accompany this type of acromion morphology. The specific mechanics of overhead sport motion are important, with certain passive motions of the shoulder accompanied by an obligate translational motion of the glenohumeral joint. With shoulder flexion and horizontal adduction, there is anterior and superior translation of the joint.²³ The baseball pitcher achieves greater external rotation and less abduction as his arm accelerates from the cocked position than the quarterback does when throwing a pass—a possible explanation for the higher risk of impingement in pitchers.²⁴

In the deceleration phase, the arm continues to remain flexed and reaches a horizontally adducted, internally rotated position, producing a superior translation force on the glenohumeral joint, thus risking impingement of the greater tuberosity, rotator cuff, or biceps tendon under the acromion and coracoacromial arch. The arm must generate an inferiorly directed force of 310 ± 80 N to maintain the centered position of the glenohumeral joint.²⁵ A tight posterior capsule

potentiates this impingement by causing greater anterior and superior migration of the humeral head.²³ Harryman et al²³ found the excessive translation created by surgical tightening of the posterior capsule to be obligate, in that the translation could not be decreased with application of a counterforce.

The strength of the periscapular musculature, in particular the serratus anterior, is also relevant. If these muscles are weak and fatigue readily, impingement worsens as the acromion becomes unable to rotate out of the path of the forward-elevating humeral head.¹⁷

The association of glenohumeral instability and impingement in athletes was first elucidated by Jobe et al.²⁶ They described an instability-impingement complex in which the forces generated by repetitive overhead activity may eventually exceed the ability of the anterior static restraints of the shoulder to compensate. Eventually, progressive attenuation of these restraints can cause a traction injury to the rotator cuff and biceps tendon, producing muscular weakness and fatigue. When this occurs, subtle increased anterior and superior migration of the humeral head can occur when the arm is placed in provocative positions, causing secondary impingement of the rotator cuff²⁷ and possibly the biceps tendon against the coracoacromial arch. In the models studied, it is assumed that the supraspinatus and biceps tendons are subject to similar stresses and are therefore predisposed to a similar pathologic mechanism.

The role of other factors in the development of biceps degeneration (Fig. 2), particularly primary fiber failure and hypovascularity, remains unclear. Although there are insufficient data about the incidence and pathogenesis of primary bicipital tendinopathy (i.e., that which is not caused by mechanical

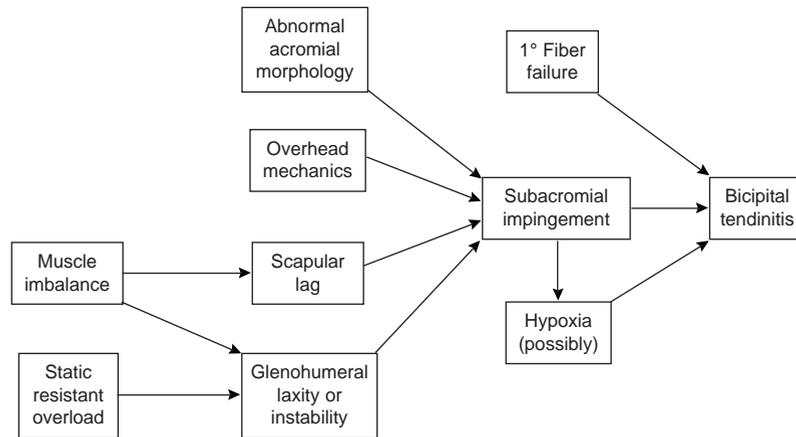


Fig. 2 Factors leading to the development of biceps tendinitis in athletes.

impingement) in athletes, it seems intuitive that primary failure from repeatedly exceeding the tensile capability of the biceps tendon during athletic activities contributes to its degeneration. Proponents of the theory of primary tendinopathy point to the occurrence of degeneration of the tendon within its groove, while the more proximal tendon in the subacromial space remains pristine.⁶ The bicipital groove in these cases often narrows, owing to the development of osteophytic spurs along its margins. Some patients have degeneration of the tendon in the joint with continued pain after subacromial decompression; the pain is relieved with subsequent surgical tenotomy or tenodesis of the biceps tendon, perhaps providing further evidence of primary tendinopathy.

Hypoxia related to diminished blood flow has been implicated as a factor in the development of rotator cuff failure.²⁸ A similar role in the development of bicipital tendinopathy seems plausible. Kannus and Józsa²⁹ evaluated 268 failures of the long head of the biceps among 891 tendon ruptures and found hypoxic degenerative tendinopathy in many cases. However, they did not report whether the hypoxia was primary or

due to mechanical impingement. Rathbun and Macnab³⁰ documented diminished blood flow within the rotator cuff and biceps tendon with the arm held in adduction. When the arm was abducted, blood flow was noted to improve. No study has yet evaluated the variation in blood flow to the rotator cuff and biceps tendon during overhead activities.

When bicipital degeneration persists, rupture of the tendon may result. The functional effects of this condition have been studied by Mariani et al.³¹ In a comparison of surgical and nonsurgical treatment of tendon ruptures, conservatively treated shoulders demonstrated no differences in residual arm pain or shoulder range of motion. Athletic performance was not evaluated in that study, but the authors did find 21% less supination strength and 8% loss of elbow flexion strength in the group treated nonoperatively.

We have had experience in treating biceps tendon degeneration in high-demand overhead athletes. We have found that they generally perform much better and with less pain after removal of the diseased tendon from the shoulder, either surgically or as a result of spontaneous rupture.

Origin Disorders

In addition to changes caused within the substance of the tendon, there is evidence that a significant proportion of the stress generated during athletic activities is transmitted to the biceps origin. For example, Andrews et al¹⁹ believe that eccentric overload caused by sudden deceleration of elbow extension by the biceps during follow-through leads to tearing of the superior glenoid labrum complex.

Snyder et al³² introduced the term "SLAP lesion" to characterize injuries to the superior labrum at the biceps origin and classified the various patterns of injury into four types. Type I lesions involve degenerative fraying of the labrum but leave the biceps attachment intact. Type II injuries are those in which the biceps anchor has pulled away from the glenoid attachment. Type III lesions involve a bucket-handle tear of the labrum with an intact biceps anchor. Type IV lesions are similar to type III lesions with the exception that the tear extends into the biceps tendon. In the authors' experience, these injuries are caused by compression of the superior glenoid rim, which may occur during a fall with the outstretched arm abducted and flexed slightly forward. This shearing mechanism can occur by direct violence or from repetitive overuse with overhead activities. Snyder et al found several SLAP injuries caused by repeated pull on the biceps anchor during overhead sports. The exact relationship between shoulder instability and SLAP lesions is debated, although cases in which the SLAP lesion was attributed to instability have been reported.³³ In addition, patients with anterior instability frequently have concomitant Bankart and SLAP lesions.

Destabilization of the biceps anchor produced increases in anteroposterior and superoinferior translation of the humeral head in

an experimental model.¹⁶ Other authors have found that detachment of the biceps anchor decreases the resistance of the shoulder to torsion and leads to increased strain on the inferior glenohumeral ligament.¹⁵ In this manner, a deleterious feedback loop can be initiated, in which biceps anchor detachment as a result of a fall or repeated pull on the arm can lead to excessive humeral head migration during athletic activities and increase the forces applied to the anterior static restraints. Eventually, the tissues may attenuate in response to the forces applied to them, producing subtle instability. With increasing humeral head translation during provocative activity, further destabilization of the biceps insertion and overstraining of the static stabilizers of the shoulder could result (Fig. 3).

Tendon Instability

The cause of biceps tendon instability in athletes has not been well described. Curtis and Snyder³⁴ have noted this entity in younger patients who participate in throwing sports, but the specific manner in which this problem develops is not defined. Several studies have challenged the idea that the transverse ligament is responsible for biceps tendon stability within its

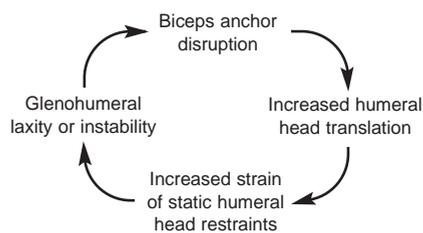


Fig. 3 Cycle that can be established by destabilization of the biceps anchor in athletes. The increased humeral head translation that results can lead to increased stress on the anterior glenohumeral restraints, which can worsen the degree of humeral head instability and further destabilize the biceps anchor.

groove. In one study,³⁵ sectioning the transverse ligament at the groove did not allow medial translation of the tendon; however, when the cuff overlying the biceps was also released, the biceps readily subluxated.

In a cadaveric study, Petersson³⁶ found five cases of medial biceps subluxation, in all of which there was a concomitant defect of the supraspinatus tendon. In only one case did he find medial subluxation superficial to the subscapularis tendon. In the remaining shoulders, internal degeneration of the subscapularis had occurred, allowing the tendon to subluxate medially beneath the subscapularis tendon.

Walch et al⁹ described the pathologic changes in the biceps tendon associated with “hidden” lesions of the rotator interval. As the coracohumeral ligament and superior glenohumeral ligament coalesce laterally at their insertion into the lesser tuberosity, they form a pulley through which the biceps tendon travels. This pulley was found to be degenerative or absent in cases of biceps tendon subluxation or dislocation. The biceps tendon appeared to subluxate under the subscapularis tendon because the bulk of the superior subscapularis was abnormal (torn), with only the superficial fascia of the tendon remaining intact.

Bell and Noble⁶ reported the occurrence of biceps tendon subluxation after an isolated subscapularis tear caused by forceful internal rotation against resistance. In 16 patients with isolated subscapularis tendon rupture reported by Gerber et al,³⁷ more than half evidenced biceps lesions, four of whom had frank dislocation of the tendon. These reports suggest that in most patients with subluxation or dislocation of the biceps tendon, an associated cuff tear involving either the rotator interval or the subscapularis is likely. In our experience, isolated

biceps tendon instability without a concomitant cuff lesion is almost nonexistent. In patients with subscapularis rupture, dislocation of the biceps tendon out of the groove is commonly visualized with magnetic resonance (MR) imaging.

Patient Assessment

Pain is usually the presenting complaint and is localized to the anterior aspect of the shoulder over the bicipital groove. Occasionally, the nature and location of the pain are vague, especially when another condition, such as rotator cuff impingement or shoulder instability, is also present. Information regarding the onset and progression of the pain, history of a traumatic event, athletic participation, activities that worsen the pain, prior treatment and outcomes, and the degree to which the patient is disabled should be obtained. Popping, grinding, and sensations of shoulder instability are critical. Origin disorders (i.e., SLAP lesions) will often present as a painful click deep within the shoulder. Patients with tendon instability may describe snapping around the shoulder with certain motions.

A thorough physical examination includes assessment of shoulder symmetry, tenderness, range of motion, and presence of impingement signs. Inspection for glenohumeral instability should include the apprehension test, relocation test, sulcus test, and load-shift test, with care taken to assess side-to-side differences. It is important to bear in mind that athletes with bicipital disorders secondary to subtle shoulder instability may complain of pain only, rather than true apprehension with a sensation of imminent shoulder subluxation, during the apprehension test.²⁷

The Yergason test for biceps tendinitis is performed by having the

patient supinate the forearm against resistance with the elbow flexed 90 degrees. A positive test is marked by pain in the biceps region. A more specific examination is Speed's test, which is performed by having the patient attempt to elevate the extended, supinated arm against resistance. Pain in the anterior shoulder with this maneuver is suggestive of biceps tendinopathy.

To assess for SLAP lesions, the supine patient is asked to relax the shoulder while the arm is abducted approximately 90 degrees and the humerus is loaded and rotated internally. In the patient with biceps anchor instability, this maneuver will produce pain deep in the shoulder, often accompanied by an audible snap or clunk as the humerus reaches its limit of internal rotation.

O'Brien et al³⁸ recently presented clinical and anatomic evidence to support a test for isolating SLAP lesion-related pain from pain due to other shoulder disorders. Standing behind the patient, the examiner brings the involved arm to 90 degrees of flexion and 10 to 15 degrees of adduction and then applies a downward force while asking the patient to resist this force. Pain described as deep within the joint that occurs when the test is performed with the thumb pointing inferiorly (shoulder internally rotated) and that is reduced or eliminated when the thumb points superiorly (shoulder externally rotated) is purportedly due to superior labral injury.

Few techniques to test for biceps instability have been described. One common method involves positioning the arm as for the shoulder apprehension test while the bicipital groove is simultaneously palpated. As the arm approaches 90 degrees of abduction and comparable external rotation, a clunk will be appreciated near the anterior edge of the acromion.⁶ The integrity of the sub-

scapularis should be evaluated thoroughly, as associated tears of this structure may coexist with biceps instability. The so-called liftoff test, as described by Gerber et al,³⁷ is performed by bringing the patient's arm into maximum internal rotation behind the back. The patient's ability to maintain this position after the examiner releases the hand is indicative of an intact subscapularis.

Radiographic Evaluation

Diagnostic imaging for evaluation of a suspected biceps tendon disorder begins with a standard radiographic series (scapular anteroposterior, scapular outlet, and axillary views), which will rarely demonstrate abnormalities specific to the biceps itself but may reveal associated conditions. These films will provide information regarding osseous degenerative changes in the glenohumeral joint or the acromioclavicular joint, acromial morphology, and osseous abnormalities indicative of prior shoulder instability or fracture.

In cases in which a biceps lesion is suspected, the bicipital groove view, as described by Cone et al,⁴ is ordered. This view is obtained by placing the cassette at the apex of the shoulder with the arm externally rotated and orienting the beam along and slightly medial to the long axis of the humerus. This projection provides an excellent image of the bicipital groove and may reveal the presence of groove spurs or narrowing.

The Fisk view is obtained with the patient cradling the cassette on his forearms and leaning the affected shoulder over the cassette. A beam projected down the long axis of the humerus over the bicipital groove will image the groove, allowing further assessment of narrowing or changes.³

Arthrography and ultrasonography have also been used in evalua-

tion of the biceps tendon. Biceps anatomy, changes within the bicipital groove, and subluxation of the tendon can all be assessed with arthrography. In addition, arthrography may provide information about the presence or absence of a rotator cuff tear. However, the invasive nature of the test has diminished its popularity, especially with the availability of MR imaging. Ultrasonography has also been used extensively in the evaluation of the biceps tendon, with some studies claiming superior evaluation of the tendon when compared with arthrography.^{39,40} Its efficacy is highly user-dependent, thus limiting its applicability to centers that regularly utilize the modality for this purpose.

Magnetic resonance imaging has rapidly become the radiologic study of choice for evaluating the biceps tendon.⁴¹⁻⁴³ Biceps tendon subluxation associated with upper subscapularis deficiency and rotator interval lesions can be readily revealed with this modality. It has been less successful in detecting early traumatic injury to the biceps origin. Partial detachment is especially difficult to diagnose if the patient age and history are not known.⁴⁴ It is anticipated, however, that diagnosis of these injuries on the basis of MR imaging findings will improve with advances in technology and with greater awareness by both surgeons and radiologists of biceps tendon disorders.

Injecting contrast material before MR imaging (MR arthrography) is more sensitive than MR imaging alone and allows the detection of more subtle capsular derangements.⁴⁵ However, recognition of the normal anatomic variants, such as detachment of the anterosuperior labrum^{10,46} and the Buford complex⁴⁷ (absence of the anterosuperior labrum associated with a cordlike middle gleno-

humeral ligament), is necessary to avoid inaccurate diagnoses.

Arthroscopy is an excellent method for evaluating the intra-articular portion of the biceps (Fig. 4). Its intra-articular extent is readily visualized and is one of the landmarks used for orientation. Avulsion tears of the tendon and SLAP lesions can be identified and graded, and associated rotator cuff and subscapularis tears can be visualized. In addition, with the use of a probe, a portion of the intertubercular aspect of the tendon can be delivered into the joint for inspection. The main benefit of arthroscopy is that diagnostic evaluation of the tendon and other shoulder structures can often be coupled with therapeutic intervention.

Nonoperative Treatment

For the athlete with biceps tendinopathy, regardless of the primary underlying cause, conservative care begins with rest coupled with the use of ice and nonsteroidal anti-inflammatory medication. Activities associated with development or worsening of the tendinopathy should be avoided during this period. Occasionally, when the symptoms in the acute period are severe or when it becomes imperative for the athlete to return to his or her sport as soon as possible, a small amount of corticosteroid and a local anesthetic agent can be injected into the bicipital area.

Such injections can be valuable both diagnostically and therapeutically in differentiating rotator cuff disorders from bicipital problems. The corticosteroid-anesthetic mixture can be injected into the subacromial space, after which the patient is reexamined. If symptoms persist in the region of the biceps, an injection into that area may be useful. During injections around the biceps, the needle must be properly placed so as to avoid an

intratendinous injection. To do this, the patient is positioned sitting or supine on the examination table with the elbow flexed 90 degrees and the arm internally rotated approximately 10 degrees. After sterile preparation, the region of the groove is palpated, and injection is made into the most tender area. There should be no resistance to the injection, as resistance implies intratendinous insertion of the needle. Use of a 20-gauge needle for this technique allows ready detection of flow resistance. After 5 minutes, the patient is reexamined, and any changes are noted.

The specific increase in the risk of rupturing the degenerative biceps tendon after such an injection is unclear. However, the danger to tendinous structures following steroid injection is well known. It is critical that the patient be informed of the risk of tendon rupture before injection.

As the acute symptoms resolve, a rehabilitation program involving strengthening of the shoulder and parascapular muscles is initiated.²⁷ Because biceps activity increases during follow-through when the external rotators begin to fatigue, these muscles should be specifically targeted during the strengthening program. The internal rotators should also be strengthened, as it is this group that works eccentrically during late cocking to avoid excessive strain within the anterior static restraints. The serratus anterior and trapezius should be strengthened to allow synchronous motion of the scapula with the humerus and to avoid impingement of the biceps due to scapular lag. Finally, rehabilitation of the biceps itself is emphasized, with a focus on eccentric loading. Once strength and endurance in these muscles have been restored, a return to overhead activity is allowed. This is done on a graduated basis, slowly progressing to competitive distance, velocity, duration,

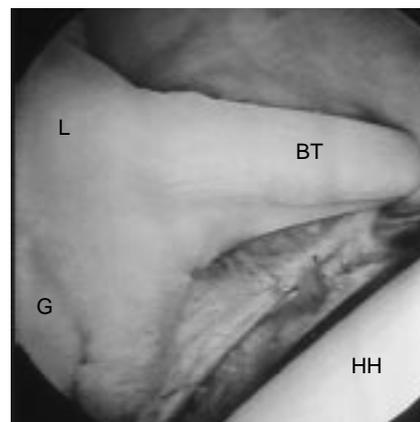


Fig. 4 The biceps tendon (BT) is well visualized during shoulder arthroscopy and can be used as a landmark for orientation. G = glenoid; HH = humeral head; L = labrum.

and frequency of activity. In our experience, patients are able to return to full activity approximately 4 months after surgery.

Given sufficient time, most athletes will respond to conservative therapy. If symptoms persist despite a well-managed supervised rehabilitation program, operative intervention may be indicated.

Surgical Treatment

Tendon Degeneration

The proper surgical treatment of biceps tendinopathy in the athlete rests partly on the question of whether isolated primary degeneration of the biceps occurs. If degeneration can arise primarily, one would assume that tenodesis without accompanying subacromial decompression would be effective in appropriately selected patients. Post and Benca⁴⁸ reported on 17 patients undergoing isolated biceps tenodesis. They carefully attempted to exclude any patients with confounding factors, such as impingement, instability, and rotator cuff tears. Sixteen of the 17 patients had satisfactory results, leading the

authors to conclude that a primary intrinsic biceps tendinopathy does exist. However, other authors have had less success with tenodesis as an isolated procedure.^{49,50}

In athletes with bicipital degeneration, we perform a complete subacromial decompression if there are accompanying signs and symptoms of impingement syndrome. The question then remains whether to perform a biceps tenodesis or a release with resection of the proximal tendon. This is a difficult decision, particularly in the case of a professional or elite thrower in whom the effect of loss of the depressive and stabilizing function of the biceps is unknown. We proceed with tenodesis when the degree of fraying and degeneration of the tendon is such that future rupture of the biceps appears imminent. If a significant portion of the tendon remains intact or the athlete does not wish to undergo tenodesis, we limit the procedure to arthroscopic debridement of the frayed portion of the tendon.

When a patient's symptoms are localized to the biceps with no accompanying evidence of shoulder instability or cuff impingement, we proceed with tenodesis of the biceps tendon alone. However, this situation is very rare, especially in the overhead athlete. An alternative approach is to perform tenotomy of the biceps tendon without tenodesis, accepting the inherent deformity, which occurs as the long head retracts into the arm. This approach is often reasonable in older patients and in rare instances in younger patients who are not concerned with deformity or who wish a quicker recovery.

Isolated biceps release or tenodesis is performed with use of the arthroscope. The patient is placed in the lateral decubitus position with the arm abducted approximately 25 degrees with 10 lb of traction. The shoulder and subacromial space are

then examined arthroscopically for associated lesions, and the morphology of the acromion and rotator cuff is assessed. With the arthroscope in the glenohumeral joint, the biceps tendon is released near its origin with the use of electrocautery, shaver, or scissors. A holding stitch may be placed into the tendon prior to release at the discretion of the surgeon. If subacromial impingement accompanies biceps degeneration, arthroscopic subacromial decompression is performed.

The arthroscopic equipment is then withdrawn from the joint, and a 3- to 4-cm incision is made, beginning 1 cm medial and 2 to 3 cm inferior to the anterolateral corner of the acromion. The deltoid is split with finger dissection, and the bicipital groove is palpated. The transverse humeral ligament is released, revealing the biceps tendon within its groove. A marking suture is placed in the biceps ten-

don in the inferior region of the groove, and electrocautery is used to score the biceps groove at the level of the marking suture, which helps restore proper tensioning to the biceps during the tenodesis.

A high-speed burr is used to decorticate the bicipital groove. A number of techniques are available to anchor the tendon within the groove, among them using a two-pronged staple (Fig. 5, A), creating a tunnel within the groove and sewing the tendon back on itself (Fig. 5, B), forming a keyhole in the groove and knotting the tendon for insertion into the hole (Fig 5, C), using suture anchors, and using a screw and soft-tissue washer. We prefer use of the screw washer, which is simple and quick, creates the most reproducible construct, and is secure enough to allow early motion. When tenodesis is not required, simple release of the tendon from the origin may be performed.

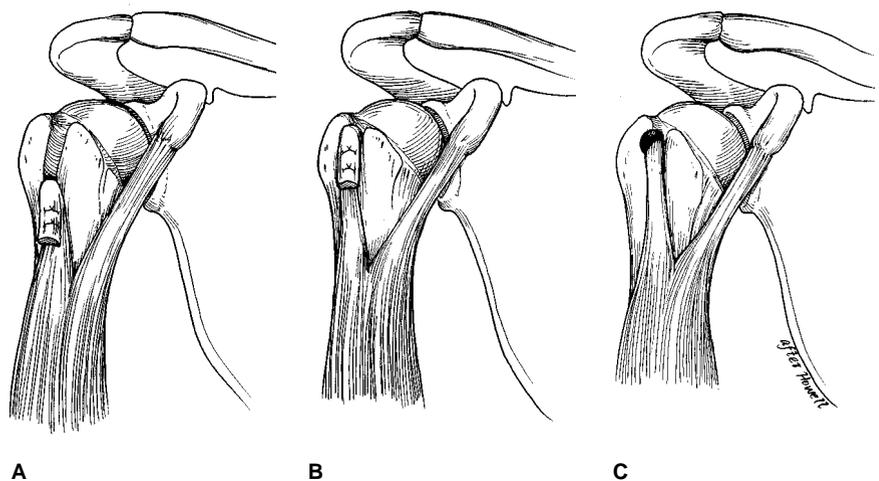


Fig. 5 Techniques for securing the biceps tendon within its groove. **A**, In the two-pronged staple technique, the tendon is pulled proximally to the appropriate tension and then secured with a staple. The proximal free edge of the tendon is pulled distally over the staple (not shown) and sewn to itself. **B**, In the tunnel technique, a burr is used to create a tunnel approximately 2 cm in length. The tendon is delivered into the distal hole and pulled out the proximal hole to the appropriate tension. The free edge of the tendon is then sewn back onto itself to secure it. **C**, In the keyhole technique, the free edge of the tendon is knotted and sutured. A burr is used to create a keyhole, wider proximally to accommodate the knotted tendon and narrowing distally. The knotted tendon is inserted into the keyhole under slight tension, locking it into place. (Adapted with permission from Hawkins RJ, Bell RH, Lippitt SB [eds]: *Atlas of Shoulder Surgery*. St Louis: Mosby, 1996, p 145.)

Origin Problems

Origin problems of the biceps tendon are best treated arthroscopically. In cases of labral fraying or tearing with a stable biceps anchor, as in type I and type III SLAP lesions, simple debridement of the degenerative portion or excision of the bucket-handle tear of the superior labrum should eliminate the patient's symptoms. However, when the biceps anchor has become unstable, as in type II SLAP lesions, debridement alone will not address the underlying problem. In these cases, it is important to restore stability to the biceps origin and thereby to disrupt the feedback cycle that leads to instability (Fig. 3). Several techniques have been described for this purpose. We have had success using a bioabsorbable tack to secure the labrum to the glenoid. The labrum may be repaired by using suture punches or hooks and fastening the tissue to the glenoid with suture anchors. This is especially useful for more posterior lesions. Before reattachment of the biceps anchor, the superior glenoid rim should be gently abraded to stimulate bleeding bone and facilitate labral healing.

Treatment of type IV SLAP lesions, involving a bucket-handle tear of the superior labrum extending into the biceps tendon, represents a particularly difficult problem.⁵¹ If the torn portion of the biceps is less than 10% to 15% of its diameter, simple resection of the

tear may be sufficient. When the tear involves 30% or more of the biceps tendon, suture repair of the torn segment may be attempted. Occasionally, these tears occur in conjunction with an unstable biceps anchor as well. In this situation, the biceps should be reattached to the glenoid as in the treatment of the type II lesion, in addition to suturing the torn portion of the tendon. In cases in which the entire tendon appears degenerative, as well as in the treatment of the older or less demanding athlete, the biceps tendon should be removed from the glenohumeral joint with or without a tenodesis.

Tendon Instability

Biceps tendon subluxation or dislocation from the groove is the result of a defect in the region of the rotator interval and coracohumeral ligament–superior glenohumeral ligament pulley or an associated tear of the medial insertion of the subscapularis. Hence, in cases of suspected tendon instability, careful evaluation of both of these regions must be performed. When the rotator interval is enlarged due to tearing of the cuff, imbrication of the subscapularis and supraspinatus tendons in the area where the biceps exits the joint may stabilize the tendon. Reconstruction of the coracohumeral ligament has also been advocated,³ along with deepening of the groove to recentralize

the tendon.⁹ If the tendon is significantly torn, tenodesis or resection may be required. If associated mechanical impingement is the cause of the tearing of the cuff around the interval, subacromial decompression should be performed.

In cases in which the medial border of the subscapularis is avulsed from its insertion into the lesser tuberosity, recentralization of the tendon can be attempted before the repair.⁹ In our experience, stabilization of the tendon is difficult in this situation, and tenodesis prior to repair of the subscapularis tendon is preferable.

Summary

Athletes place high-level demands and stresses on their shoulders. Repeated application of these stresses can result in injury to the biceps tendon at its origin, in its intra-articular extent, or within the bicipital groove. Because of the close association of biceps lesions with other shoulder problems, diagnosis of the cause of pathologic changes in the biceps in athletes can be challenging. The goal of treatment of these injuries must be identification of the underlying cause of the biceps problem, followed by treatment of all factors involved so as to return the athlete to his or her sport as quickly and completely as possible.

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