



■ ASPECTS OF CURRENT MANAGEMENT

The long head of biceps and associated tendinopathy

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This paper describes the current views on the pathology of lesions of the tendon of the long head of biceps and their management. Their diagnosis is described and their surgical management classified, with details of the techniques employed.

Pathology affecting the tendon of the long head of the biceps brachii (LHB) has been recognised for more than three centuries, but enthusiasm for its treatment has varied considerably. The explanation for this may be inadequate understanding of the anatomy, mechanics and possible pathologies of the intra-articular portion of the tendon, but also the continued debate and uncertainty as to its true function at the shoulder.

Instability of the tendon was probably the first recognised condition, as described by Monteggia¹ and Soden.² Duplay³ implicated tendonitis of the LHB in his description of *periartbrite scapulo-humerales* in 1872. Pasteur⁴ may have given the first description of tendonitis in 1932, and pathology of the LHB was extensively investigated in the 1940s and 1950s by, among others, De Palma and Callery,⁵ Lippmann,⁶ and Hitchcock and Bechtol.⁷ Neer⁸ described the involvement of the LHB in disease of the rotator cuff, but over-emphasised the role of the tendon as a depressor of the humeral head. He advised conserving the tendon whenever possible.

Recent advances have highlighted the clinical importance of instability of the tendon, the association with pulley lesions and partial tears of subscapularis (the so-called 'hidden lesion'), superior labrum from anterior to posterior (SLAP) lesions, the involvement in disease of the rotator cuff, and mechanical symptoms resulting from tendon hypertrophy. Although clinical diagnosis remains imprecise, imaging such as CT arthrography, MRI, MR arthrography and dynamic ultrasound have done much to contribute to more accurate diagnosis. The widespread use of arthroscopy, and the published results of surgical tenotomy and tenodesis have also made orthopaedic surgeons increasingly aware of

the important role of the LHB in many conditions of the shoulder.

Anatomy, mechanics and function

It is beyond the scope of this paper to provide a comprehensive anatomical or biomechanical discussion, but certain advances and concepts should be considered.

The LHB arises from the glenoid labrum and the supraglenoid tubercle. The intra-articular portion passes over the head of the humerus before entering the bicipital groove, when it becomes the extra-articular portion. Because of its location, the LHB has to face both extra-articular constraints, because of possible subacromial impingement, and intra-articular restriction, because of the constant sliding movement of the tendon within the bicipital groove during elevation and rotation of the shoulder.

Comparative anatomy has demonstrated the evolutionary movement of the scapula to a more frontal plane with associated torsion of the humeral shaft, thus reducing the action of the LHB at the shoulder.^{7,9-11} Decreased retroversion of the proximal humerus has led to the groove no longer being centred on the plane of the humeral head, but lying at an angle of about 30°.¹² As a consequence, the LHB is forced to bear on the lesser tuberosity and the medial wall of the groove, instead of at its middle. Such a position renders the tendon highly vulnerable, not only to trauma but also during everyday function, with the lesser tuberosity acting as a pulley for it (Fig. 1).

The LHB is an intra-articular but extra-synovial structure that is essentially static within the joint. It slides passively on the humeral head during abduction or rotation.⁷ The tendon is approximately 9 cm long and 5 mm to 6 mm in diameter. The articular por-

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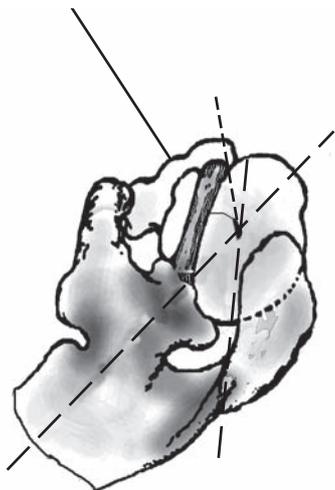


Fig. 1

Diagram showing the orientation of the bicipital groove.

tion is flatter and a little larger than the groove portion, which is round and smaller. The contribution of the superior glenohumeral ligament and coracohumeral ligament to the 'biceps pulley' mechanism is critical to the stability of the tendon, with failure of this mechanism leading to instability.

The blood supply to the proximal part of the LHB is from the circumflex humeral artery, with branches running along the bicipital groove. A characteristic vascular pattern is seen on the superficial surface of the tendon within the groove, but the deep 'sliding' surface is avascular and composed of fibrocartilage.

The innervation of the LHB is not well documented. A recent study by Alpantaki et al¹³ has demonstrated that the tendon is innervated by a network of sensory sympathetic fibres, which may play a role in the pathogenesis of shoulder pain.

Several anatomical variations of the intra-articular position of the LHB have been described, including congenital absence, a synovial 'mesentery', fusion with the rotator cuff and bifid tendons. These are all rare and of unknown clinical relevance. Equally, the origin from the supraglenoid tubercle and glenoid labrum is variable,¹⁴ but again is of unknown clinical relevance, apart from as a cause of diagnostic confusion at arthroscopy.

The function of the LHB at the shoulder is still a matter for debate. Some authors have considered it a purely vestigial structure with no true function at the glenohumeral joint, viewing it as the 'appendix of the shoulder'.⁶ The biceps is a weak abductor of the shoulder, contributing only 7% to 10% of power.¹⁵ The participation of the LHB to abduction arises only with the arm in external rotation, a position which is rarely used in activities of daily living.⁷ It

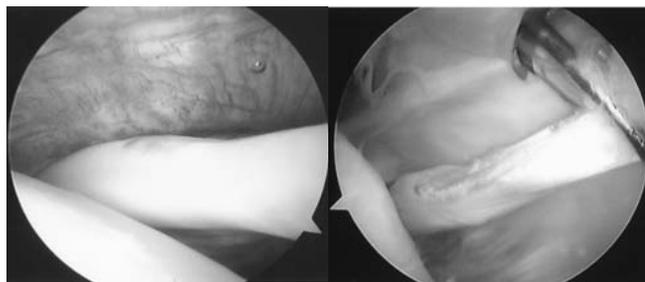


Fig. 2a

Fig. 2b

Intra-operative photograph showing a) early hypertrophy which leads to an hourglass long head of biceps tendon and b) delamination of the tendon within the bicipital groove.

has also been proposed as a depressor of the humeral head, and although some cadaver, biomechanical and radiological data support this,^{16,17} electromyographic studies,^{18,19} clinical observation and the long-term results of tenotomy in the presence of a rotator cuff tear²⁰ appear to negate this role. Hypertrophy of the tendon is more likely to be a result of tendinosis than of functional hypertrophy. The primary function of the biceps is at the elbow, where it acts as a flexor and a supinator.

There has been recent interest in its role in glenohumeral stability,^{16,21-23} especially following the description of SLAP lesions. This has been studied mostly in the context of the throwing athlete.^{16,24,25} Anterior instability leads to increased activity in the muscle on electromyography, indicating the possible role of the biceps as a secondary glenohumeral stabiliser. However, the magnitude of this function is likely to be small.

Disorders of the biceps tendon can be classified into degenerative, inflammatory, mechanical and traumatic or sports related, but such a classification is arbitrary, and different pathologies may co-exist. Although isolated pathology of the biceps does exist, it is commonly associated with abnormalities of the cuff and labrum.

Intrinsic tendon degeneration and inflammatory lesions

Tenosynovitis, tendinosis, delamination, pre-rupture and rupture probably represent the natural history of progressive degeneration of the biceps. Much new research has focused on tendinosis. The understanding of degenerative tendinosis has progressed, and new methods of treatment are being evaluated.²⁶ Unfortunately, relatively little work has focused on the rotator cuff, and none specifically on the LHB.

The LHB is subject to tenosynovitis because of its anatomy, with a synovial sheath and constrained path in the bicipital groove.²⁷⁻²⁹ Arthroscopic evaluation shows fluid, adhesions and increased vascularity around the tendon, but this must not be confused with the normal vascular pattern on the superficial surface of the tendon within the groove.

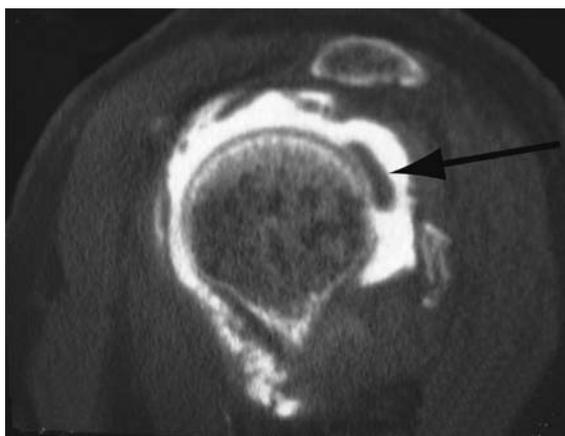


Fig. 3

CT arthrogram showing posterior dislocation of the long head of biceps (arrow).

Early tendinosis may be difficult to visualise arthroscopically. Often the tendon appears macroscopically normal, although there may be some increase in diameter (Fig. 2). As the condition progresses, fibrillation, splits and hypertrophy or attenuation occur, and may be described as delamination or pre-rupture (Fig. 2). The presence of early tendinosis is probably best appreciated by imaging studies such as MRI and Doppler ultrasound.

The majority of degenerative changes in the LHB are associated with pathology of the rotator cuff, as highlighted by Neer.⁸ The relative importance of these structures in producing symptoms is still uncertain and will probably continue to be so while our understanding of the mechanism of the generation of pain by disease of the rotator cuff remains incomplete.

Mechanical lesions, instability and entrapment

Spontaneous rupture. Rupture of the LHB is usually secondary to progression of a chronic partial tear, and may happen during a movement of daily living or a minor injury. Rupture usually occurs in the presence of a cuff tear.⁸ The classic 'Popeye' sign of a ruptured LHB is unmistakable, but not all ruptures, or tenotomies, produce this deformity. Dislocated tendons often become encased in fibrous tissue or adherent to the subscapularis before rupture, and hypertrophic tendons may become fixed within the bicipital groove, giving an autotenodesis. Dislocation itself may, by shortening the course of the tendon, produce a low-rising muscle belly.

Hypertrophy and intra-articular entrapment (the hourglass biceps). Mechanical incarceration of the tendon within the joint has been described.³⁰ It becomes hypertrophic, often in association with advanced disease of the rotator cuff, and is unable to slide into the bicipital groove. This is far more common than the tendon becoming fixed in the bicipital groove by adhesions,⁷ but has the same mechanical

effect of buckling of the tendon on elevation of the shoulder with entrapment of the tendon between the humeral head and glenoid, leading to pain and a block to terminal elevation. Because of its hypertrophy, the tendon may also dilate the entry to the groove and lead to subluxation.

Medial instability of the long head of biceps. This has long been recognised,^{1,2,31-33} but the classification and its specific associations have been described more recently. The transverse humeral ligament is not a significant stabiliser at the entry of the groove, but the superior glenohumeral ligament and the coracohumeral ligament contribute to the 'biceps sling'. Doubt has been expressed about the existence of the transverse ligament as a distinct entity, and it may be a continuation of the insertion of subscapularis.³⁴ Posteriorly, the leading edge of the supraspinatus is the restraint, although the anterior location of the groove and the anterior vector of the pull of the tendon make this less important in most functional positions. Failure of the biceps sling leads to subluxation and eventually dislocation in the presence of a rotator cuff tear. Although the difference may be subtle, it is important to distinguish subluxation from dislocation. A subluxation is defined as a partial and/or transient loss of contact between the tendon and its groove. A dislocation is the complete and permanent loss of contact between the tendon and the groove. Dislocations of the LHB can be classified into intra-articular, intra-tendinous, and extra-articular subtypes. Dislocation is nearly always associated with a tear of subscapularis, except in the rare cases of extra-articular dislocation in which the tendon is resting anterior to subscapularis.³⁵

Lateral instability of the long head of biceps. This is rare and has been described mainly in a traumatic context in association with anterior dislocation and/or fractures of the greater tuberosity.^{36,37} However, posterior instability can also be found in association with supraspinatus tears (Fig. 3). Dynamic exploration under arthroscopy or open surgery shows that, in the presence of a supraspinatus tear, the LHB can roll over the lateral rim of the groove when the arm is placed in abduction and internal rotation.³⁸

Traumatic lesions and sports-related injuries

Isolated pathology of the LHB is most commonly found in the younger, sporting population, especially in throwing athletes, gymnasts, swimmers, and participants in contact sports and martial arts. The LHB is subject to large forces of acceleration and deceleration in the throwing movement, as well as torsion and shearing, especially when coupled with forced flexion of the elbow or forearm supination.

Tenosynovitis, tears, instability of the tendon and rupture may all occur in the athlete. Prevention of rupture is paramount, as even mild loss of power in elbow flexion or supination will be poorly tolerated.

Proximal disinsertion of the biceps or SLAP³⁹ lesions and posterosuperior impingement⁴⁰ are primarily conditions of the rotator cuff and labrum, and as such are beyond the scope of this paper. However, type 2 SLAP lesions affect the

biceps anchor and type 4 lesions extend into the body of the tendon of LHB. Equally, anterosuperior internal impingement as described by Gerber and Sebesta⁴¹ may lead to bicipital tendonitis and pulley lesions.

Diagnosis and imaging

Symptoms. Pain related to pathology of the biceps tendon is located mainly at the anterior part of the shoulder, often at the bicipital groove. Pain at rest, night pain and pain on rotation are common. The pain may also radiate down the arm and muscle belly, sometimes reaching the radial aspect of the hand, but lacks a precise distribution. Patients may also describe paraesthesia in this distribution. This referred pain should not be confused with brachialgia, but may require investigation to exclude a cervical cause.

While the clunk of a subluxing and unstable biceps tendon is classic when the shoulder is rotated, especially in abduction, this clinical sign is uncommon as dislocations are usually irreducible.

Clinical examination. Comparative palpation of the bicipital groove is often useful, and is felt most easily in 10° of internal rotation.⁴² In dislocations of the LHB the tenderness is more medial on the lesser tuberosity, and the tendon can sometimes be rolled under the fingers. Several provocative tests have been described for isolating pathology of the LHB, including Yergason's test, Speed's test, and the biceps instability test. For the diagnosis of SLAP lesions, the most common clinical tests are the O'Brien active compression test and the abduction external rotation supination test. However, recent literature has shown that none of these tests is specific enough in isolation to confirm the diagnosis of biceps or superior labral pathology.⁴³⁻⁴⁶ Patients with a dislocation of the LHB may present with a very typical clinical picture. Dislocation is often traumatic and almost always associated with a tear of the upper subscapularis. The patient presents with a loss of active elevation above 90°, and it is common to find a limitation of active and passive external rotation because the dislocated biceps tendon restrains the inferior part of the subscapularis.

The clinical sign of a hypertrophied and entrapped 'hourglass biceps' is a limitation of the terminal 10° to 20° of active and passive elevation. This corresponds to a true mechanical locking of the shoulder, although there is no loss of rotation. It should not be confused with a frozen shoulder.³⁰

Plain radiography. This is of limited benefit in the diagnosing of abnormality of the LHB. The exceptions to this are the presence of calcification in the bicipital groove and bony deformity caused by fracture or osteophytes. Cystic change in the lesser tuberosity is also a sign of tendinosis, or a tear of the upper subscapularis tendon, and may be associated with lesions of the pulley system. Useful views are the anteroposterior in external rotation, the

axillary and a modified axial, the Fisk view, which can demonstrate the anatomy of the groove.

Arthrography and CT arthrography. These were probably the first imaging techniques to identify pathology reliably; rupture and dislocation are readily identified. Static subluxations and SLAP tears are well visualised by CT in conjunction with arthrography.

MRI. This is the most widely-used method of imaging the rotator cuff. However, the agreement between MRI and arthroscopic findings has been shown to be poor, at only 60%, with a concordance of only 37% in diagnosing pathology in the biceps tendon.⁴⁷ The use of MR arthrography is preferable for detecting lesions of the biceps or of the pulley system, and is the investigation of choice for SLAP lesions. The possibilities afforded by open MRI with dynamic imaging are of great interest, but the resolution currently afforded is inferior to that of conventional MRI.

Ultrasound. More interest has recently been focused on ultrasound as a dynamic technique, and a recent report⁴⁸ has shown an overall sensitivity of 49% and a specificity of 97%. However, it was poor at diagnosing intra-articular partial tears of the tendon. Dynamic ultrasound of the hourglass biceps is currently being investigated, and the preliminary results appear encouraging. It seems likely that, with the ever-increasing resolution, the use of the Doppler ultrasound technique to define vascularity, and further experience among the operators, ultrasound will become the imaging study of choice, except for the biceps anchor and the labrum.

Arthroscopy. Currently the definitive diagnosis of pathology of the LHB is still made at arthroscopy. It is an essential part of a diagnostic routine to draw the LHB into the joint to examine the portion within the bicipital groove. A dynamic examination of the tendon should be performed, which involves visualisation of the tendon arthroscopically, while the shoulder is elevated and rotated with the elbow extended, to demonstrate an hourglass tendon or subtle instability, as well as demonstrating 'hidden lesions' of the subscapularis more accurately. This dynamic visualisation is an advantage of the 'beach chair' position for shoulder arthroscopy.

Exploration of the biceps tendon during open surgery. In open surgery on the rotator cuff the rotator interval should be opened routinely to look for hidden lesions of the upper part of the subscapularis tendon and to verify the integrity of the LHB. Such lesions are found in 20% of 'isolated supraspinatus tears'.⁴⁹

Treatment

Although isolated pathology of the LHB is increasingly being recognised, associated pathology, such as disease of the rotator cuff and glenohumeral instability, must be evaluated and treated appropriately in conjunction with the lesion of the biceps.

Conservative management. Tenosynovitis may respond to rest, physiotherapy and analgesia. Injections of steroid and local anaesthetic have both a diagnostic and a therapeutic role, but many conditions of the LHB are mechanical and, when symptomatic, require surgical intervention. Evidence in favour of conservative management for lesions of the LHB is limited and almost always includes other causes of shoulder symptoms. A Cochrane⁵⁰ review looked at 26 trials of physiotherapy for shoulder conditions, and concluded that there was some evidence for mobilisation and exercise in 'rotator cuff disorders', but no trials looked specifically at pathology of the LHB. It also concluded that there was no evidence to support the therapeutic use of ultrasound or laser in this group of conditions.⁵⁰

The only publication comparing outcomes of physiotherapy and injection of the sheath of the LHB studied patients with 'peri-arthritis'.⁵¹ The accuracy of injections around the shoulder has also been called into question,^{52,53} although again studies do not specifically include injection into the biceps sheath. Such injections have been reported to be associated with tendon rupture.⁵⁴ Intra-articular injections can relieve bicipital symptoms, but they may be ineffective if adhesions or synovitis restrict the dispersal of the injection into the bicipital groove. In the authors' view, injections into the bicipital groove should be placed under ultrasound guidance to improve accuracy, and are particularly valuable when a subacromial injection has been ineffective in the presence of an intact rotator cuff.

Subacromial decompression (acromioplasty). This has been proposed to treat tendinosis of the biceps tendon in the context of an 'impingement syndrome',⁸ but no results of the use of this procedure specifically for isolated biceps tendinosis have been reported.

Coracoid decompression (coracoplasty). This procedure has been said to be effective for the treatment of combined lesions of the biceps and subscapularis.^{55,56} It has been used infrequently during the last 15 years, but it has been recently revisited by arthroscopists.⁵⁷ Except for post-traumatic deformities of the coracoid process, its true indications are still to be clarified.

Isolated arthroscopic synovectomy. Arthroscopic synovectomy of the portion of the biceps tendon in the groove has been proposed by Neviasser et al⁵⁸ and Murthi, Vosburgh and Neviasser.⁵⁹ Arthroscopic release of the tendon sheath in the groove can relieve symptoms in a way analogous to de Quervain's tenosynovitis, but is performed infrequently and is probably applicable only when a mild amount of inflammation of an otherwise intact tendon is present. Debridement of the intra-articular portion of the tendon has been proposed in partial tears or with delamination involving less than 25% of the tendon.^{60,61} In our experience, debridement is not effective at eliminating symptoms, or at preventing rupture.

Biceps relocation and reconstruction of the pulley. This procedure has been used in an attempt to preserve and stabilise the tendon. Deepening of the biceps groove, reconstruction of the

pulley and 'tubulisation' of the tendon have been performed sporadically.^{38,62,63} The results have been disappointing, with persistence of shoulder pain and stiffness because of a stenosed, non-sliding tendon, or through recurrent instability or secondary rupture of the tendon. In a series of 14 shoulders with a subluxed biceps tendon, an attempt at relocation of the tendon and repair of the torn pulley resulted in secondary rupture in 25% of cases.⁴⁹ These procedures are not currently recommended by the authors.

Proximal reinsertion of the biceps. This may be performed arthroscopically for tears of the biceps anchor (SLAP repair). The results have been good but inconsistent.^{39,64,65} In a recent review of patients treated by one of the authors (PB) with either biceps reinsertion or biceps tenodesis for SLAP type 2 lesions, the clinical results were equivalent in terms of pain relief and function, but return to sport was more frequent in the tenodesis group. Consideration should be given to performing a biceps tenodesis for these lesions depending on the age and activity of the patient. Our approach for type 4 lesions is repair of the superior labrum or excision of a small bucket-handle tear, in conjunction with a tenodesis of the LHB.

Biceps tenotomy and tenodesis. Open tenodesis has been the preferred surgical treatment for biceps pathology, and a variety of techniques have been described. The most reliable and mechanically sound procedure has been the key-stone or the keyhole technique⁶⁶ and simple suture fixation to the transverse humeral ligament or the tendon of pectoralis major.^{67,68}

Arthroscopic tenotomy of the biceps. This was described in the French literature in 1990. The clinical observation that spontaneous rupture of the LHB could alleviate pain in rotator cuff disease led Walch et al²⁰ to develop arthroscopic tenotomy as a simple and reproducible technique in patients with massive, irreparable tears of the rotator cuff. This has now become an accepted and common arthroscopic intervention. In the study by Walch et al,²⁰ tenotomy led to an average decrease of only 1.3 mm in the acromio-humeral space. Fatty infiltration and atrophy of the remaining rotator cuff does compromise the results of arthroscopic biceps tenotomy. The results published by Walch et al²⁰ and Gill et al⁶⁹ confirm the efficacy of this simple procedure, with or without treatment of concomitant pathology.

Arthroscopic tenodesis of the biceps. This is becoming more popular with increasing operative experience. Interest is now focused on techniques using sutures only, suture anchors or interference screws (Fig. 4). Many variations have been described and several papers have compared the biomechanics.⁷⁰⁻⁷⁵ Fixation with interference screws appears to be the strongest arthroscopic technique and is recommended by the authors for isolated arthroscopic tenodesis. Tenodesis associated with arthroplasty, fracture fixation, or repair of the rotator cuff, may more easily be performed with a suture or suture anchor technique, as a result of variations in access and the limited bone stock or

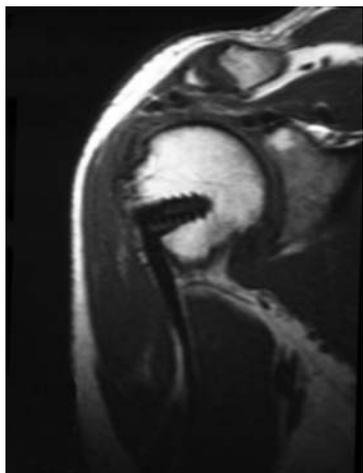


Fig. 4

MRI showing tenodesis of the long head of biceps with an interference screw.

space available for an interference screw. The site of tenodesis should be the intertubercular groove of the humerus. Other locations are non-anatomical and non-physiological, and can potentially cause dysfunction of the shoulder and pain, as emphasised by Hitchcock and Bechtol.⁷ When a soft-tissue biceps tenodesis is performed in the rotator interval, it is frequently associated with subluxation,^{76,77} and will thicken and scar the rotator interval. Attachment of the LHB to the coracoid process or the conjoint tendon as proposed in the past with open surgery,^{5,78} and more recently with arthroscopy,⁷³ also changes the course of the tendon and may produce pain caused by traction or adhesions under the insertion of pectoralis major. In addition, the increased proximal force on the humerus may contribute to subacromial impingement. Attaching the tendon to the greater tuberosity has also been proposed but this can produce a prominence which will impinge on the acromial arch. The biceps tendon should never be tenodesed in the groove and left attached to the scapula,⁶ as this leads to an iatrogenic entrapment of the LHB. The intra-articular portion of the biceps lying above the transverse ligament must always be resected. Finally, fixation to the pectoralis major tendon is simple but may produce pain by a cross-pull on that tendon.⁷

Tenotomy or tenodesis? Tenotomy may produce the classic 'Popeye' sign, although reports show little clinical difference between the two techniques,^{69,79} and as few as 40% of patients will notice the cosmetic deformity.⁶⁹ In some cases, hypertrophy, adhesions and stenosis in the groove produce an 'autotenodesis', preventing retraction of the tendon. Prolonged ache in the belly of the biceps muscle is an uncommon long-term complication of tenotomy and has been described in association with tenodesis.⁷¹ The loss of strength at the elbow resulting from rupture has been put at

20% of forearm supination and 8% to 20% of elbow flexion.^{68,80} In patients with massive, irreparable cuff tears, Maynou et al⁸¹ found that after biceps tenotomy, the muscle force for elbow flexion-supination was decreased by 40%, compared with a matched control group. Hence, elderly patients with low functional demand are candidates for tenotomy, whereas younger patients, manual workers and patients who may object to a cosmetic deformity are more suitable for tenodesis.

Acromioplasty has been carried out in association with a biceps tenotomy or tenodesis. Many years ago, Becker and Cofield⁶⁷ and Dines, Warren and Inglis⁸² advised against bicipital tenodesis without decompression, but recent studies have found that associated acromioplasty has little or no additional value. In a series of 40 patients with massive, irreparable cuff tears operated on for tenotomy alone (32 patients) or in combination with acromioplasty (eight patients), Maynou et al⁸¹ found that a complementary acromioplasty did not confer additional benefit. In their series of 307 patients followed between two and 14 years, Walch et al²⁰ found that concomitant acromioplasty was beneficial only in patients who had a normal acromiohumeral interval (> 7 mm) and an isolated supraspinatus tear. Other patients did not benefit from acromioplasty, and indeed it may be detrimental in patients with pre-operative proximal migration of the head of the humerus.²⁰

Specific situations

The broad indications for surgery have been discussed above, but there are specific situations that may not be related to pathology of the LHB, but which warrant consideration of operation on the tendon.

Loss of active elevation associated with a large rotator cuff tear. When surgical repair is not indicated or is not feasible, tenotomy or tenodesis of the LHB can be effective in restoring active elevation. In a series of 15 cases with loss of active elevation below the horizontal, tenotomy or tenodesis improved active elevation in all cases.²⁰ It is important to differentiate these cases of 'painful loss of elevation' from a true 'pseudoparalytic shoulder' with anterosuperior escape of the humeral head and insufficient strength to maintain the extended arm above the horizontal. These latter patients will not benefit from tenotomy, and we consider this circumstance to be a contraindication to arthroscopic biceps tenotomy or tenodesis. A massive cuff tear with advanced glenohumeral osteoarthritis (OA) or necrosis of the head of the humerus (Hamada⁸³ stage 4 and 5) is also a contraindication to an isolated biceps release.⁸³

Routine tenotomy or tenodesis with cuff repair. When to perform a tenotomy or tenodesis of the LHB with a repair of the rotator cuff is questionable. Some surgeons advocate routine tenodesis for all cuff repairs, some only in association with tears of subscapularis, and others only in the presence of significant pathology of the biceps. We systematically perform a biceps tenodesis with repair of the rotator cuff. Anatomical and clinical studies have shown

that there is a tendency towards degeneration of the tendon in the distal, extra-articular portion of the biceps.⁸⁴ In a series of 80 patients undergoing biceps tenodesis, only 49% of grossly inflamed, fibrotic and degenerated tendons were seen intra-articularly with the arthroscope.⁵⁹ This study also found that the incidence of biceps pathology was directly proportional to the extent of disease of the rotator cuff and to the age of the patient. In subscapularis tears, the biceps pulley is nearly always disrupted or damaged and dynamic arthroscopic exploration of the shoulder has shown that instability and entrapment of the LHB is frequent. Surgical repair of the anterior portion of the supraspinatus or subscapularis is unlikely to allow normal movement of the biceps in the groove or at the entry to the joint, and clinical studies have shown that associated biceps tenodesis improves the results of repair of the cuff in the long term.⁸⁵ The functional role of the tendon of LHB on glenohumeral stability and depression of the head is limited. Hence, retaining an abnormal tendon has more negative functional consequences than the loss of the tendon itself. A number of failed rotator cuff repairs may be attributed to persistent problems with the LHB.

Repair of the biceps after spontaneous rupture without a cuff tear. Elderly patients with limited activity should be treated conservatively.^{86,87} In some patients, although the functional deficit is minimal, they may complain of cramps during occupational activities involving flexion of the elbow and supination of the forearm, typically when using a screwdriver or lifting a weight. In the young (< 60 years) active patient, when seen early, ideally in the first six weeks, an open biceps tenodesis can be performed through a small, medial incision. Mariani et al⁶⁸ compared 26 patients who had an early tenodesis for a rupture of the LHB with 30 who had conservative treatment. On biomechanical testing, the conservative group had lost 21% of strength of supination compared with 8% for the surgical group.⁶⁸ However, Warren,⁸⁸ using Cybex testing in ten patients with chronic ruptures of the LHB, found only 10% of loss of power of supination.

Return to sports after biceps tenodesis. O'Donoghue⁸⁹ performed tenodesis of the LHB in the groove in 53 young athletes as treatment for an unstable tendon; 77% resumed sports and could throw satisfactorily after surgery. Our experience is similar with high-level athletes who were able to return to sports at the same level.

The biceps in shoulder arthroplasty. Biceps tendonitis is a recognised complication of shoulder arthroplasty,⁹⁰ and many series describe revision surgery for such lesions. In OA, loose bodies and debris often accumulate in the bicipital groove and marginal osteophytes are common. With arthritis associated with a tear of the cuff, abnormality of the LHB is almost inevitable, though many will have ruptured spontaneously. During arthroplasty, the subscapularis tenotomy/osteotomy, capsulotomy of the rotator interval and repair of subscapularis may also compromise the function of the LHB. We therefore recommend teno-

desis of the LHB in all cases of prosthetic shoulder replacement.⁹¹

The biceps in proximal humeral fractures. The treatment of fracture of the proximal humerus is still controversial. The LHB and bicipital groove are important anatomical landmarks in the treatment of these fractures.¹² Neer⁸ three- and four-part fractures may affect the bicipital groove, although the primary fracture line is usually more posterior. Equally, fixation techniques such as cerclage sutures may involve or compromise the movement of the LHB. In these situations, and in prosthetic replacement for fracture, we recommend tenodesis of the LHB as a routine part of the reconstruction.

Summary

Pathology of the long head of the biceps brachii is increasingly recognised as an important cause of shoulder pain and dysfunction. However, it is still not completely understood and the diagnosis is both clinically and radiologically imprecise. Dynamic arthroscopic examination of the shoulder has transformed our understanding of and approach to treatment for conditions of the LHB. Although the most appropriate management of the diseased tendon has been the subject of controversy, removal of the intra-articular portion, by tenotomy or tenodesis, is increasingly accepted. As it is now recognised that the functional role of the LHB tendon at the shoulder is limited, surgeons should be aware that retaining a pathological tendon has a more negative functional consequence than the loss of the tendon itself.

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