Biceps Tendon Pathology

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13.1 Introduction

Distal biceps tendon rupture is a rare injury, making up 3–12 % of all biceps injuries [15] with an incidence of 1.2 per 100,000 people [8]. Rupture results from explosive eccentric contracture against resistance, resulting in significant flexion and supination strength and endurance deficit [20]. It most commonly affects male patients between 30 and 60 [1], with other risk factors including smoking [8], anabolic steroid use [10] and weight lifting [15].

Partial distal biceps tears are far less common, may go undiagnosed for some time [14] and cause considerable anterior elbow pain during activity. There is a paucity of evidence regarding their optimal treatment; however, endoscopy is especially useful for these tears as an accurate diagnosis of the degree of tearing, tendinosis and footprint coverage can be made. Chronic tears pose a surgical challenge due to tendon retraction or pseudotendon formation but have been successfully treated by fixation in extreme flexion or by grafts.

Distal biceps repair reliably restores function regardless of technique and approach, although debate remains regarding whether to use a single- or double-incision technique and which technique is most effective. Cortical buttons, suture anchors, transosseous tunnels and interference screws have all been used with satisfactory results.

13.2 Surgical Anatomy

The distal biceps tendon can be divided into three zones: (i) pre-aponeurosis (musculotendinous junction), (ii) aponeurosis, where the lacertus fibrosus arises and (iii) post-aponeurosis, where the tendons of the short head and the long head are connected by loose connective tissue [14].

The tendon externally rotates 90° as it travels from its musculotendinous junction to its insertion at the ulna surface of the radial tuberosity. The short head passes anterior to the long head to insert in a fan-like manner into the distal portion of the radial tuberosity. The long head has an oval footprint and inserts proximally and more posteriorly to the short head, occupying most of the tuberosity [18, 23]. Therefore, in full supination, the long head of biceps tendon drapes around the radial tuberosity.

The teardrop-shaped bicipitoradial bursa completely encompasses both parts of the tendon and is more adherent to the ulna aspect of the distal biceps than the radial aspect. It lies between the

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groove in the brachialis muscle and the distal biceps tendon with the elbow extended and between the proximal radius and the biceps tendon during pronation (Fig. 13.1).

The tendon footprint is located at the posteromedial margin of the radial tuberosity, 25–30° posterior to the frontal plane. It measures a mean length of 21 mm, with a width of 7 mm, and has footprint of 108 mm [12, 15].

Both partial and complete ruptures occur at the tendon-bone interface. Considering that the biceps tendon insertion has a lever of approximately 1 cm relative to the rotational axis of the radius, at least 3.0–3.5 cm of distal biceps tendon is needed to wrap around the proximal radius during its rotation from 90° supination to 90° pronation [27].

13.3 Presentation and Investigations

13.3.1 History

There is usually a history of sudden and sharp extension load to an elbow flexed at 90° with the biceps in a contracted state. This is followed by sharp pain, typically in the antecubital fossa, but sometimes felt in the posterolateral elbow. These may be associated with an audible "pop" [1].

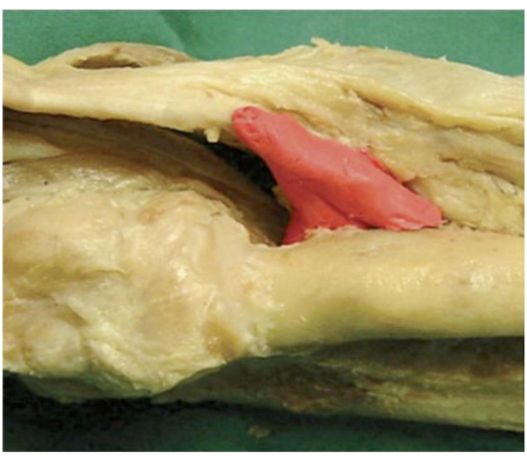

Fig. 13.1 Location of the bicipitoradial bursa between the distal biceps tendon and the radius (proximal, *left*; distal, *right*) (Used with permission from [5])

Partial tears tend to be more painful than complete tears and patients tend to remain symptomatic or progress despite non-surgical treatment [17, 18].

Those with distal biceps tendonitis/tendinosis or bicipitoradial bursitis often present with deep-seated anterior elbow pain, generally exacerbated by repetitive use. The condition is atraumatic but patients often relate their symptoms to a vague inciting event. Uncommonly for distal biceps pathology, these patients tend to be female often with co-morbidities that predispose to tendon degeneration such as diabetes, renal disease and immunosuppressive therapy.

An unrepaired rupture leads to a deficit of 27 % in supination and 47 % loss of supination endurance when compared with the normal contralateral arm. Flexion strength and endurance are decreased by 21 % [2]. Freeman et al. (2009) found a mean 25 % reduction in supination strength but only a statistically non-significant 7 % loss of flexion when compared with the normal contralateral arm.

13.3.2 Examination

In any tear, there may be ecchymosis over the antecubital fossa, palpable gap in biceps tendon and/or tenderness on palpation over the radial tuberosity. Weakness of supination against resistance tends to be more marked than flexion as brachialis compensates for weakness of flexion.

The signs of partial tears are subtle and diagnosis is difficult owing to unreliable clinical examination. There may be crepitus or grinding on passive rotation of the forearm [4] and weakness of resisted supination. A direct tuberosity compression test has been described where the examiner palpates the lateral aspect of the fully supinated radium 2.5 cm distal to the radiocapitellar joint. The patient is then asked to rotate the forearm. If this elicits more pain than the normal contralateral side, the test is considered positive [11].

Several clinical tests to aid in the diagnosis of complete rupture have been described [28], described the hook sign (Table 13.1), where the patient is asked to actively supinate and flex the elbow to 90°. The examiner then hooks their finger under the distal biceps tendon from the lateral aspect of the elbow. In the case of a complete distal biceps tendon rupture, the hook test is thought to be the most useful test in making the diagnosis, as the examiner is unable to satisfactorily hook their finger under the tendon. However, it can be unclear when the biceps tendon sheath remains attached distally despite retraction of the tendon or when a pseudotendon develops to bridge the gap in a chronic tear. The hook test is also unclear in partial or single head ruptures. In Table 13.2, the features of the hook test have been correlated with pathologies in which they might appear.

Table 13.1 Clinical assessment using the hook test

Hook test finding	Grade	Features of tendon
Normal	N	Taut, unyielding and symmetric with contralateral arm
Abnormal	A1	Taut, but yielding and asymmetric with contralateral arm
Abnormal	A2	Lax and asymmetric
Abnormal	A3	Absent cord

13.3.3 Imaging

Plain radiographs are not particularly helpful in the diagnosis of tendon rupture, but AP and lateral X-rays should be sought for preoperative planning.

A new *ultrasound* technique involving a medial approach through the pronator window has been adopted to diagnose distal biceps tears. This technique has resulted in more complete

Table 13.2 Classification, clinical findings and management of distal biceps pathologies

Grade	Injury	Clinical	Hook test	MRI	Recommended management
0	Tendinosis, bursitis	Atraumatic, tender, swollen	N	Bursitis, effusion, tendinosis	Nonoperative, bursectomy, biopsy
1A	Low-grade partial tear (<50 % footprint detachment)	Pain and weakness against resistance	N, A1	Bursitis, effusion, footprint irregularity	Endoscopic debridement
1B	Isolated head rupture	Weakness against resistance	A1	Isolated head avulsion	Repair isolated head
1C	High-grade partial tear (>50 % footprint detachment)	Pain and weakness against resistance	A1	Incomplete footprint detachment	Complete and repair
2	Complete tendon rupture, lacertus intact	Tendon medialised by intact lacertus, marked weakness	A2	Complete footprint detachment, tendon within sheath	Repair
3	Complete tendon and lacertus rupture with retraction	Retracted muscle, marked weakness	A3	Complete footprint detachment, retracted tendon and muscle	Repair
4A	Chronic rupture	Tendon medialised by intact lacertus, marked weakness	A1, A2	Complete detachment and contracted tendon within sheath (A2). A pseudotendon may bridge the native tendon to the footprint (A1)	Repair
4B	Chronic retracted rupture	Retracted muscle, marked weakness	A3	Complete footprint detachment, retracted tendon within fibrous cocoon	Repair in flexion or use tendon graft

visualisation of the ulnarly facing radial tuberosity and distal biceps insertion [30] but remains less reliable than magnetic resonance imaging (MRI).

MRI has been shown to depict the level and nature of the tear (Table 13.2). A FABS view (flexed, abducted and supinated views) has been described to allow a longitudinal view of the tendon to be obtained in one slice [6], allowing easier recognition of pathology. However, MRI has a sensitivity of 59 % for partial ruptures and cannot distinguish between those that require repair and those that do not [19].

13.3.4 Indication for Endoscopy

Endoscopy can provide both diagnostic and therapeutic implications in distal biceps pathology and has become the gold standard for diagnosis in our practice. It is particularly useful in assessing and diagnosing suspected partial or complete tears, extent of the tear and quality of residual tendon to allow for repairs in the acute setting. In chronic cases, endoscopy allows for identification and debridement of the pseudotendon and any scar tissue that extends to the footprint on the radial tuberosity and facilitates retrieval of chronically retracted tendons.

However, endoscopy is relatively contraindicated in patients with pre-existing abnormal anatomy, such as from previous injury or surgery at the elbow and antecubital fossa. Additionally, endoscopic repairs should only be attempted after a considerable number of open repairs have been performed and familiarity with diagnostic endoscopy has been developed.

13.3.5 Classification

Distal biceps pathology can be classified according to degree (partial or complete), temporally (acute or chronic) or anatomically into the three zones described above. Most injuries occur in zone 3 (tendon-bone interface). In this chapter, tendon pathology at zone three has been graded on a scale from 0 to 4 (Table 13.2). Each grade has distinct clinical, radiological and operative findings. The hook test, as described above, should be interpreted carefully in certain grades.

13.4 Surgical Techniques

13.4.1 Two-Incision Technique

The two-incision technique of distal biceps tenodesis was initially described by Boyd and Anderson [3] and modified by Morrey, leading to lower rates of heterotopic ossification and synostosis.

Anteriorly, a 3–4 cm transverse incision over the antecubital fossa is made and tendon is secured using a grasping stitch. The forearm is then fully supinated and a blunt artery forceps is passed through the dorsolateral aspect of the forearm, along the medial border of the radius, until it visibly tents the skin. At this point, it is crucial that the tip of the forceps passes along the radius only and does not breach the periosteum of the ulna to minimise the risk of radioulnar synostosis. An incision is then made on the dorsolateral aspect of the forearm over the tip of the forceps and blunt dissection is performed down to the radius.

The forearm is pronated to bring the radial tuberosity into view and placing the posterior interosseous nerve (PIN) away from the operative field. The surface of the tuberosity is burred and drill holes are made. Using forceps, the sutures attached to the proximal portion of the tendon are passed through the radius to the dorsolateral incision and tied over bone. Aggressive use of lavage may minimise the risk of heterotopic ossification and synostosis [24].

13.4.2 Single Anterior Incision

Multiple single anterior approaches have been described, utilising suture anchors, Endobuttons and Biotenodesis interference screws or combinations of cortical button and interference screw fixations [22] with good results. Endoscopically assisted procedures with anchors [21] as well as the Endobutton technique have also been published [9].

The senior author developed the Endobutton technique in 1994, altering the technique to optimise the anatomic restoration of the biceps footprint. A single longitudinal anterior incision is made distal to the antecubital fossa and dissection is continued through the deep fascia. The proximal portion of the torn tendon is retrieved and two braided number 2 nonabsorbable sutures are anchored to the distal biceps tendon using a Bunnell stitch, leaving trailing sutures exiting the distal end of the tendon. The radial tuberosity is then exposed with blunt digital dissection using the biceps tendon tract as a guide. The forearm is then fully supinated and right angle retractors used to aid exposure.

For anatomical biceps restoration, the tendon should not be attached to the radius from anterior to posterior, but more medial to lateral. This position makes repair using a single anterior incision technically difficult, as the biceps tuberosity lies in an ulnar position when the arm is in full supination. The senior author currently pronates the arm approximately 70° to place two drill holes from the radial cortex starting immediately opposite the tuberosity and drilling anterolaterally to posteromedially towards and through the radial tuberosity. The sutures from the distal biceps tendon are passed through the holes in an anterograde fashion from tuberosity to opposite cortex using a suture passer. They are then threaded through the Endobutton, tensioned and tied so that the button lies against the opposite cortex. The drill is aimed away from the PIN [13] and the Endobutton is placed under direct vision, preventing entrapment and minimising risk of synostosis and proximal radius fractures associated with large burr holes.

13.4.3 Endoscopic Repair

A 2.5 cm longitudinal incision over the palpable biceps tendon, 2 cm distal to the anterior elbow crease, is made as the standard viewing portal for the endoscopy and instruments. The lateral cutaneous nerve of the forearm is identified and protected as the distal biceps tendon and its bursa are identified. A small, transverse portal is then made on the radial side at the apex of the bursa for introduction of the scope (Fig. 13.2). At this stage, it is important to stay lateral to the biceps tendon to avoid the median nerve and brachial artery.

Endoscopic repair should not be attempted unless a clear plan of the proposed procedure is in place (Fig. 13.3) [7, 31]. Dry endoscopy is used as the bursa, proximal radius and distal biceps tendon are inspected to allow clear identification of tissue planes. The tendon is examined dynamically through forearm rotation and with traction around the tendon for evidence of fraying, delamination, synovitis and partial tear. Using a Wissinger rod, a posterior working portal can be created, to allow the shaver to come from a different direction (Fig. 13.4). If present, tenosynovitis and low-grade fraying is debrided without suction using a full-radius resector without teeth. The aperture should be in full view whenever the resector is active to minimise the risk of soft tissue being caught.

If the partial tendon rupture is to be completed, a hooked monopolar cautery device is used for division of the remaining tendon insertion [17]. If the tendon is completely torn, a chondrotome is used to debride the natural footprint. A 2.5 mm drill is advanced from the anterior cortex of the radius exiting just posterior to the footprint. A suture on a straight needle is advanced backwards through this drill hole and

Fig. 13.2 Orientation of the surgeon and the scope during distal biceps tendon endoscopy in the left elbow (Used with permission from Eames and Bain [5])

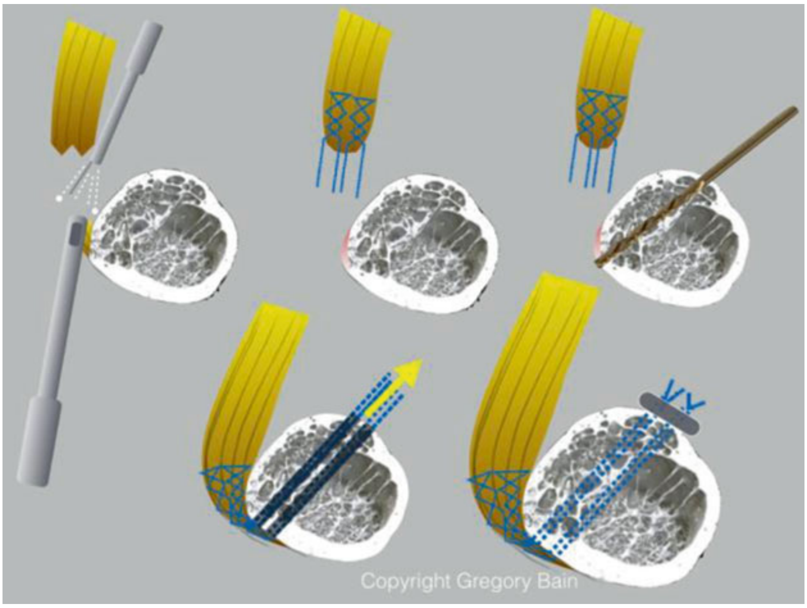

Fig. 13.3 Distal biceps endoscopic-assisted repair. (**a**) Endoscopic debridement of the torn biceps tendon stump. (**b**) Whipstitch of the torn tendon with nonabsorbable suture. (**c**) Two oblique drill holes made in the radial tuberosity aiming to exit on the dorsal ulnar surface. (**d**) Sutures shuttled through drill holes. (**e**) Sutures tied over Endobutton restoring the tendon to its footprint on the ulnar aspect of the tuberosity

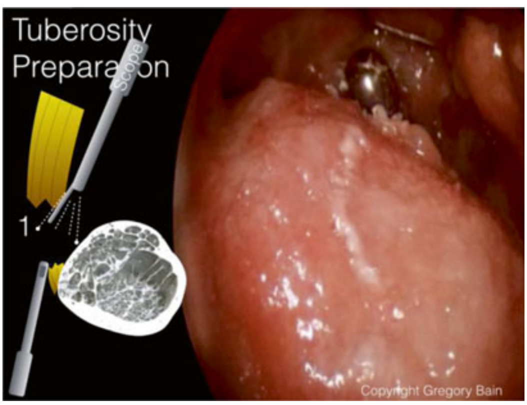

Fig. 13.4 Posterior working portal created using Wissinger rod. Scope in the front and the resector is coming over the horizon of the radius. Note the clarity of the dry endoscopy

the loop is retrieved (Fig. 13.5). This is used to shuttle the preplaced whipstitch in the distal biceps tendon. The sutures are threaded through an Endobutton and tied firmly to the anterior aspect of the proximal radius. This accurately recreates the biceps footprint and provides transosseous Endobutton fixation (Fig. 13.6a, b) [7]. A similar non endoscopic footprint technique has also been previously described [32].

13.4.4 Chronic Biceps Tendon Rupture

Management of chronic distal biceps tendon tear can be challenging owing to tendon retraction and scarring and the location of major neurovascular structures in the cubital fossa. If the patient has a low demand or is a high surgical risk, nonoperative treatment is mainstay. Surgery requires a more extensive approach and reattachment may not be possible with retraction greater than 4 cm, although good results have been reported for repair in extreme flexion [26]. Endoscopy, in this setting, can be useful to identify a pseudotendon and the level of the retracted tendon. If the lacertus fibrosis is still intact, the tendon can usually be directly repaired, although it will be tight and there will be a fixed flexion deformity. The senior author releases the lacertus from the tendon, repairs the tendon to the tuberosity and lastly repairs the lacertus. This ensures it does not deform the line of the tendon and does not compress the median nerve and the brachial artery beneath the lacertus. It is our experience that even a 70° flexion deformity repaired with an Endobutton will correct over the period of about 1 month, with gentle active mobilisation. In severe cases, tendon grafts such as semitendinosus autograft or tendon allograft may be used to bridge the deficient tendon.

13.5 Outcomes

Post-repair, those with grade 0 and grade 1A are encouraged to mobilise and strengthen the arm with physiotherapist. In those with grade 1B to grade 4 injuries, a sling is provided and the patient is encouraged to mobilise as tolerated with no resisted supination or flexion for 6 weeks. The outcome of surgical repair for distal biceps tendon rupture is good. The largest reported series using single incision technique found that 96 % were satisfied or very satisfied with the outcome of surgical repair at an average of 29 months after surgery [25]. In a series of 27 patients, Dillon et al. [16] found that the Endobutton gave return of 101 % of flexion strength and 99 % supination strength with no loss of motion. This group included patients with a chronic tear that was primarily repaired without tendon augmentation. Peeters et al. [29] demonstrated mean flexion strength of 80 % and supination strength of 91 % in 26 patients reviewed who had a mean of 16-month follow-up.

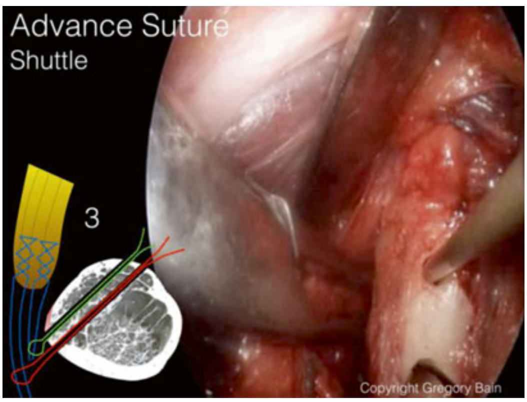

Fig. 13.5 Advancing the suture – the Tuohy needle is advanced through the drill hole and grasped on the posterior aspect of the radius

13.6 Complications

Reported complications include failure of repair, infection, haematoma, nerve palsies and fracture through drill holes in the proximal radial radius. Nerve palsies are usually transient and contributed to by aggressive retraction. Injuries may involve the lateral cutaneous nerve of the forearm, superficial branch of the radial nerve and posterior interosseous nerve and, rarely, the median nerve [21]. The PIN recovered spontaneously and radial neck fractures healed with internal fixation and bone graft. Rare complications

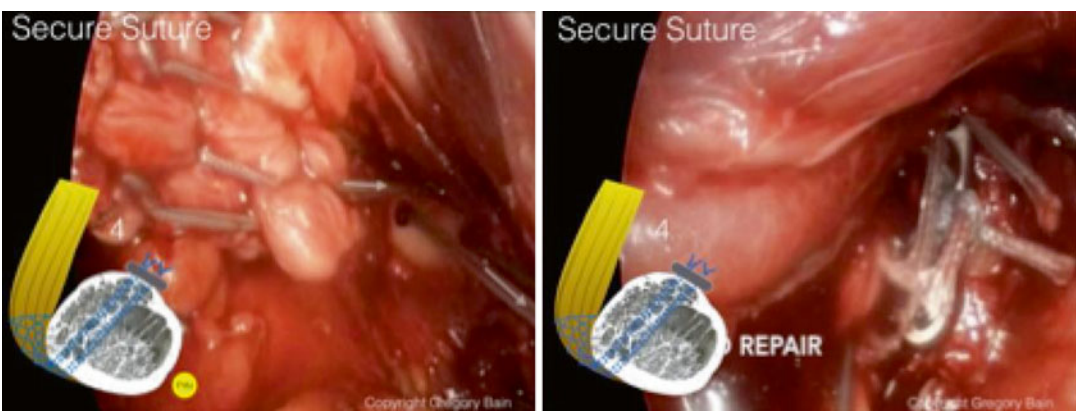

Fig. 13.6 Fixation of the tendon to the radial tuberosity. (**a**) The suture is used to advance the tendon onto the footprint. (**b**) The final position with the tendon advanced onto the footprint and the Endobutton on the anterior radius

Technical Tips for Procedures About the Elbow

1. Preoperatively and intraoperatively ensure that the patient is accurately classified, as this will direct treatment.
2. Enter the bicipitoradial bursa on the radial side under direct vision to avoid damage to neurovascular structures.
3. Use dry endoscopy to improve visualisation and prevent soft tissue swelling.
4. Use a full-radius resector without teeth and without suction to avoid entrapping soft tissues.
5. Reinsert the tendon onto its anatomic footprint on the posterior rim of the tuberosity.

include heterotopic ossification and radioulnar synostosis. Complication rates are higher for chronic injuries and revisions.

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