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Rupture of the Distal Tendon of the Biceps Brachii

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Abstract: Rupture of the distal biceps tendon is a relatively uncommon clinical entity. Typically, patients are middle-aged males who experience a sudden forced extension against an actively contracting biceps muscle. Patients usually describe a "pop" or tearing sensation in the anterior elbow region. The dominant extremity is involved in a majority of cases. While the etiology is usually traumatic, some believe that distal tendon rupture occurs through an area of prior tendon degeneration. Sudden pain, weakness with supination and elbow flexion, and deformity at the distal biceps tendon insertion are the common presenting symptoms. Diagnosis is made by history and physical findings. While plain x-rays are not usually helpful, magnetic resonance image (MRI) scans have been used to assist in diagnosing difficult cases and partial tendon ruptures. The best results are achieved when early reattachment of the tendon to the radial tuberosity is performed. The authors' preferred surgical approach is a modified two-incision technique with primary reattachment to the radial tuberosity, but use of a single anterior incision has been described. Complications include radial nerve injury and radioulnar synostosis. Postoperative management involves elbow splinting in a position of flexion with gradual range of motion exercises 2–4 weeks following repair with a return to full activities including lifting by 4–5 months. Excellent results are achieved in most cases with this approach.

Introduction

Rupture of the distal biceps tendon is a relatively uncommon injury, accounting for 3% of all tendinous injuries to the biceps [6]. Rupture of the long head of the proximal biceps tendon occurs most commonly, accounting for 96% of all injuries. Rupture of the short head of the biceps accounts for the remaining 1% [6]. Starks reported the first case of distal biceps tendon rupture in the literature in 1843, and the first operative repair was reported by Aquaviva in 1898 [10]. Since that time, there have been approximately 250 cases reported in the literature.

Although the diagnosis of acute biceps ruptures is relatively straightforward, the management of this injury is debated in the literature. Early reports advocated conservative management [8] and reattachment of the biceps to the brachialis using a single anterior incision. Other studies [2,25] have documented residual weakness in elbow flexion and forearm supination when nonoperative treatment is employed. Repair of the biceps to the brachialis will restore elbow flexion strength, but weakness in supination remains. In 1961, Boyd and Anderson [7] described a technique for reattachment of the biceps to the radial tuberosity using a two-incision technique. While Boyd and Anderson's results were excellent, concern for radioulnar synostosis led to a modification of their original approach. Currently, an extensor-splitting approach is favored when using a two-incision technique. The use of a single anterior incision to primarily reattach the biceps has also been successful.

Anatomy

The biceps brachii is innervated by the musculocutaneous nerve and is composed of a long and short head. In the anterior compartment of the arm, these two heads merge and travel superficially to the brachialis. As it travels past the elbow and through the interosseous space, the distal biceps tendon rotates through an arc of 90 degrees, inserting onto the posterior aspect of the radial tuberosity [30]. The interosseous space varies, being smallest with forearm rotation in pronation and greatest in supination. With the arm in full pronation, the biceps tendon occupies 85% of the interosseous space [29]. While this is sufficient space when the tendon is normal, impingement of the tendon may occur in cases of tendon hypertrophy.

Knowledge of the neuroanatomy of this region is important in avoiding damage to important structures. The lateral antebrachial cutaneous nerve is the terminal branch of the musculocutaneous nerve and supplies sensation to the volar-lateral aspect of the forearm. This nerve exits the arm from behind the biceps muscle by passing lateral to the tendon. It pierces the deep fascia of the arm and lies in the subcutaneous tissues of the antecubital fossa. The radial nerve travels laterally in the elbow between the brachialis and brachioradialis muscles. The radial nerve bifurcates just proximal to the antecubital fossa into its two terminal branches. The superficial branch passes deep to the brachioradialis in the forearm and supplies sensory innervation to the dorsal aspect of the mid forearm. The deep branch pierces and innervates the supinator, then continues distally as the posterior interosseous nerve in the dorsal compartment of the forearm.

In the antecubital fossa the biceps tendon is situated lateral to the brachial artery and median nerve. The lacertus fibrosis is the medial fascial expansion of the biceps tendon that lies superficial to these neurovascular structures. It runs across the anteromedial aspect of the elbow and inserts onto the dorsal border of the ulna and is believed to augment

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flexion power. The brachial artery bifurcates at the level of the radial head into the radial and ulnar arteries. The radial recurrent artery branches from the radial artery and travels laterally and proximally through the antecubital fossa. The blood supply of the distal tendon [29] consists of three separate zones. The proximal one third is supplied by the brachial artery, the distal one third is supplied by branches of the posterior recurrent artery, and the middle one third consists of an area of relative hypovascularity. Seiler et al. [29] hypothesize that this hypovascularity may contribute to chronic tendon degeneration. This cannot be the sole determining factor in distal biceps tendon ruptures because most ruptures occur at the bone tendon interface.

Biomechanics

Electromyographic (EMG) analysis of the contribution of the muscles of the arm to elbow motion found that the brachialis is the main flexor of the elbow and is active in all elbow positions [3]. The contribution of the biceps to elbow flexion is minimal when the forearm is pronated, and much more significant when the forearm is supinated. EMG studies also showed that the amount of elbow flexion determines the relative contribution of different muscles to forearm rotation. With the elbow fully extended, the supinator is largely responsible for forearm supination. The biceps becomes the primary supinator of the forearm with progressive flexion of the elbow [3].

Etiology

This injury is almost exclusively confined to middle-aged men. The average age of patients presenting with distal biceps tendon ruptures is 40–50 years old. Patients are typically active, well-muscled men who are laborers or weightlifters. Apart from a vague mention of a singular case of tendon rupture [24] and a report of partial tendon rupture in a woman [6], there are no reported instances of this injury affecting women. The mechanism of injury is classically described as a forceful, often unanticipated, extension against an actively flexed forearm. Typical activities implicated include lifting a heavy object, gymnastics, pull-ups, water-skiing, and horseback riding [26]. A direct blow to the antecubital fossa can also cause this injury. Approximately 30–70% of these injuries are work-related accidents [5,6,9]. While usually affecting the dominant extremity, nondominant and bilateral injuries have been reported. The reported case of bilateral injuries involved anabolic steroid use [21].

Disruption of the tendon is most commonly the result of rupture from the bone tendon interface at the radial tuberosity. Injury at the musculotendinous junction, muscle belly, and within the substance of the tendon has also been reported [5]. Rupture is believed to occur through an area of preexisting tendon pathology [10,19]. Kannus and Jozsa [19] demonstrated histologic evidence of tendon degeneration in 100% of the spontaneously ruptured tendons studied compared to only 34% of unruptured controls. Hypertrophic lipping along the anterior border of the radial tuberosity is occasionally seen on preoperative radiographs and may contribute to mechanical erosion of the tendon [10].

Diagnosis

The history and physical examination allow easy diagnosis of this injury in most cases. Patients commonly describe a mechanism of injury involving a sudden forceful extension against an actively flexed elbow. They report feeling a pop or tearing sensation in the antecubital region. Symptoms in these patients include antecubital pain and swelling and weakness in activities that require supination of the forearm such as using a screwdriver or turning a doorknob [4]. Patients often present knowing their diagnosis.

The physical findings include ecchymosis over the antecubital fossa that may extend into the arm or forearm. Proximal retraction of the ruptured tendon will create deformity of the distal biceps tendon (Fig. 1). To identify the normal resting position of the tendon, identify the brachial artery and palpate lateral to this landmark. Comparison to the contralateral extremity can also be helpful. A palpable defect of the distal biceps tendon is typical. In cases where the lacertus fibrosis is intact, the tendon may be tethered in the antecubital fossa. In this situation, the biceps tendon may be palpable in the antecubital fossa but does not develop tension with active flexion and supination. Weakness in supi-

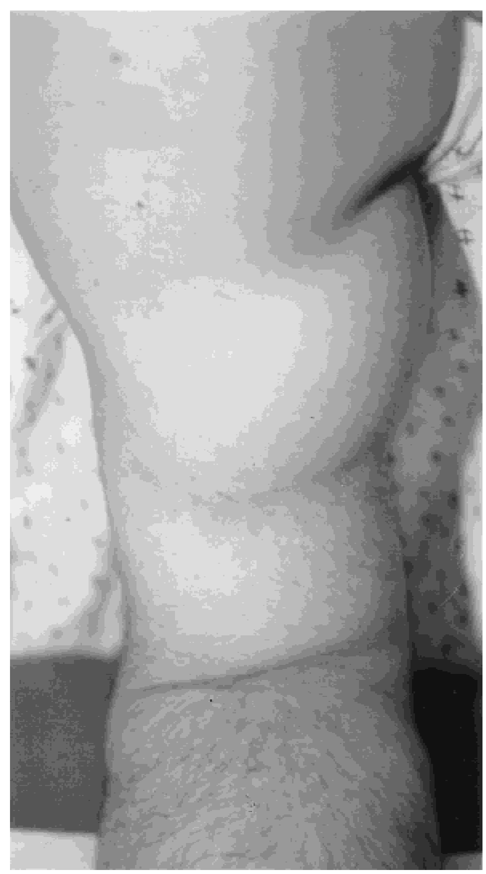

Fig. 1. Proximal retraction of the biceps muscle belly is shown with attempted flexion of the elbow.

nation is obvious. If the tendon has retracted 8 cm proximal to the antecubital fossa, then one may assume that the lacertus fibrosis is also ruptured [18]. Muscle strength testing should be performed in flexion, extension, pronation, and supination. As previously described, this injury complex will reveal a weakness that is most pronounced with supination.

Radiographic Studies

Radiographs of the elbow should be routinely taken to rule out concomitant fractures or other joint pathology. Rarely, an avulsed fleck of bone from the tuberosity is present and marks the location of the retracted tendon. While not indicated in straightforward cases, magnetic resonance imaging (MRI) can be useful in clinically confusing cases where the biceps tendon can still be palpated in the antecubital fossa. Partial tendon ruptures, cubital bursitis, bicipital tendinitis, and entrapment of the lateral antebrachial cutaneous nerve are other diagnoses that should be considered in these situations. The axial T2-weighted images tend to be more helpful [13] (Fig. 2). Other diagnoses that can be elucidated with MRI include nonretracted complete tears of the biceps tendon, tendinosis, tenosynovitis, ganglion, and injury to the brachialis. In the report by Fitzgerald et al. [14], the use of MRI in clinically confusing cases led to a change in the treatment protocol in 38% of patients.

Treatment

Nonoperative treatment of distal biceps tendon ruptures is rarely indicated. Some authors contend that no significant deficits result from a nonoperative approach [8]. However, repeated studies have shown that restoration of elbow strength and endurance requires anatomic reconstruction of the tendon. Baker and Bierwagen [2] compared the levels of strength and endurance in 3 patients who had refused operative repair compared with 10 patients who underwent direct reattachment of the tendon to the radial tuberosity. The patients treated nonoperatively showed deficits in supination strength (55% of expected), supination endurance (86% of expected), flexion strength (36% of expected), and flexion endurance (62% of expected). The patients treated with a surgical repair through the two-incision technique showed a return to normal levels of strength and endurance in both supination and flexion. Similarly, Morrey et al. [25] found mean strength deficits of 40% in supination and 30% in flexion in patients treated nonoperatively. Therefore, the only indications for nonoperative treatment are debilitated patients who do not require flexion and supination strength or patients who refuse surgery. Sling immobilization for comfort followed by progressive range of motion exercises and strengthening is an appropriate regimen for these patients. Residual weakness and activity-related pain in the antecubital fossa should be expected.

Fig. 2. An axial T2-weighted MRI of a patient depicts a partial insertional rupture (arrowhead) and degeneration of the distal biceps insertion more proximal (arrow).

Anatomic repair of the biceps tendon to the radial tuberosity has been considered by some to be a dangerous undertaking. However, several recent reports have shown excellent results with few complications when primary reattachment was performed. In 1961, Boyd and Anderson [7] first described the technique of utilizing both an anterior and a posterolateral incision as a means of decreasing the risk of radial nerve injury. The anterior exposure is through a curvilinear incision in the antecubital fossa. The posterior dissection involves subperiosteal elevation of the common extensor muscles off of the ulna, exposing the ulna and radius. This approach has been associated with proximal radioulnar synostosis [12,25].

Davison et al. [11] reported their results in eight patients with distal biceps tendon ruptures repaired using the two-incision technique. They found that while six of eight were subjectively satisfied with their result, three patients had greater than 30 degrees loss of motion in supination, one patient had greater than 30 degrees loss of pronation, and six of eight had decreased supination strength. Leighton et al. [21] used this approach in nine patients and found that while there was uniform patient satisfaction, those who injured their nondominant extremity experienced slight residual weakness compared to the procedures performed in the dominant extremity. Complications included one radioulnar synostosis that required excision. D'Alessandro et al. [9] used this technique in 10 patients and had excellent results, including athletes who were able to return to bodybuilding and arm wrestling competition. Like Leighton et al.'s experience, however, when performed in nondominant extremities they found a deficit of 25% in supination strength. Morrey et al. [25] also reported excellent results when using this technique and found that flexion and supination strength returned to 97% and 95%, respectively, when compared to the uninvolved extremity.

The use of a single anterior incision and reattachment of the tendon to the tuberosity with suture anchors has been described. Lintner and Fischer [22] report using a single anterior incision in five patients who had acute biceps ruptures. Their technique involved reattachment of the biceps stump directly to the radial tuberosity using suture anchors. Each of the patients returned to preinjury levels of activity and had full range of motion. There were no reported complications including heterotopic ossification or nerve injuries. Huec et al. [18] achieved similar results in treating eight patients with acute biceps rupture. However, they found that the resultant strength in flexion-supination in the treated extremity was 11% weaker than in the opposite extremity on average. While these results show promise in using this technique, further studies must be performed to confirm that there is not an increased rate of radial nerve injury or tendon re-rupture.

Operative Technique

The preferred operative technique of the authors is a modified Boyd and Anderson (muscle-splitting) two-incision approach. The patient is positioned supine on an operating room table with the affected arm extended on an arm board. An upper arm tourniquet may be used for a bloodless field but should be deflated prior to tendon reattachment as the tourniquet can limit excursion of the muscle belly. A small transverse anterior incision in the elbow flexion crease is preferred over the traditional curvilinear incision. This allows adequate exposure and leads to a better cosmetic result and less soft tissue dissection. A more extensive exposure may be required in chronic tendon ruptures with proximal retraction. The lateral antebrachial cutaneous nerve is identified as it pierces the deep fascia and protected. The deep fascia of the antecubital fossa is incised and the tendon is identified and retrieved into the wound. The tendon edge is freshened to healthy tendon but not extensively shortened. Two number 5 nonabsorbable sutures are woven through the tendon using a Bunnell suture technique.

The biceps tendon sheath is identified and the radial tuberosity is identified by blunt finger dissection. In longstanding ruptures the tendon sheath may become obliterated, necessitating more extensive dissection in the antecubital fossa. In these instances, the skin incision is extended and a formal Henry approach is performed.

With the forearm in supination, a hemostat is passed from the antecubital incision down the biceps tendon sheath to the radial tuberosity and out the posterolateral aspect of the forearm (Fig. 3). The location of the second incision is determined by the location where the clamp tents the skin on the posterolateral forearm. An incision is made over the clamp and the common extensor tendon is split in line with the fibers. The radial tuberosity is identified with the arm in maximal pronation and the supinator is split. A cavity is created in the radial tuberosity and three drill holes are placed along the margin of the tuberosity (Fig. 4). The biceps tendon sutures are delivered through the anterior wound to the posterolateral forearm and through the drill holes. The tendon is delivered into the posterolateral wound and advanced into the tuberosity. The sutures are tied over the bone bridge.

Fig. 3. A curved hemostat is passed to the posterolateral forearm from the antecubital incision. Note the hemostat is passed medial to the lateral antebrachial cutaneous nerve (arrows).

Postoperative care

The elbow is immobilized postoperatively in 90 degrees of flexion and mid to full forearm supination for 10–14 days. Traditionally, a flexion assist orthoplast splint with a 30-degree extension block is utilized for 6–8 weeks. During this time, the elbow is protected against any lifting force. At 6–8 weeks, unrestricted range of motion is allowed and strengthening is begun at 10–12 weeks. Return to unre-

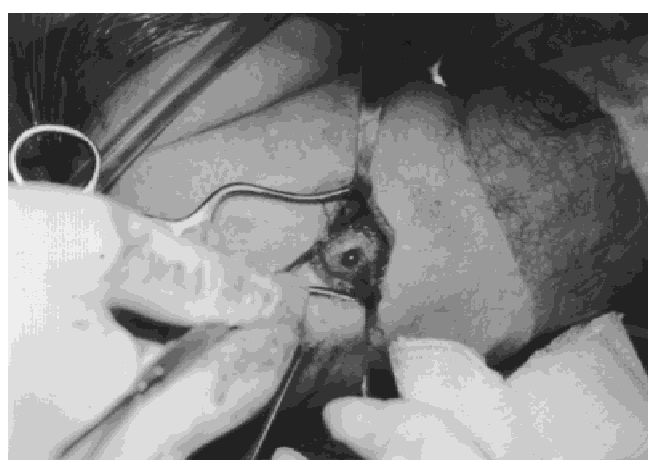

Fig. 4. With the forearm in maximal pronation, the radial tuberosity is identified and a cavity is created for insertion of the distal biceps tendon. Drill holes are placed along the anterior margin of the cavity for suture passage.

stricted activity is not permitted for 6 months. Recently, the senior author has utilized an accelerated rehabilitation program. The splint is removed at 14 days and an active assisted range of motion program is begun. A sling is utilized for comfort. Strengthening is started at 8 weeks with unrestricted activities allowed at 4–5 months.

Complications

The major complications to this procedure include nerve injury and radioulnar synostosis. The nerve of primary concern is the posterior interosseous nerve. It is more commonly injured when the single anterior incision is used but can also be damaged in the two-incision technique when excessive traction is applied to the nerve. Injuries to the median and ulnar nerves have also been reported [15]. The formation of heterotopic bone can significantly limit forearm rotation and cause pain. This complication when using the Boyd and Anderson approach is believed to be due to damage to the interosseous membrane, stimulation of the ulnar periosteum, and formation of a postoperative hematoma that contacts both bones and can be the precursor to heterotopic ossification (Fig. 5). Excision of the synostosis is usually required to restore forearm motion. In using the extensor muscle-splitting technique, the risk of synostosis is theoretically decreased because the ulna is not exposed and there is limited contact with the interosseous membrane.

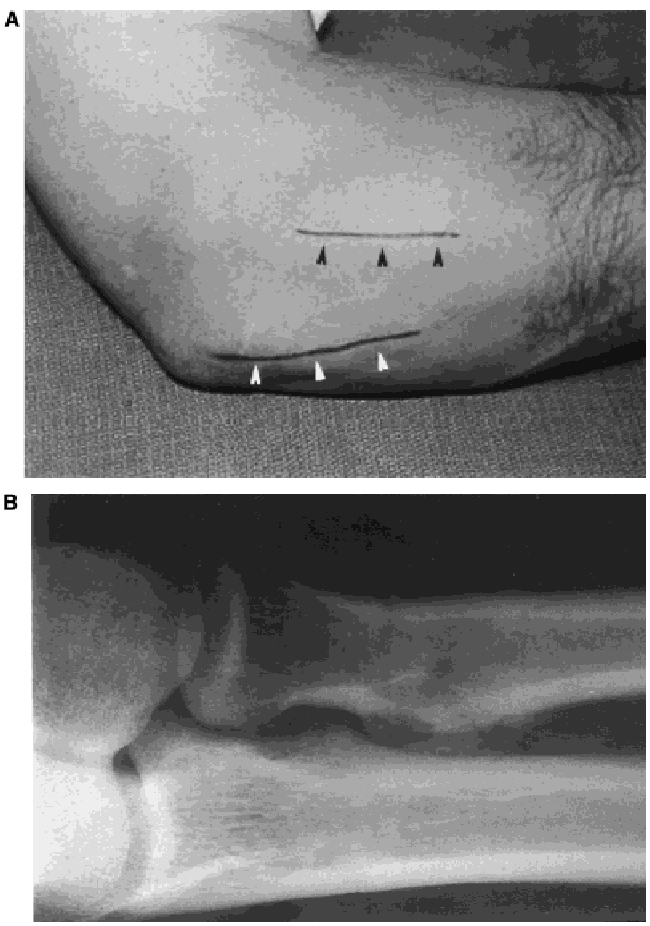

Fig. 5. A: The traditional Boyd/Anderson incision (white arrows) and modified muscle-splitting incision (black arrows) is utilized for two-incision repair of distal biceps tendon ruptures. The traditional Boyd/Anderson incision has been associated with radioulnar synostosis **(B).**

Summary

Rupture of the distal tendon of the biceps brachii is an injury infrequently seen in clinical practice. Although the diagnosis and decision for surgery are straightforward, a thorough knowledge of local anatomy combined with a careful operative technique is required to achieve satisfactory results. Use of the modified two-incision technique allows anatomic reinsertion of the tendon into the radial tuberosity while identifying and protecting important neurovascular structures. Excellent results are achieved using this approach, with return to full activity in most patients and few reported complications.

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