EVIDENCE SUMMARY

Biceps Tenodesis

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Anatomy & Pathophysiology

- The glenoid labrum consists of parallel collagen fibers that course around the circumference of the glenoid [1].
- The superior labrum inserts on the superior glenoid rim, medial to the articular cartilage margin, through a transitional zone of fibrocartilage [1].
- A normal synovial recess exists between the meniscoid or triangular superior labrum and the articular cartilage extension over the superior glenoid rim [1].
- Vascularity to the glenoid labrum originates from the scapular, circumflex scapular, and posterior circumflex humeral arteries via capsular or periosteal vessels [1].
- The suprascapular artery, the circumflex scapular branch of the subscapular artery, and the posterior humeral circumflex artery provide the labrum’s vascular supply [7].
- These vessels arborize within the peripheral aspect of the labrum [7].
- The inner portion of the labrum is avascular [7].
- The superior labrum is less vascular compared with the inferior and posterior labrum [7].
- Of the biceps tendon, 40% to 60% attaches to the supraglenoid tubercle 5 mm medial to the superior glenoid rim [1].
- The remainder of the biceps tendon attaches directly to the superior glenoid labrum [1].
- The biceps tendon typically attaches entirely (type I) or predominantly posterior (type II) on the superior labrum [1].
- The labral attachment of the biceps tendon may have equal anterior and posterior contributions (type III) or, less commonly, predominantly anterior (type IV) [1].

- The biceps tendon is an intra-articular but extrasynovial structure within the glenohumeral joint [1].
- Vascularity of the biceps tendon is provided primarily by the ascending branch of the anterior humeral circumflex artery, which travels within the bicipital groove [1].
- An avascular zone exists at the proximal portion of the biceps tendon, close to the superior glenoid [1].
- The biceps tendon passes through the bicipital groove, or intertubercular groove, between the greater and lesser tuberosities [1].
- Stability of the biceps within the bicipital groove is afforded by the biceps sling, or pulley [1].
- The biceps pulley consists of fibers from the subscapularis tendon, supraspinatus tendon, coracohumeral ligament, and superior glenohumeral ligament [1].
- The biceps pulley is composed of the superior glenohumeral ligament and coracohumeral ligament in combination with the subscapularis [2].
- The rotator cuff interval is a triangular region bounded medially by the coracoid process, superiorly by the anterior margin of the supraspinatus, and inferiorly by the superior margin of the subscapularis [2].
- In the rotator cuff interval, the anterior capsule is supported by both the superior glenohumeral ligament and the coracohumeral ligament [2].
- The biceps tendon traverses the rotator cuff interval, where it is held in place by the biceps pulley, before exiting the joint via the bicipital groove [2].
- The LHB anchor has some inherent physiologic motion [7].
- Overconstraint from repair of the LHB anchor can contribute to stiffness [7].
- Anatomic variants in the superior labrum include a sublabral foramen or absence of the superior labrum, often seen together with a cordlike middle glenohumeral ligament (MGHL) [7].
- A 2003 study identified that 3.3% of shoulders had a sublabral foramen [7].
- The same study identified that 8.6% of shoulders had a sublabral foramen with a cordlike MGHL, also called a Buford complex [7].
- The study identified that 1.5% of shoulders had an absent anterosuperior labrum [7].
- Surgical repair of anatomical variants like the Buford complex can result in loss of external shoulder rotation [7].
- The biceps muscle has two origins in the shoulder, both of which are rich in collagen [6].
- The long head originates from the bicipital tubercle at the superior rim of the glenoid and along the posterior superior rim of the glenoid and labrum [6].
- The short head originates from the coracoid tip lateral to and in common with the coracobrachialis [6].
- The lateral insertion of the biceps is to the posterior part of the tuberosity of the radius [6].
- The medial insertion of the biceps is aponeurotic and passes medially across and into the deep fascia of the muscles of the volar forearm [6].
- Loss of the long head attachment is manifested mainly as loss of supination strength (20%) with a smaller loss (8%) of elbow flexion strength [6].

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- The long head of the biceps exits the shoulder through a defect in the capsule between the greater and lesser tuberosities [6].
- The intra-articular tendon was noted as being broader than that in the groove [6].
- A shallow bicipital groove and supratubercular ridge above the lesser tubercle (the trochlea of the tendon) were thought to predispose to biceps tendon pathology [6].
- A shallower bicipital groove may be more likely to expose the long head of the biceps to impingement [6].
- The medial wall of the bicipital groove was higher, with an opening angle of 30 to 40 degrees in the largest fraction of patients [6].
- The bicipital tendon is retained within the groove by a pulley made up of fibers from the coracohumeral and superior glenohumeral ligaments, with some reinforcement from adjacent tendons [6].
- Under normal conditions, the action of the biceps is flexion and supination at the elbow [6].
- In certain conditions, particularly when paralysis or rupture of the supraspinatus has occurred, the long head of the biceps is hypertrophied [6].
- One study involving cadaver specimens found that the long head could contribute to joint stability and that this stability is increased in external rotation and decreased in internal rotation [6].
- Innervation of the biceps is supplied by branches of the musculocutaneous nerve (C5 and C6) [6].
- The blood supply to the biceps is derived from a single large bicipital artery from the brachial artery (35%), multiple very small arteries (40%), or a combination of the two types [6].
- The LHB tendon is innervated by thinly myelinated sensory neurons [7].
- Most of the innervation of the LHB tendon occurs at the LHB origin [7].
- Blood is supplied to the LHB tendon from the thoracoacromial and brachial arteries via the osteotendinous and musculotendinous junctions, respectively [7].
- A hypovascular zone found near the tendon origin at the superior glenoid attachment corresponds to where it commonly tears at the LHB pulley near the proximal groove [7].
- SLAP tears can be caused by forceful traction to the arm, direct compression loads, and repetitive overhead throwing [3].
- Increased external rotation of the shoulder in the late cocking phase increases torsional force at the LHB root, resulting in a peel-back injury to the posterosuperior labrum [3].
- Injuries can result from repetitive contact of the posterosuperior labrum with the undersurface of the rotator cuff in the late cocking phase, known as internal impingement [3].
- SLAP tears are seen more frequently in the late cocking position, occurring because of an adaptive posterior capsular contracture [3].
- Throwing athletes demonstrate increased shoulder external rotation and decreased internal rotation in abduction, which causes posterosuperior migration of the humeral head in the late cocking phase [3].
- Increased external rotation results in greater torsional loads across the superior labrum from the more posteriorly oriented LHB tendon causing the labrum and LHB tendon to displace medially over the glenoid rim [3].

- The proximal LHB tendon has been recognized as a source of substantial anterior shoulder pain [3].
- Pathology of the LHB tendon includes tendinitis, tendinopathy, tears, subluxation, entrapment, delamination, and dislocation out of the bicipital groove [3].
- Because of the relatively anterior position of the bicipital groove along the humeral head combined with humeral retroversion, the tendon is exposed to medial instability [3].
- Variations of bicipital groove morphology can increase the risk of LHB tendon pathology [3].
- Isolated LHB tendon pathology can occur but frequently is associated with other shoulder pathologies, especially rotator cuff pathology [3].
- Primary LHB tendinitis usually occurs in younger patients who participate in overhead activities such as volleyball and baseball [3].
- With LHB tendon instability, the patient describes a clicking or snapping with overhead motions [3].
- A subscapularis tear is associated with LHB medial instability [3].
- A supraspinatus tear is associated with posterolateral instability of the LHB tendon [3].
- Bicipital instability is usually associated with rotator interval injury or subscapularis tendon injury, or both [11].
- MRI accurately reveals varying degrees of bicipital instability, from a flat long head of the biceps tendon perched on the lesser tuberosity to dislocation within the glenohumeral joint with complete detachment of the subscapularis tendon [11].
- Type I extraarticular dislocation involves a partial tear of the subscapularis tendon where the long biceps tendon is completely dislocated to a point over the lesser tuberosity [10].
- In Type I extraarticular dislocation, there is invariably a rupture of the common attachment of the superior glenohumeral ligament and coracohumeral ligament [10].
- In Type I extraarticular dislocation, the outer attachment of the subscapularis tendon is always torn [10].
- Type I extraarticular dislocation corresponds in its evolution to a type II subluxation but represents a more advanced stage [10].
- Extraarticular dislocation with an intact subscapularis tendon is very rare, occurring in only 3% of patients in a series of 70 [10].
- Type II intraarticular dislocation involves a complete tear of the subscapularis tendon where the biceps tendon is interposed into the joint space and displaced inferomedially [10].
- In Type II intraarticular dislocation, the proximal two-thirds of the subscapularis tendon is ruptured [10].
- Approximately half of Type II intraarticular dislocations have a traumatic etiology [10].
- The biceps tendon is widened and flattened as a result of its contact with the lesser tuberosity in Type II intraarticular dislocation [10].
- Entrapment of the biceps tendon in the anterior joint space occurs with each internal rotational movement of the humerus in Type II intraarticular dislocation [10].
- Intraarticular dislocation is often associated with extensive tearing of the rotator cuff [10].

- The biceps pulley, which is composed of the superior glenohumeral ligament and coracohumeral ligament in combination with the subscapularis, holds the biceps tendon in place [2].
- MRA was found to have sensitivity of 82% to 89% and specificity of 87% to 98% in the evaluation of the biceps pulley [2].
- Diagnostic criteria for biceps pulley abnormalities on MRA include nonvisualization or discontinuity of the superior glenohumeral ligament, medial subluxation of the biceps tendon on axial images, biceps tendinopathy, and inferior displacement on oblique sagittal images [2].
- The LHB can have an entirely posterior, posterior-dominant, or equally anterior-posterior attachment at the superior labrum [7].
- In most cases, the LHB has a posterior-dominant or entirely posterior labral insertion [7].
- Four types of biceps tendon attachment to the glenoid labrum can be distinguished: Type I (all posterior), Type II (most posterior with small anterior contribution), Type III (equal contributions), and Type IV (most anterior with small posterior contribution) [8].
- The long head of the biceps originates from the bicipital tubercle at the superior rim of the glenoid and along the posterior superior rim of the glenoid and labrum [6].
- Meyer noted that much of the origin of the long head is via the superior labrum [6].
- The size of the bicipital tubercle does not reflect the size of the biceps tendon [6].
- The long head of the biceps exits the shoulder through a defect in the capsule between the greater and lesser tuberosities [6].
- Many studies have attempted to correlate construction of the groove with bicipital pathology [6].
- If a correlation exists between bicipital groove morphology and the biceps tendon, a shallower groove may be more likely to expose the long head of the biceps to impingement [6].
- The long head of the biceps can contribute to joint stability, which is increased in external rotation and decreased in internal rotation [6].
- Loss of the long head attachment is manifested mainly as loss of supination strength (20%) with a smaller loss (8%) of elbow flexion strength [6].
- Lucas reported a 20% loss of elevation strength in external rotation with rupture of the long head of the biceps [6].
- Mariani et al. reported that loss of the long head depressor effect is unlikely to worsen impingement [6].
- In internal rotation, no loss of strength was evident with long head rupture [6].
- Biceps tendinitis is rarely the primary cause of shoulder pain [11].
- Biceps tendinitis is usually secondarily involved as a part of an impingement syndrome or degenerative lesions of the rotator cuff [11].
- The anatomy of the bicipital groove can be evaluated by the Fisk view [11].
- In the Fisk view, the x-ray tube is superior to the shoulder and the image of the bicipital groove is projected down onto the cassette [11].

- The medial aspect of the triceps tendon inserts directly into the medial aspect of the olecranon process without expansion [9].
- The medial aspect of the triceps tendon is thicker than the lateral aspect and consistently shows a distinct, thickened, rolled tendon edge medially [9].
- The mean medial to lateral width of the triceps tendon insertional footprint is 20.9 mm (or 78% maximal width of the olecranon) [9].
- The mean proximal to distal maximum length of the triceps tendon footprint is 13.4 mm [9].
- The mean length from the tip of the olecranon process to the most proximal aspect of the tendon insertion near the curved apex of the olecranon is 14.8 mm [9].
- The lateral triceps expansion is continuous with the superficial fascia of the anconeus muscle and antebrachial fascia inserting into the radial aspect of the proximal ulna distally [9].
- The lateral triceps expansion has a width that is approximately 70% of the width of the central tendon [9].
- The mean length of the superficial triceps tendon is 15.2 cm (range, 13.3 to 17.1 cm) measured from the tip of the olecranon to the most proximal extent of the tendon medially [9].
- The most common mechanism of triceps injury is a sudden eccentric load to a contracting triceps muscle, such as a fall onto an outstretched arm [9].
- Triceps ruptures most commonly occur at the tendon-bone insertion [9].
- Muscle belly ruptures and tears at the musculotendinous junction of the triceps also occur [9].
- Predisposing conditions for triceps rupture include olecranon bursitis, local corticosteroid injections, anabolic steroids, Type I diabetes, rheumatoid arthritis, and metabolic bone diseases [9].
- Increased osteoclastic bone resorption leads to weakening of the triceps insertion site in metabolic bone diseases [9].
- Triceps rupture is a rare condition constituting less than 1% of all tendon ruptures [9].
- Triceps rupture is most common in males to females with a ratio of 3:2, in the fourth decade of life [9].
- Patients with triceps rupture may recall a popping sound or tearing sensation at the time of injury [9].
- Patients report pain, swelling, and bruising along the posterior elbow [9].
- Delayed presentation is common when some motion and strength is preserved in triceps rupture [9].
- Complaints of numbness or tingling in the ulnar nerve distribution may occur, particularly when presenting with a concomitant hematoma [9].
- Tenderness to palpation over the posterior aspect of the elbow is a finding in triceps rupture [9].
- A palpable defect of the tendon proximal to the olecranon may or may not be present in triceps rupture [9].
- Passive motion is usually preserved but active extension may be compromised or present depending on the degree of rupture in triceps injury [9].
- With complete triceps ruptures, the inability to actively extend against resistance or gravity is pathognomonic [9].
- A positive modified "Thompson squeeze" test may confirm complete triceps rupture [9].

- An intact lateral expansion may mask the common examination findings in acute triceps ruptures [9].
- A fleck sign on the lateral radiograph is pathognomonic for an avulsion fracture or triceps rupture [9].
- MRI may be used for pre-operative

Clinical Presentation

- The long head of the biceps tendon (LHBT) has been implicated in intra-articular shoulder pathology since Codman's writings nearly a century ago [19].
- Painful LHBT tendinitis may ensue from tears about the rotator interval [19].
- Painful LHBT tendinitis may ensue with any chronic inflammatory pathology of the glenohumeral joint [19].
- Clinical tests including the O'Brien, Yergason, Speed, and direct palpation tests have limited specificity for LHBT pathology [19].
- A history of radiating anterior shoulder pain may inform the examiner of pain generation from the LHBT [19].
- MRI is a tool used to evaluate biceps pathology [19].
- Ultrasonography is a tool used to evaluate biceps pathology [19].
- Arthroscopic examination of the LHBT and its pulley is a tool used to evaluate biceps pathology [19].
- Arthroscopic examination is limited to the intra-articular LHBT and the proximal groove [19].
- Arthroscopic examination misses less common distal biceps groove lesions [19].
- Treatment of LHBT pathology depends on concomitant injuries, patient factors, and surgeon preference [19].
- Isolated traumatic tears are generally treated nonsurgically [19].
- Tenodesis for the dominant arm of a laborer is a potential rare exception to nonsurgical treatment of isolated traumatic tears [19].
- Tenodesis for an individual who cannot tolerate deformity is a potential rare exception to nonsurgical treatment of isolated traumatic tears [19].
- Arthroscopic tenotomy is acceptable for less physically demanding individuals who may tolerate deformity [19].
- Outcomes for LHBT pathology treatment are generally good to excellent [19].
- Tenotomy results in cosmetic deformity (Popeye) about 30% of the time [19].
- Vigorous activity may result in cramping pain of the biceps muscle belly [19].
- Arthroscopic suprapectoral tenodesis may be performed for patients who need full supination strength and endurance [19].
- Arthroscopic suprapectoral tenodesis may be performed for SLAP tears [19].
- Arthroscopic suprapectoral tenodesis may be performed in conjunction with rotator cuff repair [19].

- Open subpectoral tenodesis is an option if biceps groove pathology is a concern [19].
- Arthroscopic-assisted subpectoral tenodesis is an option if biceps groove pathology is a concern [19].
- Sutures through bone tunnels have more cyclic displacement than anchors, keyhole, screw, or button techniques [19].
- There is no evidence that substantiates one biceps fixation approach or method over another [19].

Investigations

- Plain radiographs including scapular Y, AP, and axillary lateral views should be obtained to assess the glenohumeral joint for abnormalities [12].
- MRI may be used to assess the long head of the biceps (LHB) tendon, associated fluid, possible synovitis, and the morphology of the bicipital groove [12].
- MRI can help determine the presence of bony osteophytes [12].
- MRI can help identify concomitant shoulder and acromioclavicular (AC) joint pathologies [12].
- Studies have demonstrated poor correlation between MRI and arthroscopic findings regarding LHB pathology [12].
- MRI has poor to moderate sensitivity for inflammation, partial-thickness tendon tears, and tendon ruptures [12].
- Magnetic resonance arthrography (MRA) is more specific and sensitive for LHB pathology and superior labrum anterior to posterior (SLAP) tears than MRI alone [12].
- In patients with no pathology, MRA shows the biceps tendon surrounded by contrast fluid resembling a kidney bean [12].
- Both MRI and MRA should be performed in the sagittal oblique and axial planes because LHB subluxation and dislocation are often associated with partial-thickness and full-thickness subscapularis tendon tears [12].
- Ultrasonography is accurate and cost-effective in the diagnosis of LHB dislocation, subluxation, and rupture [12].
- Ultrasonography is not as accurate in diagnosing partial-thickness tendon tears [12].
- The exact role of ultrasonography for the diagnosis of tendon inflammation has not been fully defined [12].
- Proton density–weighted sequences with fat suppression have the greatest sensitivity for detecting biceps tendon degeneration [2].
- Tendon caliber change is more specific than signal intensity for detecting biceps tendon degeneration [2].
- Diagnosing partial tears of the biceps tendon at the entrance to the bicipital groove can be challenging on MRI or MRA without directed effort [2].
- Biceps tendon partial tears at the groove entrance show abnormal signal intensity, but only half have an associated caliber change [2].
- Evaluation in all imaging planes aids in the identification of a biceps groove entrance lesion [2].

- MRA has a sensitivity of 82% to 89% and specificity of 87% to 98% in the evaluation of the biceps pulley [2].
- Diagnostic criteria for biceps pulley pathology on MRA include nonvisualization or discontinuity of the superior glenohumeral ligament [2].
- Diagnostic criteria for biceps pulley pathology on MRA include medial subluxation of the biceps tendon on axial images [2].
- Diagnostic criteria for biceps pulley pathology on MRA include biceps tendinopathy [2].
- Diagnostic criteria for biceps pulley pathology on MRA include inferior displacement of the biceps tendon on oblique sagittal images [2].
- MRI findings in adhesive capsulitis include thickening of at least 4 mm in the coracohumeral ligament [2].
- MRI findings in adhesive capsulitis include thickening of the joint capsule in the rotator cuff interval [2].
- MRI findings in adhesive capsulitis include obliteration of the subcoracoid fat [2].
- With MRA, all five patients with a surgically identified rotator cuff interval lesion had contrast extension to the undersurface of the coracoid process [2].
- The rotator cuff interval was found to be significantly larger in patients with chronic anterior instability [2].
- No single physical examination finding is completely accurate for the diagnosis of a SLAP tear [13].
- A combined physical examination approach aids in the diagnosis of SLAP or LHB pathology [13].
- Plain film radiographs are most commonly normal in distal biceps pathologic findings and do not show pathologic changes [16].
- Biceps ruptures typically do not involve bony ruptures, and minimal changes are seen on standard radiographs of the elbow [16].
- MRI may show distal biceps rupture but is unnecessary in most cases and occasionally may be read as falsely negative [16].
- Even in the setting of rupture of a previously repaired distal biceps tendon, MRI did not affect the operative plan [16].
- MRI is useful to exclude alternative diagnoses and to evaluate the extent of suspected partial rupture [16].
- MRI is useful in cases in which the history suggests a biceps rupture but the clinical examination is unclear [16].
- MRI tells the surgeon the expected location of the distal tendon end and whether it has retracted proximally [16].
- MRI findings suggestive of complete distal biceps rupture include absence of the tendon insertion or a fluid-filled sheath [16].
- MRI findings suggestive of partial distal biceps rupture include high signal intensity, fluid within the tendon sheath, or thinning or thickening of the tendon distally [16].
- Positioning of the prone patient with the shoulder abducted over the head and the elbow in 90 degrees of flexion and the forearm in supination (the FABS view) has been suggested to improve visualization of the distal biceps insertion into the radial tuberosity [16].

- Ultrasound is a lower-cost diagnostic tool that has been shown to be accurate in the diagnosis of complete or partial distal biceps tears [16].
- Ultrasound findings suggestive of complete distal biceps rupture include tendon absence, fluid, and mass in the antecubital fossa [16].
- Ultrasound findings suggestive of incomplete distal biceps rupture include a focal hypoechogenic area or thinning of the tendon [16].

Treatment

- Nonsurgical treatment of distal biceps tendon ruptures can be recommended for very low-demand patients or those not medically fit for surgery [4].
- Nonsurgical treatment of distal biceps tendon ruptures can yield acceptable outcomes with modestly reduced strength and endurance and little or no pain [4].
- Biomechanical studies show that supination strength will decrease up to 40% with loss of biceps function [4].
- Biomechanical studies show that flexion strength will decrease up to 30% with loss of biceps function [4].
- Fatigue or lack of endurance with supination and loss of terminal supination are the most common functional deficits noticed by patients treated nonsurgically [4].
- Most complete ruptures of the distal biceps tendon are treated surgically [4].
- The primary indication for surgical repair is a complete rupture of the distal biceps tendon [4].
- Surgical repair aims to prevent chronic pain and weakness in young, active patients with heavy occupational or recreational demands [4].
- A partial tear of the distal biceps that has failed to respond to nonsurgical measures is a surgical indication [4].
- Partial tears requiring surgical intervention typically involve greater than 50% of the tendon fibers [4].
- Repair of a distal biceps rupture may not be indicated in medically unfit patients with low functional demands [4].
- Primary repair should be cautiously attempted in chronic tears that have significant retraction and scarring [4].
- In chronic tears with significant retraction and scarring, consideration should be given to autograft or allograft reconstruction [4].
- Musculotendinous ruptures of the distal biceps should generally be treated nonsurgically [4].
- Anatomic repair to the biceps tuberosity is preferred over nonanatomic repair to the brachialis to restore supination strength [4].
- Modern fixation techniques including transosseous tunnels, suture anchors, cortical buttons, and interference screws provide adequate fixation to allow early range of motion [4].

- Biomechanical studies show cortical buttons are mechanically superior to suture anchors and interference screws [4].
- Clinical studies have failed to show a difference in rerupture rates between cortical buttons, suture anchors, and interference screws [4].
- A delay greater than 6 to 8 weeks in surgical management of retracted tears may require tendon grafting due to fixed contracture of the biceps muscle [4].
- The precise definition of chronic tears and the requirements for grafting have not been clearly defined [4].
- Most partial tears with less than 50% involvement of the tendon seen on MRI can be treated nonsurgically [4].
- If symptoms persist in partial tears, the tear can be completed, débrided, and repaired back to the tuberosity [4].
- Historically, distal biceps ruptures were repaired through a single extensile anterior incision [4].
- A high incidence of neurovascular injuries and loss of supination strength resulting from nonanatomic repairs led to the development of two-incision techniques [4].
- Less invasive single-incision techniques have regained popularity due to the use of modern tendon fixation techniques [4].
- Tendon to bone fixation in single-incision repairs can be accomplished with suture anchors, a cortical button, and/or interference screws [4].
- Clinical studies have failed to show a difference in rerupture rates for single-incision repairs using different fixation methods [4].
- The original two-incision technique was complicated by heterotopic ossification and radioulnar synostosis [4].
- A modified muscle-splitting two-incision technique was proposed to reduce the incidence of synostosis [4].
- The modified two-incision technique splits the muscle fibers of the extensor carpi ulnaris or extensor digitorum communis as well as the supinator [4].
- Splitting the supinator muscle in a two-incision repair can lead to postoperative fatty infiltration of the supinator muscle [4].
- Postoperative fatty infiltration of the supinator muscle is associated with loss of supination strength postoperatively [4].
- Tendon fixation with double-incision repairs usually is accomplished by creating a bone trough and placing heavy sutures in transosseous bone tunnels [4].
- Maintenance of the tuberosity height during two-incision repairs is associated with improved supination strength [4].
- The anterior protuberance of the radial tuberosity acts like a supination CAM [4].
- Two-incision repairs may allow a better recreation of the anatomic location of tendon attachment on the posterior aspect of the radial tuberosity [4].
- Anatomic direct repair can generally be attempted up to 6 to 8 weeks after injury for chronic tears [4].

- Reconstruction of chronic retracted tears has been performed using semitendinosus autograft or allograft [4].
- Reconstruction of chronic retracted tears has been performed using acellular dermal allograft [4].
- Reconstruction of chronic retracted tears has been performed using Achilles allograft [4].
- Nonanatomic repair of the distal biceps tendon to the brachialis muscle was historically recommended but will fail to restore supination strength [4].
- Nonanatomic repair of the distal biceps tendon to the brachialis muscle generally should not be performed [4].
- Both single-incision and two-incision techniques are effective at restoring elbow flexion and supination strength [4].
- There is no significant difference in outcomes between single-incision and two-incision techniques [4].
- Biomechanical studies demonstrate the importance of proper anatomic restoration of the tuberosity footprint [4].
- Most studies demonstrate a restoration of strength and endurance to within 90% of normal compared with the opposite limb [4].
- A randomized prospective study showed slightly greater final flexion strength with two-incision repair compared to single-incision repair [4].
- The randomized prospective study showed a 10% greater final flexion strength with two-incision repair [4].
- The randomized prospective study showed a higher rate of transient lateral antebrachial cutaneous nerve injuries with single-incision repair compared to two-incision repair [4].
- The rate of transient lateral antebrachial cutaneous nerve injuries was 40% with single-incision repair and 7% with two-incision repair [4].
- Factors associated with loss of supination strength after distal biceps repair include a nonanatomic anterior site of the tendon [4].
- Factors associated with loss of supination strength after distal biceps repair include decreased height of the radial tuberosity [4].
- Factors associated with loss of supination strength after distal biceps repair include supinator muscle fatty infiltration [4].
- Tenodesis can be done with a PEEK tenodesis screw, two suture anchors, or the use of a FiberSnare [14].
- The resistance to cyclic loading is comparable between PEEK tenodesis screw, suture anchors, and FiberSnare techniques [14].
- The ultimate pull-out strength of the biotenodesis screw is stronger than that of suture anchors [14].
- Long-term results are comparable whether biceps tenodesis is done arthroscopically or through a mini-open approach [14].
- The choice between arthroscopic and mini-open biceps tenodesis techniques should be based on the skills and experience of the operating surgeon [14].

- Tenodesis and tenotomy of the long head of the biceps tendon have been shown similarly effective as treatment modalities in three separate systematic reviews [18].
- Among patients treated with tenodesis or tenotomy, only 74% to 77% achieved good to excellent results [18].
- Among patients treated with tenodesis or tenotomy, 19% to 24% had persistent biceps symptoms [18].
- Persistent symptoms following a biceps procedure often result from unrecognized and unaddressed bicipital tunnel disease [18].
- A retrospective cohort study reported a threefold higher failure rate for surgical techniques that did not include release of the extra-articular bicipital sheath compared with those where the sheath was released [18].
- A meta-analysis comparing biceps procedures with tunnel decompression versus nondecompression included 30 studies with 1881 subjects [18].
- Group 1 (tunnel decompression) was associated with significantly better Constant scores compared with group 2 (nondecompression) [18].
- The Constant score for the tunnel decompression group was 88.3 compared to 81.7 for the nondecompression group [18].
- The difference in Constant scores between tunnel decompression and nondecompression groups was statistically significant ($P = .001$) [18].
- No significant differences were identified between tunnel decompression and nondecompression groups with respect to revision rates [18].
- No significant differences were identified between tunnel decompression and nondecompression groups with respect to SST scores [18].
- No significant differences were identified between tunnel decompression and nondecompression groups with respect to VAS pain scores [18].
- No significant differences were identified between tunnel decompression and nondecompression groups with respect to ASES scores [18].
- The majority of studies included in the meta-analysis comparing tunnel decompression and nondecompression were level IV [18].
- In the absence of rotator cuff pathology, an anterior approach through the deltopectoral interval can be used for biceps tendon displacement [20].
- The transverse humeral ligament can be incised to expose the long head of the biceps tendon during an anterior approach [20].
- In rare instances, the biceps tendon can be placed back in the groove and the transverse humeral ligament repaired using interrupted sutures [20].
- More commonly, tenodesis should be performed for biceps tendon displacement [20].
- If a pathologic process of the rotator cuff is present with subluxing biceps tendon, an anterosuperior approach is used [20].

- The anterosuperior approach begins just lateral to the acromioclavicular joint and extends distally in line with the deltoid fibers [20].
- The deltoid is split beginning just lateral to the acromioclavicular joint and continuing 5 cm distally in the deltoid raphe [20].
- The acromial branch of the thoracoacromial artery should not be excised in the proximal dissection [20].
- An acromioplasty and excision of the coracoacromial ligament are performed during the anterosuperior approach [20].
- The long head of the biceps tendon can be tenodesed to the humerus with interference screws, tenodesis screws, or suture anchors [20].
- The intraarticular portion of the tendon is excised during the procedure for biceps tendon displacement [20].
- The rotator cuff is repaired if a pathologic process is present [20].
- A shoulder immobilizer is worn for 2 weeks following biceps tenodesis for tendon displacement [20].
- A sling is used for an additional 2 weeks after the immobilizer period [20].
- Active use and exercises are begun after the sling period [20].
- Rehabilitation depends on the size of the tear if the rotator cuff was repaired [20].

Key Evidence

References

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