Treatment of Distal Biceps Tendon Ruptures

Benjamin J. Widmer, MD, and Robert Z. Tashjian, MD

Abstract

Distal biceps tendon rupture is an injury typically reported in the dominant extremity of middle-aged men. Clinical findings are the mainstay of diagnosis, but magnetic resonance imaging or ultrasound imaging can provide additional diagnostic information. Anterior 1- or 2-incision repairs are commonly used. Various fixation techniques have been reported, all with comparable biomechanical results and clinical outcomes. Complication rates are lower in patients treated closer to time of injury. Tendon retraction associated with chronic ruptures can present a difficult surgical problem.

Advanced soft-tissue imaging adds helpful information about the level of biceps tendon retraction and possible reparability. When the tendon can be reapproximated safely at less than 45° to 90° of elbow flexion, then primary repair may be performed. When reapproximation is not possible, options are reconstruction and tenodesis. Reconstruction performed through 1 or 2 incisions with either allograft or autograft has successfully restored both motion and power.

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In 1925, Biancheri[1] examined the incidence of biceps tendon ruptures and found that 96% ruptured at the long head, 1% proximally at the short head, and 3% distally. In 1941, Dobbie[2] specifically examined distal biceps injuries and made an early attempt at a meta-analysis. He reviewed the 24 surgically treated cases of distal biceps injuries previously reported in the literature and sent a questionnaire to almost 500 active surgeons. From their replies, he identified 51 new cases of distal biceps injuries repaired with a variety of techniques and noted that the "end results as reported are equally satisfactory" independent of technique and are "for the most part excellent." He identified only 3 reported complications.

Interest in the surgical treatment of distal biceps injuries has continued to grow with the 1961 description by Boyd and Anderson[3] of a 2-incision repair technique and more recently with several reports[4-7] of promising results with 1-incision repairs. This increased interest is reflected in a "distal biceps tendon ruptures" PubMed search that yielded 46 citations for calendar year 2007.

Distal Biceps Tendon Anatomy

The biceps muscle has 2 tendinous origins and 1 tendinous insertion. The long head of the biceps originates at the supraglenoid tubercle and traverses the shoulder joint before exiting through the lateral rotator cuff interval. It then passes through the intertubercular groove into the proximal arm. The short head takes origin from the coracoid. The distal biceps tendon inserts into the radial tuberosity and supinates the forearm and assists with elbow flexion.[8] It also functions as a secondary elevator and abductor of the shoulder.[9]

> "Partial ruptures should be treated without surgery initially.."

Elbow and forearm position has been determined to affect the function of the biceps muscle. Electromyograms have demonstrated that the flexion activity of the biceps is inhibited by forearm pronation.[10] Maximum supination strength is achieved with forearm flexion, and maximum flexion strength is achieved with forearm supination.[11]

The blood supply to the distal biceps tendon is somewhat tenuous. The brachial artery provides proximal perfusion, and the distal blood supply stems from the posterior radial recurrent artery and the brachial artery. This leaves a watershed area approximately 2 cm in length 1 to 2 cm proximal to the insertion.[12]

More details about the distal biceps footprint have been revealed in recent years. The biceps tendon occupies 85% of the proximal radioulnar joint at the level of the tuberosity in full pronation and

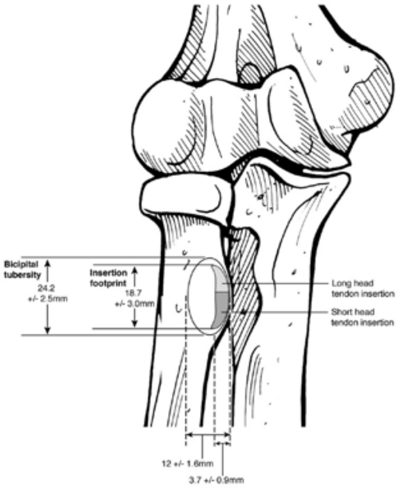

Figure 1. Anatomy of radial tuberosity insertion of distal biceps tendon.

35% in full supination. This represents a 50% reduction in the space available for the tendon during transition from supination to pronation.[12] The radial tuberosity has been found to have 2 distinct portions—a rough posterior portion for tendon insertion and a smooth, bursa-covered anterior portion.[12] The tuberosity is 24 mm proximal to distal and 12 mm medial to lateral. The tendon footprint is 19 mm proximal to distal and 4 mm medial to lateral.[13] Therefore, the tendon attaches to only approximately one third of the overall width of the tuberosity (Figure 1). In addition, an anatomical study demonstrated that, in 10 of 17 specimens, 2 distinct distal tendons (distal extensions of the long- and short-head muscle bellies) were easily identified as receiving equal musculocutaneous innervation and attaching separately to the radial tuberosity. The long-head distal tendon was noted to be crescentic and deep and to insert proximally, whereas the short-head distal tendon was consistently oval and superficial and inserted distally[14] (Figure 1).

The tendon insertion is a mean 23 mm distal to the articular margin, is located on the posterior/ulnar aspect of the tuberosity, and is oriented 30° anterior to the coronal plane with the arm fully supinated.[15] With the arm in full supination, the center of the tuberosity is a mean 45° anterior to horizontal in the plane of the forearm, and the posterior margin of the tuberosity is a mean 15° anterior to horizontal in the plane of the forearm. These anatomical properties result in the tendon inserting approximately 30° anterior to horizontal in the plane of the forearm (halfway between the posterior margin and the tuberosity center) in full supination. When there is a rotational deficit limiting full supination, this location can make a 1-incision repair difficult. Similarly, with the 1-incision technique, a more anatomical repair can be achieved when the fixation instrument—anchors, EndoButton (Smith & Nephew, Andover, Mass), and so forth—is directed slightly radial during insertion (Figure 2).

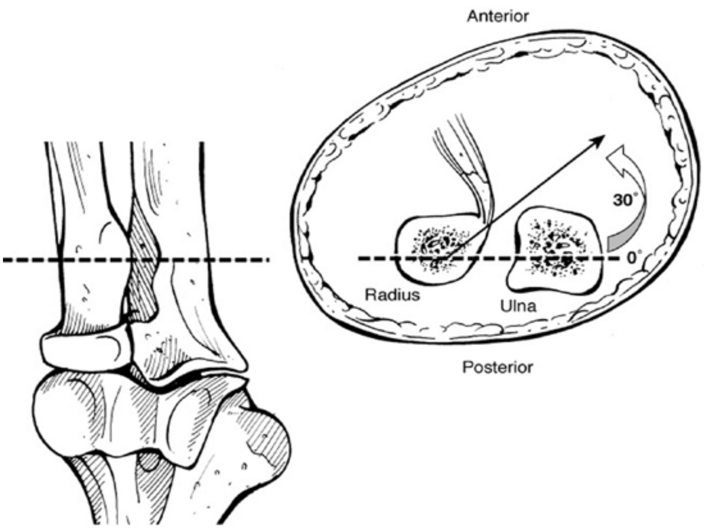

Figure 2. Angulation of radial tuberosity insertion of distal biceps tendon.

Figure 3. Lateral antebrachial cutaneous nerve just lateral to distal biceps tendon during anterior approach for repair.

Surgical Anatomy

An understanding of the relevant surgical anatomy is essential to safe and efficient distal biceps repair. The musculocutaneous nerve innervates the biceps and brachialis and then continues in the interval between these 2 muscles as the lateral antebrachial cutaneous (LABC) nerve. This nerve provides sensation to the lateral forearm. It should be carefully identified and protected during distal biceps repair, as a traction injury can result in numbness or paresthesias along the forearm. The LABC nerve is superficial and just lateral to the biceps tendon and is easily identified during initial exposure (Figure 3). Care should be taken during repair to not reroute the distal biceps anterior to the nerve.

The radial nerve runs between the brachialis and the brachioradialis and is usually out of the surgical field during dissection. It bifurcates just anterior to the lateral epicondyle, and the posterior interosseous nerve courses radially to enter the supinator while the superficial radial nerve continues distally beneath the brachioradialis. Although the nerve is not routinely exposed during surgery, constant awareness of it and its distal posterior interosseous branch is needed while retractors are being

Figure 4. Hook test. Patient's arm is abducted and elbow flexed to 90° with forearm in supination; examiner hooks index finger behind distal biceps tendon.

placed posterolateral to the radial tuberosity. We prefer to not hook instruments, like Hohman retractors, posterior to the radius but rather to use several deep right-angle retractors for exposure. The median nerve courses ulnarly to the brachial artery and along the radial aspect of the pronator teres before diving deep to the flexor digitorum superficialis. Finally, the lacertus fibrosis extends from the biceps tendon ulnarly and overlies the brachial artery, the bifurcation of the brachial artery, and the median nerve. Release of the lacertus is often required to obtain sufficient mobilization of the biceps to achieve a repair without significant tension.

Epidemiology

This injury classically has involved the dominant extremity of male laborers in the fourth and fifth decades of life. It typically has been associated with eccentric contraction of the biceps with the elbow in midflexion.[16] Ruptures have also been described in various systemic conditions, including rheumatoid arthritis, ankylosing spondylitis, gout, systemic lupus erythematosus, syphilis, tuberculosis, malignancy, and end-stage renal disease.[17]

Safran and Graham[17] more accurately characterized the incidence of this injury and defined the possible role of smoking in predisposing patients to ruptures. They found an incidence of 1.5/10,000 in ages 30 to 39, 0.5 in ages 40 to 49, and 0.7 in ages 50 to 59. Ninety-three percent of patients were men, and 50% of cases were in patients 30 to 39 years old. The dominant extremity was involved in 86% of cases, and an eccentric contraction preceded all injuries. Smokers had more than 7-fold increased risk for rupture.

Etiology

The etiology of distal biceps tendon injuries is multifactorial and includes mechanical failure, tendon degeneration, and limited vascularity. Mechanical factors include relative interosseous impingement caused by full pronation, which may lead to degeneration from repetitive compression.[12] In addition, an oblique vector is applied to the intact tendon with contraction of the flexor-pronator mass. This contraction increases the cross-sectional area of the flexor-pronator mass, thereby placing the lacertus fibrosis on tension. The tense, medialized lacertus fibrosis initiates an oblique force vector on the biceps tendon.[14] Tendons perform the worst when obliquely loaded during eccentric contraction, thereby potentially predisposing the distal biceps to rupture compared with tendons having a dissimilar loading pattern.[18]

Tendon degeneration has been implicated as a cause for tendon rupture in numerous anatomical sites, including the distal biceps. Kannus and Jozsa[19] histologically analyzed tendon rupture specimens and age-matched cadaveric controls of a variety of ruptured tendons, including the distal biceps. All ruptured tendons were abnormal: 97% demonstrated degenerative changes, and inflammatory findings accounted for the other 3%. In the age-matched cadaveric controls, however, degenerative changes were found in only 34% of specimens.

Finally, a relatively hypovascular zone of the distal tendon has been proposed as a possible predisposing factor leading to distal biceps tendon ruptures. The hypovascular zone is located within the tendon substance distally, not directly at the tendon insertion. Most ruptures are tuberosity avulsions, not midsubstance ruptures, though musculotendinous injuries have also been described.[12,20] Therefore, given the common location of tendon ruptures, the zone of limited vascularity is unlikely to have a significant effect on the rate of ruptures.

Clinical Evaluation

Distal biceps tendon injuries represent a spectrum of disease from tendonitis to partial-thickness tears to complete tears. In addition, intact tendons may become symptomatic because of bicipital tendinosis (intrasubstance degeneration) or cubital bursitis. The clinician should be aware of this variety of pathology and not discount a possible injury when a complete rupture is not identified.

Partial ruptures present with a palpable but painful tendon and are most easily confused with tendinosis or bursitis. Pain is exacerbated with resisted elbow flexion and forearm supination. The hook test is typically intact but painful.[21] This test is performed with the arm abducted to 90° and the elbow flexed to 90° with the forearm in supination. The examiner's finger is then used to "hook" the biceps tendon from lateral to medial in the antecubital fossa (Figure 4). When the tendon can be hooked, at least some portion of the tendon is intact.[21] In a cohort of 45

Figure 5. Skin incision for anterior approach for distal biceps tendon repair 2 fingerbreadths distal to flexion crease centered over radial tuberosity.

patients who underwent surgical exploration of the distal biceps tendon, the hook test was 100% sensitive and specific in diagnosing a complete distal rupture.[11] The authors reported that sensitivity and specificity were higher for the hook test than for MRI (92% sensitive, 85% specific) in diagnosing a complete rupture in their series. MRI or ultrasound can be helpful in identifying abnormal intratendinous signal changes associated with bicipital tendinosis and tuberosity edema or partial tendon avulsions associated with partial tears.

Musculotendinous junction injuries are rare; only a few have been reported.[20] Presenting clinical findings are similar to those of tendinitis and partial rupture. MRI is useful in differentiating musculotendinous injuries from partial ruptures. Patients with musculotendinous injuries typically do very well with nonoperative management.[20]

Patients with acute ruptures typically develop distal arm pain and swelling associated with ecchymosis and a traumatic event. Range of motion is limited, and there is a palpable defect in the antecubital fossa; this defect is often exacerbated by elbow flexion. The hook test is often positive. MRI or ultrasound may be used to confirm the diagnosis and evaluate the level of tendon retraction.

Chronic ruptures often present with a history similar to that of acute ruptures, but on a delayed basis. After the patient recovers from the initial pain of injury, supination weakness and early biceps muscle fatigue may persist. A palpable distal arm mass associated with a palpable defect and an abnormal hook test provides evidence confirming the rupture. In these cases, MRI or ultrasound may be quite helpful in evaluating the level of tendon retraction. An intact lacertus fibrosis can limit proximal migration of chronically ruptured tendons. Significant retraction may limit the surgeon's ability to perform a direct repair, leaving a tenodesis to the brachialis and a salvage reconstruction using a soft-tissue graft as the only possible surgical options.

Treatment of Partial Ruptures

Partial ruptures should be treated without surgery initially. The vast majority of partial ruptures result from degenerative changes associated with a traumatic injury, either single events or smaller, repetitive insults. Anti-inflammatory medications can decrease symptoms but are unlikely to improve the underlying pathology. Activity modification and physical therapy are also reasonable nonoperative treatments.

When nonoperative options have been exhausted, the surgical option of choice is release of the remaining distal biceps tendon, débridement of the biceps tuberosity, and reattachment. This surgery may be performed with an anterior or posterior approach. A series of 7 patients treated with anterior repair had "uniformly good results," with 2 patients sustaining transient LABC palsies.[22] A posterior approach through a longitudinal split in the extensor digitorum communis and the supinator was described for complete débridement and refixation through transosseous tunnels.[23] Six of 8 patients in the series were "completely satisfied" with their outcome.

Treatment of Acute Ruptures

The rationale for acute repair of distal biceps ruptures stems primarily from 2 studies that found persistent weakness and fatigue of elbow flexion and forearm supination without repair.[8,24] Both studies evaluated strength with isokinetic dynamometry. In one,[24] the nonoperative group demonstrated a 21% loss of strength and endurance in elbow flexion, a 27% loss of supination strength, and a 47% loss of supination endurance, whereas the operative group demonstrated mildly increased levels of performance in these trials. The other study[8] demonstrated a 30% loss of flexion strength and a 40% loss of supination strength compared with the contralateral extremity in the nonoperative group; with anatomical repair, patients' strength recovered to near normal.

Operative Technique for Acute Repair

Two-Incision Technique. In 1961, Boyd and Anderson[3] were the first to describe using a 2-incision approach for anatomical repair of the distal biceps tendon. This repair has been modified numerous times, but its essential principles remain unchanged. The repair begins with a small transverse incision about 2 fingerbreadths distal to the antecubital flexion crease (Figure 5). The track of the biceps tendon is identified and explored. The tendon is freed of soft-tissue attachments and scar tissue, and the lacertus fibrosis is released. After excursion is sufficient, 2 braided, nonabsorbable sutures are placed into the tendon in running-locking fash-

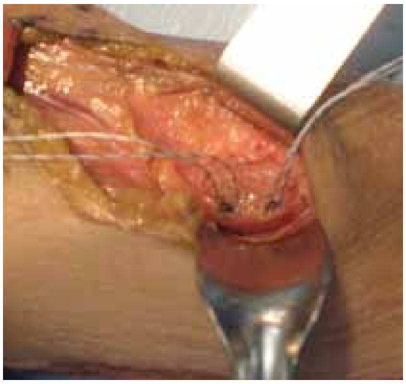

Figure 6. Anterior exposure of radial tuberosity with 2 anchors in place.

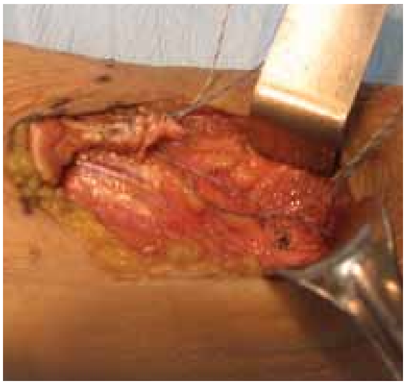

Figure 7. Distal biceps tendon with single limb of suture from each anchor sutured into distal tendon (1 with Krackow suture, 1 with Bunnell suture).

ion. A clamp is placed around the tuberosity through the interosseous membrane while much care is taken not to disturb the ulnar periosteum. A second dorsal incision is made over the now subcutaneous clamp, and dissection is carried down to the radial tuberosity. A high-speed burr is used to prepare a trough in the tuberosity, and 3 transosseous tunnels are placed through the posterior wall of the trough. The clamp is then used to deliver the sutures through the interosseous membrane into the wound. The tendon is placed into the trough, and the sutures are passed through the transosseous tunnels and tied. The wounds are then irrigated and closed.

One-Incision Technique. One-incision techniques are also in widespread use and are gaining popularity with improvements in implants used for tendon repair. When using

Figure 8. Final repair of 1-incision technique using anchors.

Figure 9. Lateral radiograph of elbow shows placement of suture anchors.

a 1-incision anterior approach, it is important to recall that the true anatomical insertion is difficult to access, even in full supination (Figure 2). The approach begins with a transverse incision 2 fingerbreadths distal to the antecubital flexion crease. Several large veins of the antecubital venous complex need to be mobilized, and often ligated, to gain adequate exposure for repair. The distal biceps track and tendon stump are identified, and the tendon is released from adherent soft tissue and the lacertus fibrosis. Care is taken to avoid excessive radial retraction, as this can injure the LABC nerve. Blunt dissection is carried down to the radial tuberosity between the brachioradialis and the pronator teres. The radial recurrent branches are preserved, if possible. The radial tuberosity is identified, and all remaining soft tissue is removed. Deep right-angle retractors are used to retract medially, laterally, and distally during the repair. Hohman retractors are avoided to limit placement of retractors posterior to the proximal radius and possible injury to the posterior interosseous nerve. The tendon is then securely fixed with suture anchors or an EndoButton.

Suture Anchors. Two cortical anchors are placed in the tuberosity perpendicular to the cortex, 1 distally and 1 proximally (Figure 6). One limb of the braided, nonabsorbable No. 2 suture from 1 anchor is then placed into the distal 3 to 4 cm of the tendon in running-locking fashion. One limb of the No. 2 suture from the other anchor is then run in Bunnell fashion into the tendon (Figure 7). The elbow is placed in 30° of flexion, and the suture for the distal anchor is held taut while the proximal suture is tied. The distal suture is then tied (Figures 8, 9).

EndoButton. During instrumentation of the radial tuberosity, the arm must be maintained in full supination. The guide pin should be started centrally in the tuberosity and aimed 30° ulnarly to avoid the posterior interosseous nerve.[25] The guide pin is overdrilled with the appropriate drill provided by the device manufacturer. All remaining soft tissue is removed from the tuberosity. EndoButton sutures are placed in running-locking fashion in the distal 3 to 4 cm of the tendon. The sutures are tied over the button, leaving a 3-mm gap between the knot and the button so it can traverse the far cortex. The forearm is flexed to 90° and supinated before the guide pin is used to pass the “kite string” sutures through the posterior cortex and soft tissues. The kite-string sutures are then manipulated to “flip” the button into the transverse position and lock the tendon into the tuberosity. The kite-string sutures are then pulled through the button and out of the skin[4] (Figure 10).

Figure 10. Lateral radiograph of elbow shows placement of EndoButton (Smith & Nephew, Andover, Mass).

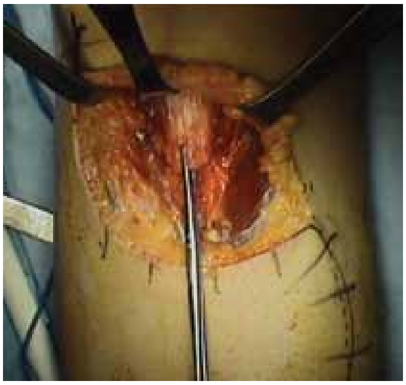

Figure 11. Distal biceps tendon stump in chronic injury precludes direct repair.

Treatment of Chronic Ruptures

In the chronic setting (>4 weeks from injury), the tendon may retract significantly and require grafting for anatomical reconstruction. With advances in surgical technique and fixation implants, anatomical reconstructions augmented with a graft are becoming easier to perform. Nonanatomical reconstructions should still be considered in these cases, with the final decision regarding surgical treatment based on the individual patient's needs, functional deficits, and expectations. Although preoperative imaging may aid in the decision to perform a primary repair or reconstruction, the final decision is made during surgery. During exposure, the lacertus fibrosis and any additional soft-tissue restraints must be released. The feasibility of tendon reapproximation is then determined. Primary repair has

Figure 12. Augmentation of distal biceps tendon with semitendinosus allograft using Pulvertaft weave through distal biceps tendon stump.

been recommended for tendons that can be reapproximated with 45° to 90° of elbow flexion.[7,26,27]

When primary repair is not feasible, there are 2 surgical options: tenodesis to the brachialis muscle and extension of the remaining distal biceps tendon with a tendon graft. Numerous grafting options and fixation methods have been described. Several authors have had success with use of transosseous tunnels, suture anchors, and EndoButtons in combination with Achilles allograft, semitendinosus allograft/autograft, and flexor carpi radialis autograft[27-31] (Figures 11, 12). Nonanatomical reconstruction by tenodesis to the underlying brachialis can be clinically successful, particularly in recovering flexion strength. It is essential to properly tension the biceps muscle, or pronounced weakness can result. Flexion strength with tenodesis has been reported to equal that of anatomical repair, but half of the patients who undergo tenodesis lose 50% of supination strength. Endurance in flexion and supination did not differ significantly between acute repair and tenodesis.[32]

Biomechanics

Given the numerous fixation options, an understanding of the biomechanics of various repair techniques is essential to determining the optimal surgical construct. Both load-to-failure and cyclic load-displacement testing of various fixation constructs has been performed in cadaver models. Some authors have reported that EndoButton fixation is stronger than either suture anchors or bone tunnels as a biomechanical construct.[4,33-36] Other investigators have found interference screw fixation superior to both suture anchors and transosseous techniques.[37,38] Still others have found no meaningful difference between these various fixation methods.[39]

In a single cadaveric study, Mazzocca and colleagues[35] evaluated various distal biceps repairs, including transosseous tunnels, suture anchors, tenodesis screw fixation, and EndoButton. They found no significant difference between methods in cyclic displacement, which ranged from 2.25 to 3.5 mm in all specimens. They determined mean loads to failure to be 439 N for EndoButton, 381 N for suture anchors, 310 N for transosseous tunnels, and 231 N for tenodesis screw. The EndoButton load to failure was significantly larger than that of all other tested constructs. No other relationships between constructs reached statistical significance. Although significant differences can certainly be demonstrated in the laboratory, they may be less relevant in the clinical setting. All techniques are likely sufficient for early passive motion, and EndoButton fixation may allow early active motion.[35] Active elbow flexion in cadaveric specimens was shown to require only 25 N for flexion to 30°, 35 N for flexion to 90°, and 67 N for flexion to 130°.[4] The largest specimen in this study required 123 N for full elbow flexion.[4] Consequently, the loads to failure reported by Mazzocca and colleagues[35] in the weakest construct still far surpassed the in vitro forces required for immediate active range of motion.

The effect of reinsertion location on ability of a repair to restore the normal flexion and supination force imparted by the biceps tendon was also examined in a cadaver model.[39] In the native state, the radial tuberosity acts as a cam to increase supination torque. When the tendon is not reinserted anatomically into the posterior tuberosity, loss of the cam effect theoretically could result. In that cadaveric study,[39] 1 elbow specimen from a matched pair underwent a 1-incision anterior repair with transosseous fixation while a 2-incision repair into the posterior tuberosity with transosseous tunnels was performed on the opposite elbow. No significant difference was found between groups in either forearm supination torque or elbow flexion force with a similar load applied to the biceps muscle. These results suggest that whether the tendon is reinserted anatomically into the footprint or into the anterior aspect of the tuberosity, the functional differences are likely to be minimal.

Functional Outcomes and Complications

Outcomes of Acute Injuries

Recent reports have described success in using the 1-incision anterior approach in restoring patient function and minimizing complications. A single-surgeon series of 53 acute repairs with suture anchors found restoration of normal motion to within 5° in all parameters.[6] Disabilities of the Arm, Shoulder, and Hand (DASH) scores were not significantly different from those of normal controls. No reruptures or heterotopic ossification was reported. Another single-surgeon series with suture anchors found 7 good and 46 excellent results according to Andrews-Carson scores.[5] No patients reported fair or poor results.

A series of 21 patients treated with a 2-incision technique demonstrated mean flexion-extension of 0° to 141°, pronation-supination of 74° to 75°, and a mean DASH score of 3.6.[40] Both isometric and dynamic flexion strength improved to mildly better than that of the normal side, whereas isometric and dynamic supination returned to within 11% of the normal side. In another series, all 45 patients treated with the 2-incision technique regained “without a complication” normal motion and neurologic function, according to retrospective review.[41] A review of 13 patients documented that flexion strength of 91% and supination strength of 84% of the contralateral side were regained.[42] Mean motion loss of 3° pronation, 8° supination, and 6° extension was reported.

Outcomes of Chronic Injuries

As already mentioned, significant delays in treatment typically predispose patients to increased risk for postoperative complications.[41,43] However, surgically treated chronic ruptures can show significant improvements in function and strength. In a series of patients evaluated a mean of 119 days after injury, those treated without surgery demonstrated a persistent 20% loss of forearm supination and elbow flexion strength, and those treated with semitendinosus autograft augmented reconstruction regained normal supination and flexion strength compared with a group of uninjured controls. Neither group demonstrated a change in endurance strength.[31]

> “...significant delays in treatment typically predispose patients to increased risk for postoperative complications.”

Other investigators have reported similar encouraging results for reconstruction of chronic ruptures.[27,30] Supination and flexion strength typically recovered to 80% to 90% of normal, and motion recovered to near normal. Supination strength in chronic ruptures that were primarily repaired was mildly decreased compared with supination strength in chronic ruptures that underwent reconstruction with a graft.

Complications

Several authors have reported complications after acute repair with a 1-incision technique. In a single-surgeon series of 53 cases, patients sustained 1 wound complication, 2 transient paresthesias of the LABC nerve, and 1 posterior interosseous nerve palsy that resolved in 6 weeks.[6] In another series of 53 patients, no infections or reruptures were reported, but mild motion limitation due to heterotopic ossification was found in 4% of patients, and a transient radial nerve palsy occurred in 2% of patients.[5]

Rehabilitation

Early, protected passive motion traditionally has been used after repair. Recently, several authors have challenged this idea with the institution of more aggressive postoperative therapy protocols that include early active motion. Cheung and colleagues[42] used a postoperative protocol beginning with immediate passive motion in a hinged brace limited between full flexion and 60°. The extension block was increased by 20° every 2 weeks until full extension was achieved. No reruptures or complications were reported. Cil and colleagues[40] advocated a more aggressive protocol in which no extension block is required. Twenty-one patients underwent 2-incision repair; after surgery, they were treated with a sling for 1 to 2 days and then allowed full active motion with daily activities and a 1-pound weight restriction for 6 weeks. At minimum 2-year follow-up, there were no clinical disabilities or tendon ruptures.

Figure 13. Anterior heterotopic bone formation after 1-incision repair with EndoButton (Smith & Nephew, Andover, Mass).

A series of 74 patients treated with a 2-incision, transosseous tunnel technique and not stratified by chronicity revealed a complication rate of 31%.[43] Six patients had persistent anterior elbow pain, 5 had sensory paresthesias, 4 had heterotopic bone formation, 3 had loss of rotation, and 3 had superficial infections. In addition, 1 patient had a rerupture, and 1 developed complex regional pain syndrome. When stratified by chronicity, the overall complication rate was 24% in acute ruptures (<10 days), 38% in subacute ruptures (10-21 days), and 41% in delayed ruptures (>21 days). It should be noted that other investigators typically do not report persistent anterior elbow pain as a complication. Another study, of 45 cases, found that 27% of patients had 12 complications: 7 nerve complications, 3 functional synostoses, 1 rerupture, and 1 case of complex regional pain syndrome.[41] Patients treated within 14 days of injury had a 20% complication rate, and patients treated 15 days or more after injury had a 40% complication rate. Although the trend toward fewer complications in interventions performed within the first 2 weeks is not significant, the authors found the procedure technically much easier to perform within 14 days of injury.

The increased complexity of operative intervention for chronic ruptures suggests a higher complication rate, but the authors who compared operative and nonoperative treatment reported no infections, radial nerve palsies, heterotopic ossification, or ruptures in the 7 patients treated surgically.[31] In a series of 4 patients who underwent Achilles tendon allograft reconstruction, no complications were noted at a mean follow-up of 3 years.[30] One in a series of 7 patients with Achilles allograft reconstruction developed heterotopic ossification that did not limit motion.[27] No other complications were encountered in the series. These studies imply a complication profile lower than that found in acute repairs, but it is important to note that these small series of reconstructions are a fraction of the size of most series published on acute repairs.

> **"Either an anterior 1-incision approach or a 2-incision approach is acceptable for repair."**

Heterotopic Ossification

Although relatively uncommon, radioulnar heterotopic ossification with or without synostosis is one of the most frustrating and difficult postoperative complications to manage for both patient and surgeon (Figure 13). In a series of 8 patients who developed radioulnar heterotopic ossification after 2-incision repair, motion was severely limited.[44] All patients had been treated with primary repair within 14 days of injury. Flexion ranged from 115° to 135°, and rotation averaged 25° and was absent in 2 patients. All patients underwent open resection of heterotopic ossification a mean of 6 months after primary repair. Treatment after resection included immediate continuous passive motion, 700-cGy external beam radiation on postoperative day 1, and use of oral indomethacin for 3 weeks. Testing performed a mean of 57 months after resection revealed mean flexion to 135°, supination to 86°, and pronation to 65°. These range-of-motion values were found to be no different from those for acute repair controls.

Conclusions

Distal biceps tendon rupture is a relatively unusual injury typically reported in the dominant extremity of middle-aged men. Clinical findings are the mainstay of diagnosis, but MRI or ultrasound imaging can provide additional information. Either an anterior 1-incision approach or a 2-incision approach is acceptable for repair. Various fixation techniques have been reported, all with comparable biomechanical results and clinical outcomes. Complication rates are lower in patients treated closer to time of injury. Tendon retraction associated with chronic ruptures can present a difficult surgical problem. Advanced soft-tissue imaging adds helpful information about the level of biceps tendon retraction and possible reparability. When the tendon can be reapproximated safely at less than 45° to 90° of elbow flexion, then primary repair may be performed. When reapproximation is not possible, options are reconstruction and tenodesis. Reconstruction performed through 1 or 2 incisions with either allograft or autograft has successfully restored both motion and power.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

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