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Current concepts in the aetiology, assessment and management of partial distal biceps tendon tears

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Abstract

Partial distal biceps tendon tears encompass a spectrum of disease. They can be either traumatic or degenerative in nature. Traumatic tears usually involve the short head. Degenerative tears can involve either or both short and long head components with the tear affecting the lateral fibres first. Chronic tears may be associated with a narrow radioulnar space, distinct head insertions and radial tuberosity hypertrophy. Patient history and clinical examination findings suggestive of partial tearing of the distal biceps tendon should be confirmed with advanced imaging. Magnetic resonance imaging allows assessment of the tear size, morphology and associated pathologies. Non-surgical management, including physiotherapy and injections, is appropriate in selected cases. Surgical management can involve either endoscopic or open techniques. In small tears or low demand patients, a simple debridement of the bursa, tuberosity and tendon may be indicated. In larger tears in higher functioning patients, release of the remaining fibres, debridement and an anatomical repair is indicated. In this review paper, the authors present current concepts on the pathogenesis and management of partial distal biceps tendon tears.

Keywords
Partial distal biceps tendon tear, endoscopy, pathogenesis, management, review

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Introduction

Partial distal biceps tendon tears (PDBTs) encompass a spectrum of disease, from tendinopathic micro-tears to near-full-thickness rupture from the radial tuberosity. The pathology has become increasingly recognized with magnetic resonance imaging (MRI scanning), although it's true prevalence in the population is unknown.[1,2] The mechanism of *full-thickness* distal biceps tendon tears is well reported with a defined episode of injury, deformity, pain and weakness. As a result, these patients tend to present acutely. *Partial* tears, on the other hand, may have a variable presentation, with either an insidious or acute traumatic history, pain, mechanical symptoms and subtle examination findings. As a consequence, the condition may remain undiagnosed or mismanaged, leading to a delay in treatment.

Recommended management algorithms for PDBTs typically focus on patient factors and a tear percentage of 50% as a guide for conservative treatment versus repair. The '50%-rule' on a 2-dimensional MRI measurement, however, is likely an over-simplified parameter for a complex three-dimensional structure with known anatomical variants.

In this article, we challenge traditional dogma and review current concepts in the aetiology, pathogenesis,

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and management of PDBTs using current evidence and author's experience. An improved understanding of PDBTs will enable an effective patient-based approach to management of the condition.

Anatomy and biomechanics

Biceps tendon anatomy is highly variable with a spectrum reported in the literature. The biceps short head tendon arises from the coracoid process and the long head tendon arises from the supraglenoid tubercle. The muscle bellies may remain separate throughout their entire length or interdigitate. The muscles are surrounded by loose epimysium. The short remains ulnar with the long head radial.[3]

The short and long head may remain distinct or coalesce before insertion. Eames et al. dissected and examined 17 cadaveric specimens. In all patients, the distal separate tendons could easily be separated throughout their length, whether there was corresponding muscle interdigitation at the pre-aponeurotic level or not. The long head inserted as an oval, with the short head in a 'fan-like' configuration.[3] Boyle et al. assessed the anatomy of 106 normal elbow using 3T MRI scans.[4] They found that 91% exited the biceps muscle as single discrete entities, with the same proportion coalescing, with indistinguishable separation prior to insertion. Interdigitation occurred at a mean of 38 mm from the musculotendinous junction. They found the mean total footprint width (10 mm) and length (16 mm) to be similar between individuals with narrow confidence intervals, and a mean tendon insertion 'footprint angle' – in reference to the longitudinal axis of the radius, of 32 degrees.

The biceps short head is positioned further from the axis of joint flexion and has traditionally been considered a more powerful flexor. The long head is positioned more proximally, wrapping around the radial tuberosity and has been considered a more powerful supinator. More recent studies, however, have cast doubt on this hypothesis. Bhatia et al. showed a large variation in footprint insertions.[5] Tomizuka et al. found, with serial cadaveric sectioning of the distal biceps to simulate a partial tear, that the greatest loss of supination occurred with a complete short head avulsion.6 Therefore, the precise footprint anatomy and biomechanical role of each biceps head may differ between individuals.

Pathogenesis and classification

Partial tearing may have either a traumatic or degenerative aetiology. Isolated tearing of the short head is rare but can occur following trauma in the presence of a bifid distal tendon. In an acute injury, it is thought that the short head tears under tension first when the elbow is near extension with the force propagating up the bifid tendon sparring the long head, although the exact mechanism is debated.

More commonly, PDBTs may be degenerative or attritional. Boyle et al. reviewed 26 cases on MRI scan, and compared these to a control group. Larger radial tuberosities, the presence of enthesophytes and a smaller radioulnar space were significantly more common in the PDBT group ($p < 0.05$). It is unclear if tuberosity changes lead to PDBTs or whether these changes are secondary to biceps tendon pathology, but it does suggest that an attrition of the distal tendon between the radial tuberosity and ulna may be the cause of a PDBT in select cases.[2] Degenerative tears are a heterogeneous group. We studied the morphology of partial tears on MRI scan.[6] Either the short head or long head can rupture in isolation. They can involve part of either the short or long head insertions, or both. Usually, the tear begins on the lateral (radial-sided) fibres and can be seen to be 'peeling off' the tuberosity at endoscopy or on MRI.

The presence of two discrete tendons that do not interdigitate before insertion appears to be more common in the PDBT group compared to a control group of normal elbows ($p < 0.05$). Discrete single-head insertions are more likely to rupture in isolation, leaving the other head intact on the radial tuberosity (Figure 1).

Clearly, the morphology of PDBT varies significantly. Unlike partial tears of the rotator cuff, there are no natural history MRI studies on PDBT.[7] This should be considered and discussed with patients when making treatment recommendations.

History and examination

Patients usually present primarily with pain in the antecubital fossa and forearm but may also report some weakness in activities involving flexion and supination. This may be more noticeable after an unfamiliar volume of activity, such as manual labour.[8,9] While swelling and bruising in the antecubital fossa and forearm may suggest an acute injury, these symptoms are often not present.[10] Patients may also describe mechanical symptoms, such as a 'click' or 'grind' – particularly in cases with a hypertrophic radial tuberosity with radioulnar impingement.

On inspection, swelling in the antecubital fossa may be seen due to bicipitoradial bursitis. Tenderness at the DBT is usually identified, with pain elicited by resisted flexion and supination. The tendon is usually palpable. Nonspecific clinical findings in the presence of a palpable tendon may result in delay to diagnosis. Several provocative tests have been developed in recent years to aid in the diagnosis of PDBT, tendinosis or bicipital bursitis.[11–13] The site of pain is important. Tenderness at the tuberosity insertion may reflect partial tearing, with pain proximally over the tendon substance itself more likely in the presence of a tendinopathy.

Biceps pistoning should be assessed. The patient pronates and supinates the forearm, while the examiner

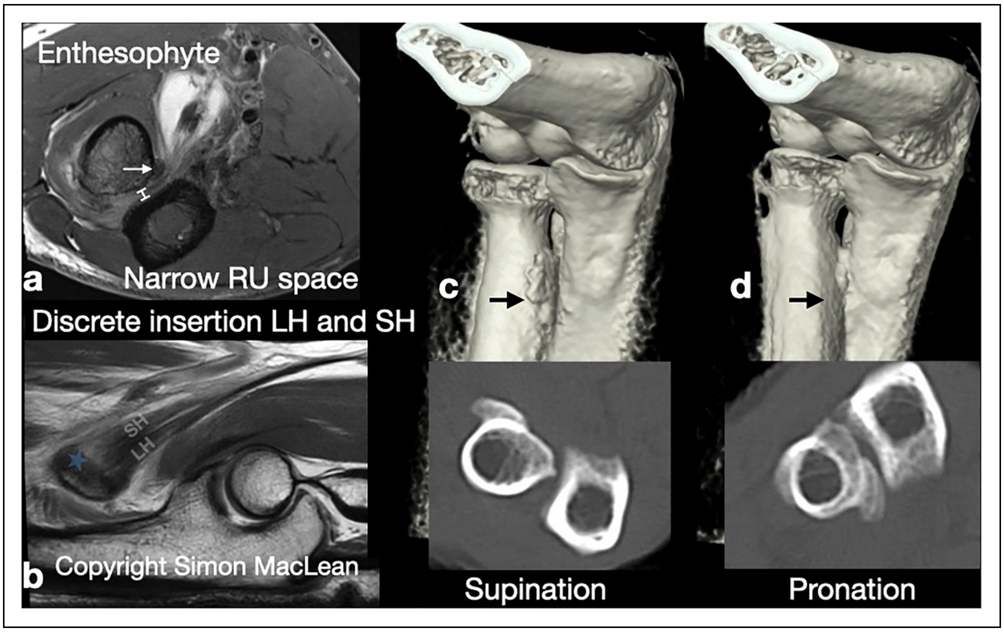

Figure 1. Anatomical factors associated with partial distal biceps tendon tears. (a) Axial MRI slice showing an enthesophyte on the radial tuberosity with a narrow radioulnar space. (b) Sagittal MRI slice showing discrete insertions of the long and short head with a short head tear (blue asterisk). (c, d) Dynamic 4D CT images with axial equivalents showing significant narrowing of the radioulnar space in pronation from supination (radial tuberosity – black arrow). Copyright Mr Simon MacLean. MRI: magnetic resonance imaging.

observes the biceps piston in the upper arm. The examiner should look for proximal migration on the biceps muscle bulk and compare it to the other side. The complete tear will have proximal migration with minimal piston with forearm rotation.

The TILT sign involves passively supinating and pronating the patient's forearm with the elbow flexed to 90 degrees while palpating the dorsal forearm overlying the radial tuberosity. The tuberosity presents itself beneath the examining fingers with full pronation of the forearm. A positive test result is indicated by tenderness over the radial or lateral aspect of the tuberosity (tilt sign) only in full forearm pronation and not in supination.[13]

The biceps palpation-rotation test is a variation of the TILT sign and is performed by palpating the bicipital tuberosity at the lateral forearm while ranging the forearm from supination to pronation with the arm adducted at the patient's side and the elbow flexed to 90 degrees. A positive test elicits tenderness at the tuberosity with the arm in pronation but not in supination.[14]

The resisted or 'yielding' hook test involves positioning the shoulder in horizontal abduction with the elbow at 90 degrees and the forearm supinated (Figure 2). The biceps tendon is 'hooked' on the radial side of the tendon by the examiner's index finger, and the patient is instructed to resist a pronation torque applied by the examiner. The test result is positive if this manoeuvre is painful or if tension of the tendon is decreased compared to the contralateral side.[12]

The distal biceps provocation test is performed with the patient standing and the elbow supported by the examiner and flexed to 70 degrees (Figure 3). The examiner's hand is placed on the patient's forearm, and the patient is asked to flex their elbow against resistance with the forearm supinated, then repeating the test with the forearm pronated, and documenting pain using a visual analogue scale. The test is positive if the patient reports an increase in pain with the pronated position compared to the supinated position. This can be explained as the abraded tendon is compressed against the bone as it wraps around the radius in pronation.[11]

A study by Caekebeke et al. in 2022 evaluated the TILT sign, the resisted hook test and the biceps provocation test in a single patient cohort.[15] They found that the biceps provocation test yielded higher accuracy than the resisted hook test and the TILT sign. When the biceps provocation test and the resisted hook test were combined, the sensitivity increased to 98%. (Table 1)

The proximal radioulnar grind test, described by MacLean, is analogous to the distal radioulnar joint grind test (Figure 4). Compression of the proximal radius and ulnar with passive pronosupination produces pain at the elbow and crepitus- particularly in patients with a narrow radioulnar space and hypertrophic radial tuberosity.

Integrating these tests into daily practice may help minimize delays in the diagnosis of partial distal biceps tendon ruptures. However, as clinical evaluation cannot distinguish between a partial biceps tendon rupture and tendinosis or

Figure 2. (a) Examining supination against resistance. (b) The 'yielding' hook test – tested with the elbow at 90 degrees and the forearm supinated. Copyright Dr Greg Bain.

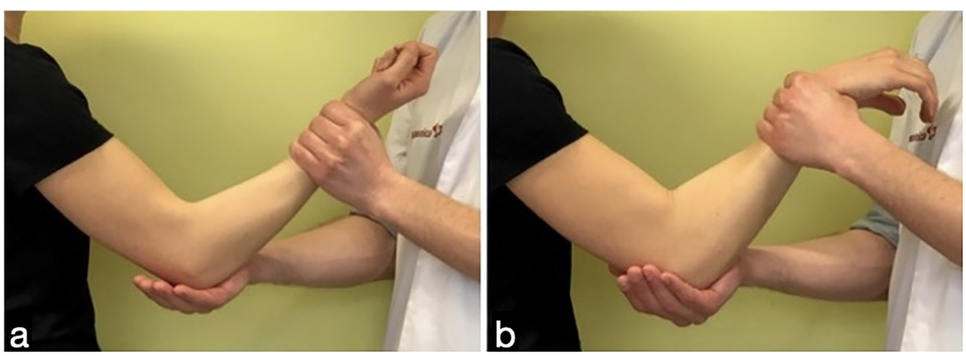

Figure 3. The BPT is a two-part test. (a) The patient is standing, with the elbow supported by the examiner and flexed to 70 degrees. The examiner's hands are placed on the patient's forearm and the patient is asked to flex the elbow against resistance with the forearm supinated (BPTs). (Copyright MoRe Foundation) (b) The forearm is then pronated, and the test is repeated (BPTp). Care is taken not to place the hands on the hand or wrist as resisted wrist flexion or extension might elicit pain in other elbow pathologies. (Copyright MoRe Foundation).

Table 1. The sensitivity and specificity of clinical test for DBT partial tear.

	Original paper[11, 13, 14]		Caekebeke et al.[15]	
	Sensitivity	Specificity	Sensitivity	Specificity
The TILT sign	100%	NA	58%	55%
The resisted hook test	100%	98%	78%	76%
Biceps provocation test	100%	100%	95%	97%
Biceps palpation-rotation test	100%	NA	NA	NA
The resisted hook test + Biceps provocation test	NA	NA	98%	73%

bursitis at the distal biceps tendon insertion, advanced imaging is still recommended to grade the lesion and determine appropriate treatment.

Imaging

Imaging studies play a critical role in the diagnosis and management of PDBTs. Advanced imaging outlines the morphology of the tear and associated conditions pathology such as tuberosity enthesophytes, hypertrophy and radiobicipital bursitis.

Standard radiographs are a useful first-line investigation. These may reveal radial tuberosity hypertrophy or osteophytes which may be addressed during surgical treatment, if needed.[16]

We recommend MRI scanning for advanced imaging of these injuries. Ultrasound has obvious limitations, is operator-dependent and is less reliable in determining PDBT versus normal tendon. MRI is commonly used in the diagnosis of DBT pathology, and the sensitivity and specificity of an MRI for complete tears are reported to be 100% and 82.8%, respectively.[17,18] However, the sensitivity for partial tears or other distal biceps tendon pathology is significantly lower (sensitivity 59.1% and specificity 100%). To optimize the view of the distal biceps tendon from the musculotendinous junction to its insertion, a flexion abduction supination (FABS) view was suggested in 2004 (Figure 5).[19] This view shows a longitudinal view of the DBT often in one image. This view has been widely adopted because it was thought to be better in diagnosing DBT lesions. However, a recent retrospective evaluation showed no significant difference in sensitivity and specificity for the FABS view MRI compared with standard MRI in the detection of distal biceps injuries.

Figure 4. The proximal radioulnar 'grind' test. The proximal radius and ulnar are compressed to narrow the radioulnar gap whilst passively pronation the forearm from full supination. A 'click' or pain at the elbow is associated with distal biceps pathology. The patient's face should be examined for apprehension when performing the manoeuvre. Copyright Mr Simon MacLean.

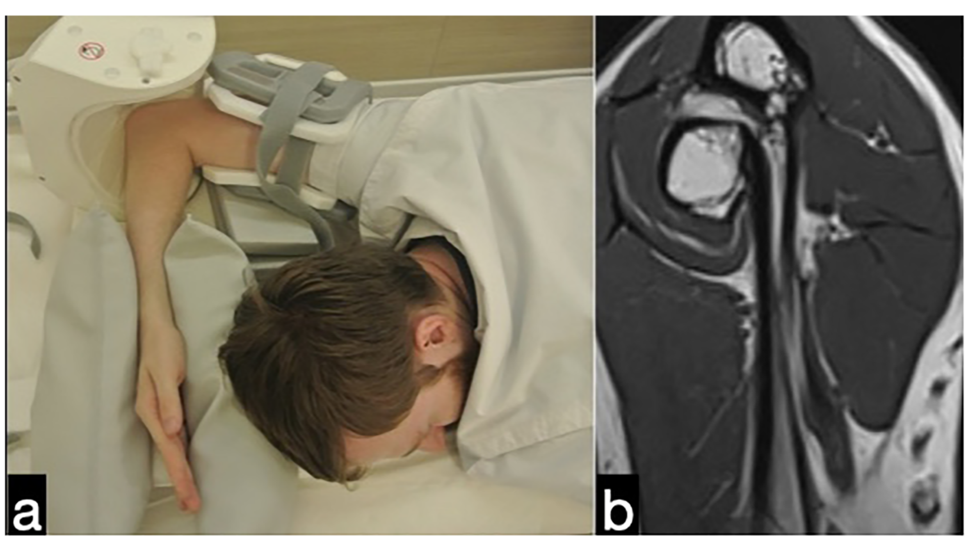

Figure 5. (a) Flexion abduction supination view positioning with shoulder abduction and elbow flexion-supination. (b) Flexion abduction supination magnetic resonance imaging view (three-dimensional double-echo steady state with water excitation) showing normal distal biceps tendon. The entire tendon can be viewed from the insertion to the musculotendinous junction on a single image. (Copyright More Foundation).

It did show a higher inter-rater reliability and more accurate grading of the extent of the pathology on the FABS view compared to standard MRI (Figure 5).[20]

MRI scanning allows the morphology of the tear to be determined, with any associated pathology – and this can be used to dictate treatment.

Dynamic 4D-CT scanning has been performed for patients with mechanical symptoms in their elbow. Hypertrophied radial tuberosities with impingement and dynamic radioulnar gap narrowing can be determined although we would not consider this a routine investigation in our practice.[21,22]

Management

Management of a PDBT injury should be dictated by the underlying pathology, imaging findings and patient features. Acute PDBT tears that primarily affect the short head should be managed in the same manner as a complete tear, whereas chronic injuries that present without a clear history of trauma and imaging findings consistent with degenerative pathology, such as bursitis or tendinopathy, should be managed with a similar algorithm to other degenerative tendon disorders.

Non-surgical management

It is reasonable to consider non-surgical management for all distal biceps pathologies. While full-thickness acute tears tend to be relatively painless despite loss of muscle power and altered cosmesis, partial tears and tendinopathy pose a different challenge, as they often cause patients substantial pain with activity. When treating a patient non-surgically, it is important to emphasize that there is no evidence to suggest tendinopathy or a degenerate partial tear will progress to a full-thickness rupture. This reassures both clinicians and patients that non-surgical management is both safe and worthwhile as a first-line measure.

Physiotherapy

This is first-line treatment for the majority of patients, even in the presence of low-grade structural tendon damage or secondary bursitis. It is certainly the most important treatment for patients with interstitial tendinopathy without associated structural tendon damage or extensive bicipitoradial bursitis.

Activity modification involves a reduction in activities that aggravate the patient's symptoms or modification of how these activities are performed. Frequency, maximal load and the position of forearm rotation and elbow flexion during lifting can be adjusted. Structured rehabilitation should include consideration of the site of disease within the DBT. For instance, patients with insertional tendinopathy with or without associated enthesopathy or tuberosity changes should avoid exercises in pronation due to the compression of the tendon within the radioulnar space. These patients are more likely to have attritional tears that may not respond as well to therapy. Conversely, disease localized to the tendon itself is more likely to respond to therapy. In these patients, the avoidance of pronation is not as important but pronation does still place the biceps at its maximal length when the elbow is extended.

There is little robust evidence available to recommend the best physiotherapy programme for distal biceps tendinopathy or partial tears.[23,24] Massaging and rubbing a painful tendon is not advised and eccentric strengthening is no longer the mainstay. Therapy tends now to focus on isometric low to moderate loads and permissive acceptance of mild pain during loading. Pain greater than 3 on a visual analogue scale or pain that lasts into the next day should be avoided and the programme adjusted.

Four general stages of rehabilitation may be considered beginning with isometric loading then strengthening with increased load, followed by functional strengthening exercises such as pulling and finally explosive exercises. At each stage, initial mid-range exercises are followed by gradually working into extension before progressing to the next stage. Patients should expect this process to take a minimum of 3 months and frequently up to 6 months with good compliance.

Injection therapies

Injection treatments may be considered after a sustained period of activity modification and physiotherapy that has not improved the patient's symptoms. They are most likely to work for degenerative tendinopathy, synovitis or bursitis where there is no significant structural damage to the tendon insertion. Both corticosteroids (CSI) and platelet-rich plasma (PRP) injections have been described in the literature for treatment of distal biceps tendinopathy but with very poor-quality evidence to make scientific recommendations.[25,26] There is even less good quality evidence for other injection therapies to treat DBT pathology and hence only PRP and CSI will be discussed here. Injection treatment is best performed using ultrasound guidance due to the depth of the tendon insertion and the proximity of neurovascular structures. It is advised that an experienced musculoskeletal radiologist or an individual trained in ultrasound evaluation of the DBT should perform injections.

Corticosteroid treatment. While in general, corticosteroid injections (CSI) should be avoided where possible due to the effect of steroid on tendon homeostasis, they are still used by some clinicians. CSI may be more effective in the presence of bursitis or synovitis rather than structural damage, and if used, patients should be counselled regarding the potential deleterious effects. It is essential that if used CSI should not be placed into the DBT itself. Lee et al. managed 12/19 PDBT patients with ultrasound-guided CSI with symptomatic relief, although follow-up was only 6 months.[27] Maree et al. reported a case note review of 20 patients following CSI performed in clinic, with a mean follow-up of 40 months. 18/20 elbow returned to full function, although 5/20 had only partial relief, and one had no relief.[25] Technique for injection was by two methods, using 2 ml lignocaine HCL, 2%, and 1 ml of corticosteroid (Celestone); (a) Clinically, with the arm fully supinated at the point of maximal tenderness (volar entry), or (b) ultrasound-guided with the arm in full pronation (dorsolateral entry).

Platelet-rich plasma. PRP use for tendinopathy is relatively common. Compared to CSI, it is not associated with progression of tendon disease or rupture, hence may be a safer alternative to CSI. However, the reports of PRP use for DBT tendinopathy are sparse. In addition, the treatment is expensive and there is a myriad of PRP formulations with no clear indication which may be most effective for treatment of tendinopathy. Hence, if used, patients should be counselled regarding the lack of high-quality evidence for its use in tendinopathy in general and also specifically to the DBT.

Open surgical treatment

Surgical treatment for PDBTs can be performed open, endoscopically assisted or by endoscopy only. Endoscopic surgical treatment is most beneficial in the presence of bursitis and synovitis or in order to assess the tendon insertion for small interstitial tears. However, biceps endoscopy requires advanced training which is difficult to acquire with the relatively small number of cases that require surgical treatment.

When surgical treatment is indicated, open surgery remains the mainstay approach although much of what can be achieved through an open approach can also be done endoscopically in experienced hands.

Open surgery may be used to address the following conditions:

- Bursitis and synovitis
- Degenerate or acute partial tears for repair or debridement
- Radioulnar impingement caused by a narrowed radioulnar space

A standard single incision volar approach is advocated for surgical assessment and treatment of the diseased DBT, although a posterior approach has been described as well.[28] A volar approach allows ready access to the bicipitoradial bursa, the tendon throughout its length and the lateral aspect of the insertion where tears typically originate. All surgical procedures can be performed through this approach, and this is therefore our preferred approach.

Acute short head tears

This is an uncommon entity that has been postulated to occur in patients with a bifid tendon insertion (Figure 6 and 7).[29] These tears present like an acute full-thickness tear with a clear history of injury, asymmetry of the biceps and bruising that occurs the next day. Because of their acuity and the larger size of the torn short head, early surgical repair should be offered. Outcomes are good, whether the short head is repaired in isolation alongside the long head or the long head is taken down and the two repaired together.[29] If the short head is repaired in isolation a footprint technique is preferred as it is more anatomical and relocates the short head next

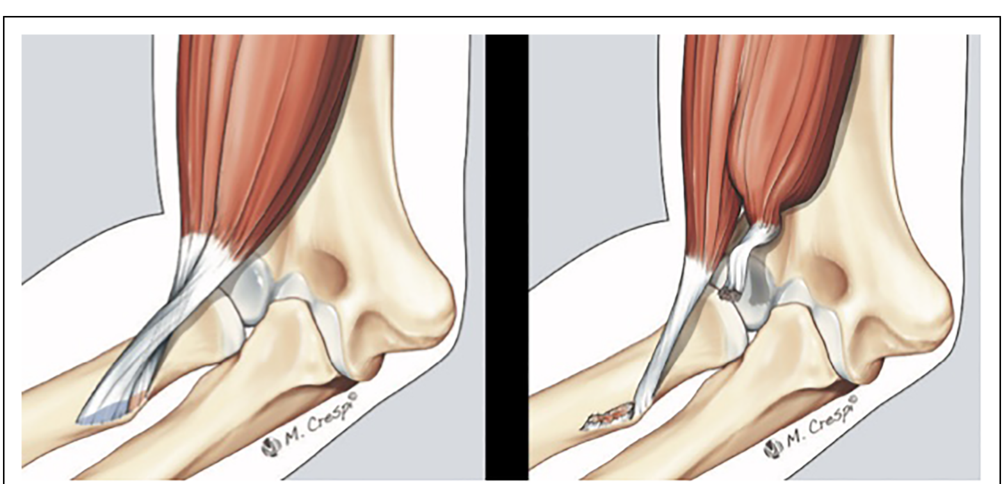

Figure 6. Propagation of force along a bifid tendon during an acute short head tear. Copyright Mr Joideep Phadnis.

to the long head.[30] A more anterior isolated short head repair is less anatomic but unlikely to give an inferior outcome. Either way, it is useful to also place stitches between the heads to re-enforce the repair and allow load sharing (Figure 8).

Chronic reconstruction of the short head in isolation has also been reported and is performed with an Achilles tendon allograft alongside the long head.[5] In the chronic setting, it may be apparent that there is bowstringing of the long head if the native short head muscle belly is significantly retracted. In this situation, the long head may be released and incorporated into the short head reconstruction to prevent a mismatch in the length tension relationship of the two heads.

Figure 7. FABS MRI scan of a patient with a chronic retracted short head tear FABS MRI scan of a patient with a chronic retracted short head tear. Copyright Mr Joideep Phadnis. MRI: magnetic resonance imaging; FABS: flexion abduction supination.

Degenerative tears

Degenerative tears are different to acute partial tears and are part of the spectrum of degenerate tendon disease. Patients present more insidiously, without a clear inciting event, deformity or bruising. They also typically have more pain than patients with acute partial tears but have preservation of power despite the pain. Degenerate tears should only undergo surgery after a trial of non-surgical treatment has been exhausted, typically after a minimum of 6 months and if the patient's symptoms persist, typically after a minimum of 6 months. Several pathologies may require treatment including avulsions or tears to the tendon insertion, bicipitoradial bursitis, synovitis and tuberosity hypertrophy or enthesopathy. Debridement of bursitis and synovitis alone is an option, however in the presence of insertional tears it is more reliable to release the tendon from the tuberosity, debride the diseased tendon and reattach it in a standard manner. The radial tuberosity should also be assessed for hypertrophy and enthesopathy and when present should be debrided. Debulking of the tuberosity may also be required in rare cases where there

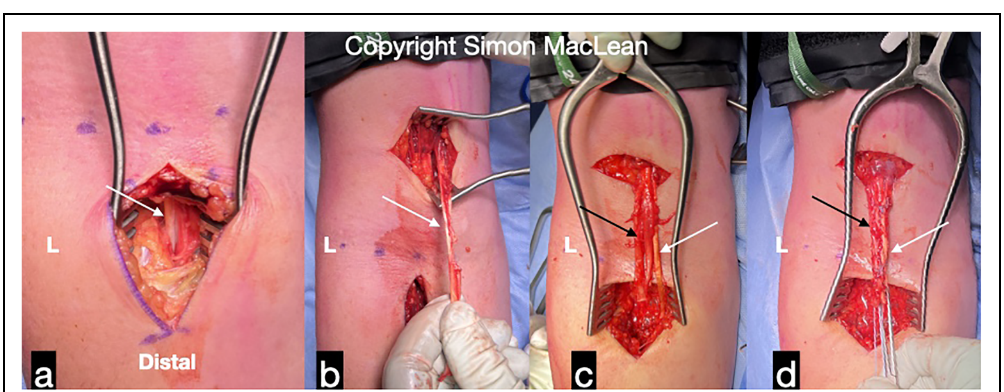

Figure 8. Open repair of a chronic short head tear with retraction. White arrow = long head, black arrow = short head. Longitudinal incision distal to the elbow crease. After incision the pseudosheath, the long head is normal in appearance and intact at it's insertion (a). The short head has retracted and is retrieved through a separate proximal incision. The long head is released distally and retrieved through the same incision (b). The short head tendon is dissected from adjacent fibrous tissue and both heads are laid adjacent to each other (c). Both heads are sutured side-by-side. The distal tendons are secured with a Krackow suture (one Krackow per head) producing four strands for a distal anatomical footprint repair (d). Copyright Mr Simon MacLean.

is tuberosity hypertrophy. In extreme cases, this can present with loss of forearm pronation or clicking and pain during forearm rotation (Figure 9).

Biceps endoscopy

Since the first description by Sharma and MacKay in 2005,[31] biceps endoscopy has become a well-established technique for diagnosis and treatment of distal biceps pathology,[6, 32] ranging from bursitis,[21] tendinopathy to various grades of partial avulsions[1] and complete DBT tears.[2, 18, 25, 26, 31] The biggest advantage of endoscopy over an open technique that the entire insertion can be visualized without pulling on the pathological tendon.[20] Several studies have shown that biceps endoscopy can be performed safely, with no added risk to the anterior and posterior neurovascular structures.[3,4,7]

Sharma and MacKay used a portal proximal to the elbow crease, resulting in an oblique tunnel in the radius, potentially placing the posterior interosseous nerve (PIN) at risk.[29] Eames and Bain described a distal anterior portal in 2006, and most surgeons have adapted this as their working portal for DBT endoscopy. Bhatia et al. described additional (proximal) portals that can be used for safe evaluation and treatment of DBT pathology.[4] Most use standard arthroscopic equipment and a 4 mm scope but a wrist scope can also be used. Recently, Reinares et al. described the use of the nanoscope (Arthrex) for DBT repair.[27]

Technique[11]

The procedure can be performed under general or locoregional anaesthesia, depending on the preference of the patient. The patient is supine position, and the arm is placed on an arm table. A tourniquet can be used but is not necessary and, in complete or isolated short head tears, can limit the reduction of a retracted tendon.

An anterior 2 cm longitudinal incision is made centrally, 3 cm distal to the flexion crease. To protect the lateral antebrachial cutaneous nerve only the skin is incised. In patients with bursitis, tendinosis or a partial tear, the superficial part of the tendon can easily be reached with minimal blunt dissection and followed to the bicipital bursa. We advise the use of Langenbeck retractors to protect the neurovascular structures in the antebrachial soft tissue.[7] With the forearm supinated, the bursa is entered, and the scope is placed between tendon and the tuberosity. The insertion is evaluated (Figure 10) and if there is an injury, it is debrided with a standard closed barrel shaver to reduce risk to associated structures (Figure 11). The shaver and other working instrument are placed through the distal part of the same volar wound. A bursectomy can be performed at this point. Care is taken to always have a clear view of the shaver tip when it is in use. After arthroscopic assessment, a decision can be made to perform debridement only, anchor repair of detached tendon or 'release and repair' – with detachment of the remaining stump, and repair.

Postoperatively the elbow is protected for 1 day with a removable splint (eXo elbow, Jakedesign, Belgium) after which the patient is encouraged to actively mobilize the elbow.

Functional outcomes

Similar to partial rotator cuff tearing, a proportion of patients with PDBT remain asymptomatic without any

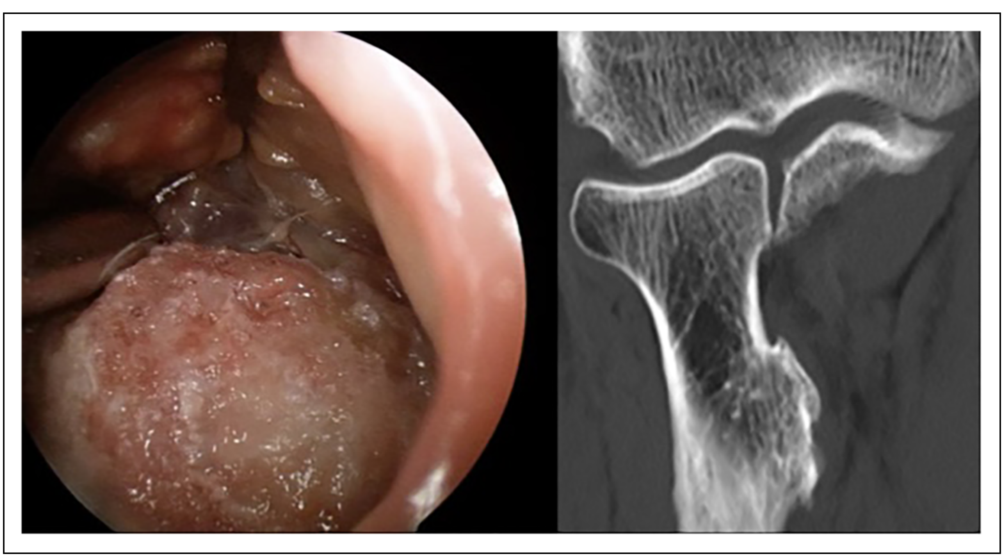

Figure 9. CT scan and intra-operative view of a patient with degenerate tendinopathy and partial tears with clicking and reduced pronation. The tendon was released and repaired and the tuberosity debulked to restore full pronation. Copyright Mr Joideep Phadnis.

functional deficit. Most studies examining the outcomes have focused on operative treatment. Surgical management in most studies report the 'release and repair' technique – with the tear being completed surgically to a full-thickness repair, before repair to the tuberosity insertion.

Figure 10. Endoscopic DBT surgery. We recommend the use of retractors to protect the anterior neurovascular structures when shavers or other instruments are used. (Copyright MoRe Foundation).

Schmidt et al. reported good to excellent range of motion and DASH scores for the 'release and repair' technique with intramedullary fixation.[31] Tagliero reported a favourable outcome with 10-year follow-up in patients managed either operatively *or* non-operatively with PDBTs with a variety of techniques. Predictors for surgical intervention included older age and supination weakness.[33] Behun et al. reported on a systematic review of 19 studies with surgical outcomes for PDBTs;[32] 94% satisfactory clinical outcomes were reported. Bauer et al. followed up 132 patients with PDBTs; 55.7% of the contacted patients who tried an initial non-operative course required surgery. Good to excellent surgical outcomes were reported for pain and function. There was no difference in outcomes in the patients who had delayed surgical treatment following an initial period of non-operative treatment. Robbrecht et al. compared surgical outcomes of partial with full distal biceps tears and found there to be no statistically significant difference between groups.[34] Worner et al. is the only study to report the outcomes of suture anchor fixation in PDBT. In comparison to endobutton fixation, there were similar good to excellent outcomes scores, but a statistically significantly higher number of failures in the suture anchor group at follow-up.[35]

There is only one study reporting the outcomes of patients with endoscopic partial *or* full DBT repairs. Jarret et al. reported outcomes of 75 patients with full DBTs using a minimally invasive approach with a

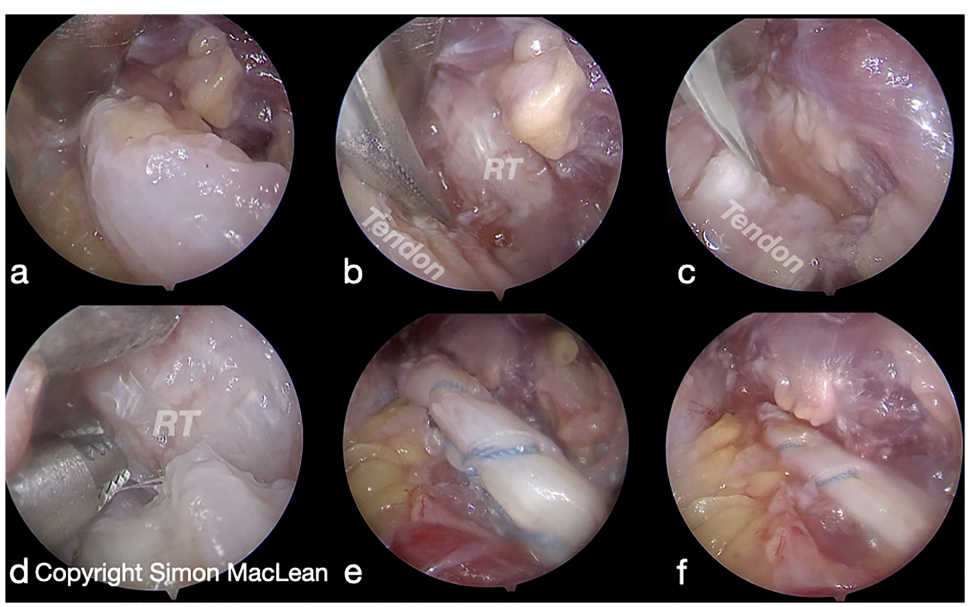

Figure 11. Endoscopic assessment of the distal biceps tendon before and after 'release and repair'. (a) A PDBT degenerative 'peel-off' lesion is identified. (b) The tendon is retracted to closely inspect the tear morphology and radial tuberosity (RT). (c) The tear is completed using sharp dissection with a scalpel off the tuberosity. (d) A closed barrel shaver is used to resect tuberosity spurs. The tendon is repaired using an onlay footprint technique, viewed in full supination (e) and pronation (f). Copyright Mr Simon MacLean.

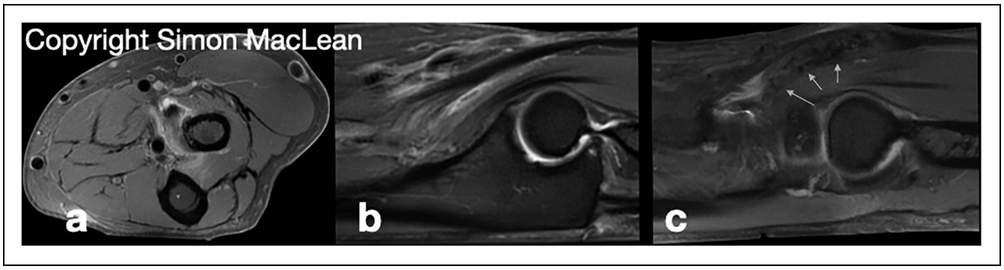

Figure 12. A partial 'peel-off' tear with the entire lateral-sided short and long head involved (a – axial, b – sagittal sequences). The entire tendon was identified to be degenerate at surgery. A release, tuberosity debridement and repair were performed. The patient remained symptomatic with pain and weakness. A post-op MRI at 6 months showing attenuated but attached heterogeneous tendon stump (c). Copyright Mr Simon MacLean. MRI: magnetic resonance imaging.

speculum and hooded endoscope. Median DASH at follow-up was 1.8 and there were only 2/72 re-ruptures.[36]

Return to play and work

Although no specific literature exists for return to play (RTP) following PDBT, several studies have reported RTP following DBT repair. These focus on return to weightlifting, National Football League, or Martial Arts following surgery, with a range of 24–40 weeks.[37,38] Full DBTs are not a comparable group to those with PDBT however, who tend to be older often with established tendinosis, therefore these results may not be translatable. A systematic review of return to work following DBT repair reported 89% of patients able to return without restriction at a mean of 14 weeks.[39]

Complications

Complications reported in the literature include, lateral cutaneous nerve neuropraxia (up to 34%), PIN neuropraxia, re-rupture and heterotopic ossification (up to 34%).[32,35] Rarely, MRI and endoscopic inspection reveals an entire distal tendon which is thin, friable, avascular, and repair of this tissue may risk re-rupture (Figure 12). In these cases, we prefer an isolated endoscopic debridement of bursa and tuberosity and avoid repair.

Summary

A high suspicion of PDBT is based on the clinical history and examination findings. It is important to differentiate a traumatic mechanism from a more insidious one. Ultimately, MRI is important to assess the morphology of the tear and associated pathologies, such as a hypertrophied radial tuberosity and bursitis.

In low demand patients or in those with an insidious history, an initial non-operative approach is recommended. In those that fail conservative management, either an endoscopic-assisted or open approach is reasonable. Endoscopy has the advantage of an accurate tear assessment with a minimally invasive approach. Debridement of the tear, bursitis and tuberosity with an arthroscopic shaver may be the only treatment required in selected cases.

For traumatic short head-only lesions, either an acute isolated hear repair can be performed or release of the remaining insertion and repair of the entire tendon. In more chronic cases or those involving the majority of the footprint, 'release and repair' with debridement and de-bulking (if required) of the tuberosity is recommended.

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