7 New Insights in Diagnosis and Treatment of Distal Biceps Pathology

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7.1 Introduction

7.1.1 Anatomical and Biomechanical Aspects of the Distal Biceps Tendon

Biceps brachii is composed of two separate heads and is innervated by a branch of the musculocutaneous nerve [1]. The proximal tendon of the long head is attached to the supraglenoid tubercle, and the proximal tendon of the short head is attached to the coracoid process. The biceps (muscle and tendon) rotates 90° externally from origin to insertion onto the bicipital tuberosity [2] and acts on three joints: the glenohumeral, ulnohumeral, and proximal radioulnar joints. A completely bifurcated distal tendon insertion is not uncommon [3, 4]. The short head of the distal biceps tendon was reported to insert more distally, and the long head was inserted more eccentric and medial. The moment arm of the long head was higher in supination, and the short head had a higher moment arm in neutral position and pronation [5]. These findings may allow functional independence and isolated rupture of each portion and may have consequences for restoring the native anatomy during a surgical repair. Several authors reported an isolated rupture of one of the two tendons in cases of bifurcated distal biceps tendons [4].

The blood supply for the proximal zone of the distal biceps tendon comes from the brachial artery by branches that extend across the musculotendinous junction. The distal zone has a separate blood supply by branches from the posterior interosseous recurrent artery. The middle zone receives vessels from both vessels but only through its paratenon cover [6]. The middle zone is considered as a transition area at which tendon repair mechanisms may be limited and is therefore more prone to injury and even rupture [6].

The lacertus fibrosus envelopes the forearm flexor muscles and serves as a stabilizer of the distal biceps tendon and particularly the short

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head. As the forearm flexors contract, the lacertus is tensed, subsequently causing a medial pull on the biceps tendon and perhaps contributing to its rupture [7]. When intact, it may lessen the functional deficits and the need for surgical reconstruction of a distal biceps tendon tear in low-demand patients [8]. The need to preserve an intact lacertus fibrosus or even repair the lacertus at the time of surgery is very controversial [9]. A surgical technique, using the lacertus fibrosus, as a local graft source for chronic distal biceps tendon ruptures, to avoid harvest site morbidity was described [10].

The attachments of the two biceps brachii tendons are surrounded by the bicipitoradial bursa draped over the two tendons, lying between the brachialis muscle and the distal tendons when the elbow is extended and between the proximal radius and biceps tendon in pronated position [11]. This structure is of clinical importance during endoscopic evaluation of the distal tendon after injury in cases of uncertain rupture of the tendon [3]. Injection of the bursa under ultrasound control can be part of the conservative treatment regime.

7.1.2 Possible Complications

Posterior interosseous nerve injury is the most devastating neurologic complication of distal biceps tendon refixation [12, 13]. The posterior interosseous nerve pierces the supinator muscle in the proximal forearm and circumflexes the radius at approximately 1.0–1.5 cm distal to the center of the bicipital tuberosity [12]. The distance between the point where the posterior interosseous nerve crosses the radius and the radiocapitellar joint changes with forearm rotation: the mean distances are 4.2, 5.6, and 3.2 cm in neutral position, pronation, and supination, respectively [14]. The posterior interosseous nerve can be injured during the refixation of the tendon or become entrapped by scar tissue in more chronic tears [3, 12]. Dissection of the bicipital tuberosity should be performed with a supinated forearm, and caution is required when placing deep retractors around the tuberosity with the single-incision approach. It is advised not to use a Hohmann retractor at the lateral side of the tuberosity [15].

When approaching the bicipital tuberosity, dissection through the subcutaneous tissue requires caution in order to protect the lateral antebrachial cutaneous nerve. This is a sensory terminal branch of the musculocutaneous nerve. In chronic distal biceps ruptures with tendon retraction, the lateral antebrachial cutaneous and the posterior interosseous nerve can become entrapped within reactive inflammatory and scar tissue as it passes between the biceps and brachialis muscles [16]. Care must be taken to avoid forceful use of retractors nearby the lateral antebrachial cutaneous nerve and to protect the nerve at the time of refixation of the tendon to avoid iatrogenic entrapment by the repaired tendon or sutures.

7.2 State-of-the-Art Treatment

7.2.1 Partial Tears of the Distal Biceps: Workup and Treatment

Partial tears are rare injuries, occurring mostly in middle-aged men. While most of the pathology of the distal biceps is related to complete ruptures, partial tears or bursitis at the insertion site may present with mild pain in the antecubital fossa, so patients' diagnosis may be delayed. A high index of suspicion is needed in order to perform a timely diagnosis. The present paragraph reviews current aspects of diagnosis and treatment strategies. Patients presenting with pain at the antecubital fossa typically present with biceps tendinopathy. Other causes of pain include intra-articular problems such as rheumatoid arthritis, osteoarthritis, anterior capsular strain, loose body, or pronator syndrome, but these are rare. On clinical examination, patients usually show a full range of motion in both flexion-extension and pronation-supination but may show a very slight decrease in terminal extension with supination due to pain secondary to tendinopathy. The hook test is a very useful test to assess the integrity of the distal biceps. The patient is asked to bilaterally flex the shoulder to head level and to flex the elbow approximately to 90° while maintaining the forearm in supination. The index finger is then used to “hook” the distal biceps tendon [17].

Radiographs of the elbow are typically normal. Ultrasound (US) is accurate to diagnose complete tendon ruptures, but its role in diagnosing partial ruptures is less clear [18]. MRI may reveal tendinopathic changes or the presence of bicipitoradial bursitis. These changes may be best seen using the FABS (flexion-abduction-supination) view in which the patient is placed prone with the affected arm in flexion, abduction, and supination [19]. Of note, it may be difficult to distinguish between tendinosis and partial tears involving less than 50% of the tendon. Findings related to the presence of a partial tear include increased signal intensity in the distal biceps, the presence of peri-tendinous or intra-sheath fluid, and increased bone marrow signal at the tendon insertion site. A trial of 6 months of conservative management seems reasonable. High-grade tears with greater than 50% of the attachment site have more failures after conservative treatment.

Partial tears are typically a delayed diagnosis so patients may have tried different treatments at the time of consultation. A trial of 6 months of conservative management seems reasonable. Conservative management has not been clearly protocolized, and most authors use physical therapy, the cessation of aggravating activities (including splinting), NSAIDs, and the use of steroid/anesthetic injections. Progressive strengthening is recommended until patients can perform their desired activities. While this form of treatment can be useful in some patients, a recent systematic review of surgical outcomes of partial ruptures showed that only in 5 of 65 patients documented to have received conservative management; this form of treatment was effective [20]. High-grade tears with greater than 50% of the attachment site have more failures after conservative management, and some patients could benefit from early surgical repair.

7.2.1.1 Endoscopic Techniques

The use of endoscopy to treat distal biceps injuries has been recently advocated [21].

The use of endoscopy to treat distal biceps injuries has been recently reported using different techniques [3, 6]. The endoscopy can be utilized as a diagnostic aid in defining the extent of the rupture, for removing adjacent bursitis, to debride the partial biceps tear, or to complete and reattach the tendon. It is a complex technique and should be reserved for experienced arthroscopists.

The patient is placed supine, with the arm on an arm table. A tourniquet is helpful for visualization, and in partial ruptures the risk of not reaching the attachment site is nonexistent. The tendon can be palpated and it is usually central on the forearm. The incision can be made 3–4 cm distal to the elbow crease. Blunt dissection is carried out until the tendon is apparent. Injuries to the lateral antebrachial cutaneous nerve (LABCN) and the posterior interosseous nerve (PIN) are frequent complications. To decrease the rate of these complications, we recommend handheld retractors and avoid Hohmann retractors around the radial neck and tuberosity. Dissection of the LABCN is discretional to the surgeon, but not dissecting it may as well protect it further than dissecting it.

The scope is advanced to the bicipital tuberosity and the forearm is supinated to improve the working space. The medial fibers are usually intact in cases of a genuine partial tear. The distal short head of the biceps can be ruptured with preservation of the proximal long head of biceps insertion, and ganglions at the site of rupture are frequently seen [16].

Vandenberghe et al. suggest the following protocol to decide appropriate treatment of distal biceps tears [21]. Tears smaller than 25% are debrided; between 25 and 50%, they are partially repaired with the use of an anchor, and those greater than 50% are detached and fixed using a cortical bone technique. In the latter, the scope can be used to localize the proper insertion site, and, while removing the scope, the sheath can provide protection for the drills used for cortical preparation.

A guide wire is drilled in the center of the tuberosity through both cortices and must be directed straight posteriorly or with slight ulnar deviation. The guide wire is over-drilled with a bigger cannulated drill in the first cortex and a smaller drill on the second cortex (different systems may have different sizes). The guide wire may have trailing sutures, and it can be advanced through the posterior forearm to introduce the button and tendon into the drill site until the button has passed the second cortex. It can then be flipped by flexing and extending the elbow. Alternatively, an antegrade sliding technique can be used. In this technique, the sutures from the grasped tendon are passed through a button, which is advanced in an antegrade fashion with the use of a handle until the button has passed the second cortex. It is then deployed from the handle and toggling with the suture achieves flipping of the button. Sliding and tensioning of the limbs of the suture advance the tendon to the desired position. The sutures are then tied, and the position is locked. Otherwise, an interference screw can be used to secure the tendon and offset it to its lateral position in the radial tuberosity.

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As an alternative to the single anterior incision, a single posterior incision or a double incision can be used (see below).

7.2.2 Single- or Double-Incision Technique

The first surgical technique involved an anterior approach ("Henry's") with a single curvilinear incision centered on the antecubital fossa; in this approach, the radial nerve and the posterior interosseous nerve are at risk of injury. To avoid this risk, Boyd and Anderson developed a technique that included a double incision and an interosseous access to reinsert the biceps to the radius through a bone tunnel [16]. Kelly further modified the second access with a posterior approach through the muscle, dissociating the fibers of the extensor carpi ulnaris. The preparation of the radius, however, seems to increase the risk of postoperative calcification and radioulnar synostosis.

A subsequent modification of the single anterior approach was based on suture anchors in a narrow space bounded by the brachioradialis and the pronator teres. Suspensory cortical fixation with buttons demonstrated optimal mechanical properties. However, radial preparation is required, with major risks of calcification and synostosis. Moreover, once the button has passed the second cortex, it lays very close to the posterior interosseous nerve.

Single anterior incision techniques are associated with higher risk of nerve damage, while dual access or techniques that require radial preparation may lead to a greater risk of calcification and synostosis. The anterior approach may also be performed with a small transverse median incision, which could reduce the risk of nerve damage [13].

7.2.2.1 Fixation Techniques

Four different fixation methods are currently used:

- Intramedullary fixation with transosseous suture
- Tenodesis with interference screw
- Anchor suture
- Mono- or bicortical fixation with button

Simple elbow flexion to 90° generates a force of 90N at the tendon [14]. Tendon rupture occurs with a force of 204N. A technique based on suture anchors can be performed using a single anterior approach and keeping the forearm in supination: the tendon is reinserted with one or two anchors or with an interosseous screw after preparing the tuberosity. The perforation of the posterior cortex is thereby avoided. Gasparella reported good results in 14 patients at a mean follow-up of 26 months using two anchors. A deficit in supination [22] was found in two cases.

Transosseous fixation techniques with a cortical suspensory button were also developed. These techniques are based on the preparation of the radial tuberosity and the creation of a slot for the biceps tendon with a 4 mm hole [13]. A radiological control of the correct positioning of the button is mandatory. The suture fixation with cortical suspensory button turned out to be the most tolerant to the load: the fixation with a standard button has a breaking load of 270N, while screw anchors do not resist more than 57N. Mazzocca studied the cyclic load breaking, highlighting that the EndoButton technique presents a significantly higher load: 440N against 381N of suture anchors, 310N of the bone tunnel, and 232N of the interference screws [23]. Mazzocca also studied the cyclic mobilization of the different fixation techniques with inverse results: the interference screw presents minimal mobilization. These movements may delay or inhibit the healing process. In order to improve the fixation, other techniques have also been proposed that associate an interference screw fixation with a cortical suspensory button. In these cases, a bone tunnel of 8 mm is necessary [13]. None of these techniques are free from risk of complications related to access and posterior interosseous nerve protection.

7.2.2.2 Intramedullary Repair with Cortical Button

The patient is placed in supine position with an arm lying on a table with the tourniquet at the root of the arm. An anterior approach is created, with an oblique or longitudinal incision of approximately 6–8 cm in the middle of the forearm, about 2 cm distal to the elbow crease. This procedure is performed by blunt dissection under the skin, in order to avoid injury to the lateral antebrachial cutaneous nerve, which is retracted laterally. We proceed by separating the interval between the pronator teres muscle and brachioradialis, where it is common to see veins of large diameter that flow into the basilic and cephalic vein. In addition to these vessels, the radial artery is often present and should be protected. If the tendon is retracted, it can be gently mobilized to free it from post-traumatic adhesions. The degenerated distal portion is cut to about 0.5 cm. The tendon is then prepared with two ultrahigh molecular weight polyethylene Krackow sutures for 3 cm. The distal centimeter of the tendon is not prepared, but it is left as a shortening zone with the wires passing inside in a straight line ("sliding zones"). This will allow the tendon to be shortened and to lay the button easily on the cortex, which is secured with both sutures at about 2–3 mm from the tendon. Once the tendon is prepared, the peritenon of the biceps is opened up to the radial tuberosity. Serous fluid and hematoma may come out of the sheath. Once the tuberosity is prepared to bone, the forearm of the patient is supinated, and a slotted 1.5 mm wire is inserted at a 45° angle to the level of the tuberosity; this wire serves as a guide for dedicated cannulated cutters. A 4 mm bicortical tunnel (tunnel dimensions may vary depending on the device) is drilled first, followed by a proximal-to-distal 7–9 mm 1.5-cm-long half-tunnel (half-tunnel dimensions may vary according to the diameter of the tendon). A high-speed cutter or a Citelli can be used to broaden the entrance hole of the tendon proximally to an ellipsoidal shape to avoid conflicts or kinking of the repaired tendon. In this phase, it is essential to remove bone fragments with the suction to prevent heterotopic ossification. At this point, the traction sutures of the cortical button are inserted in the slot of the guide wire, which, once it crosses the soft tissues, comes out from the dorsal surface of the forearm and carries the sutures. The elbow is flexed to 100° and the suture is pulled with a more robust wire (traction suture). Once the cortical button passes the second cortex, the cortical button is flipped. With the image intensifier, it is mandatory to check the correct position. At this point, the elbow is completely extended to control the resistance. At the end of the surgical procedure, it is important to verify the correct tension on the tendon, which passes through the center of the surgical access. The elbow is immobilized at 90° for pain relief.

A recent systematic review identified all articles reporting distal biceps ruptures to compare outcomes between single- and double-incision techniques. In a total of 87 articles, lateral antebrachial cutaneous nerve neurapraxia was the most common complication in the single-incision group, occurring in 77 of 785 cases (9.8%). Heterotopic ossification was the most common complication in the double-incision group, occurring in 36 of 498 cases (7.2%). Posterior interosseous nerve palsy occurred in 2.7% (13/785) of single-incision procedures versus 0.2% (1/498) in the double-incision group. When combining heterotopic ossification and synostosis rates, the double-incision group demonstrated complications in 9.8% (47/498) of cases versus 3.2% (25/785) for single-incision cases. Additional complications in the single-incision group included superficial wound infection (11/785), nerve paresthesia (22/785), nerve dysesthesia (5/785), median nerve palsy (1/785), and other complications ranging from screw fractures to persistent elbow pain (49/785). In the double-incision group, additional complications included superficial wound infection (5/498), nerve paresthesia (2/498), nerve dysesthesia (3/498), posterior interosseous nerve palsy (1/498), ulnar nerve palsy (1/498), and other complications ranging from sterile stitch abscesses to lateral antebrachial cutaneous neuritis (30/498) [24].

7.3 Future Treatment Directions

More research is needed to assess whether or not separate reconstruction of the two bundles is better than single-strand reconstruction as described in this chapter. Handling of the tuberositas remains an interesting topic for the future. Reduction of the native bone of the tuberositas results in less tensioning of the biceps, whereas a pathologically thickened tuberositas may rub against the reinserted tendon and might be related to re-rupture of the biceps.

7.3.1 Rehabilitation After Distal Biceps Tendon Repair

A tear of the distal biceps tendon of its insertion at the radial tuberosity is a common soft tissue injury. With improved, stable surgical refixation techniques and the experiences of decreased rotation and flexion strength after conservative treatment, operative therapy is warranted. A whole variety of different surgical fixation techniques are available, with most of them being backed up by biomechanical evidence for sufficient primary stability of the construct. The most common technique now is the suture button fixation, which fixes the tendon on the tuberosity by a monocortical suture button. However, the postoperative treatment protocols vary significantly as there is few data available on their efficiency. The postoperative protocol should aim for protection of the repair by de-tensioning of the tendon. Usually, this is achieved by an immediate postoperative splint in flexion of at least 70°, followed by an orthosis providing an extension block. Forearm rotation also influences the tension of the distal biceps tendon, as the tendon wraps around the tuberosity in pronation and becomes tensed. In supination, the tendon unwinds off the proximal radius and thereby slackens. Hence, it is reasonable to place the forearm not only in flexion but also in supination.

The protocols also vary with respect to the administered time schedule. More cautious protocols advocate an extension block for 6 weeks, starting for 2 weeks in 90° flexion, followed by 2 weeks in 60°. After another 2 weeks of an extension limit of 30°, progressive range of motion is started. Full weight bearing should not be reached before 2 months. Heavy lifting and contact sports are allowed 6 months after the repair.

Another aspect of rehabilitation is the prevention of heterotopic ossification or radioulnar synostosis, which has been reported after distal biceps repair. The etiology of the ossification is not fully understood. It is unclear whether the amount of postoperative movement correlates with the development of heterotopic ossification. Even though there is only low-quality data on its use, the oral application of indometacine is part of many postoperative protocols. In a recent study, Costopoulos et al. reported a low percentage of less than 1%, after the administration of 75 mg of indometacine per day for a period of 10–42 days [25]. Prospective studies with conclusive study protocols are still missing.

7.4 Take Home Message

The short head of the distal biceps tendon inserts more distally and the long head inserts more medially. The moment arm of the long head is higher in supination, and the short head has a higher moment arm in neutral position and pronation. These findings may allow functional independence and isolated rupture of each portion and may have consequences for restoring the native anatomy during a surgical repair.

While most of the pathology of the distal biceps is related to complete ruptures, partial tears or bursitis at the insertion site may present with mild pain in the antecubital fossa so patients' diagnosis may be delayed.

Distal biceps tendon repair is a safe, replicable technique that offers optimal clinical results. Both the single- and double-incision techniques are safe and offer good clinical results. Patients gain full recovery of elbow articulation, strength, and resistance, with very low risk of complications. Endoscopic techniques could improve visualization, optimize the repair process, and reduce potential complications.

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