Distal Biceps Tendon Ruptures

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Historical Perspective

In 1925 Bianchieri examined the frequency of biceps tendon ruptures and found 96% ruptured proximally at the long head, 1% proximally at the short head and 3% distally.[1] In 1941, Dobbie looked specifically at distal biceps injuries with an early attempt at a meta-analysis. He reviewed the twenty-four previously reported surgically treated cases of distal biceps injuries in the literature as well as sending a questionnaire to nearly five hundred active surgeons. From the replies, he identified fifty-one new cases of distal biceps injuries repaired with a variety of techniques noting 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.[i]

Interest has continued grow in the surgical treatment of distal biceps injuries with Boyd and Anderson's description of a two-incision repair technique in 1961 and more recently with several authors reporting promising results with single-incision repairs. This increased interest in the distal biceps is reflected by a PubMed search for "distal biceps tendon ruptures" yielding 46 citations for the calendar year 2007.[ii]

Distal Biceps Tendon Anatomy

The biceps muscle has two tendinous origins and one tendinous insertion. The long head of biceps originates at the supraglenoid tubercle and traverses the shoulder joint prior to 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 primarily functions to supinate the forearm and assist with elbow flexion. It also functions as a secondary elevator and abductor of the shoulder.[iii] Elbow and forearm position has been determined to affect the function of the biceps muscle. EMG studies have demonstrated that the flexion activity of the biceps is inhibited by forearm pronation.[iv] Maximum supination strength is achieved with forearm flexion, and maximum flexion strength is achieved with forearm supination.[v]

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 2cm in length 1-2 cm proximal to the insertion.[vi]

A more detailed understanding of the distal biceps footprint has been revealed in recent years. The biceps tendon occupies 85% of the proximal radioulnar joint at the level of tuberosity in full pronation and 35% in full supination. This represents a 50% reduction in the space available for the tendon during transition from supination to pronation.[vi] The radial tuberosity has been identified to have two distinct portions – a rough posterior portion for tendon insertion, and a smooth, bursa-covered anterior portion.[vi] The tuberosity measures 24 mm proximal to distal and 12 mm medial to lateral. The tendon footprint measures 19 mm proximal to distal and 4 mm medial to lateral.[vii] Therefore, the tendon only attaches to approximately 1/3rd of the overall width of the tuberosity. (Figure 1) Also, an anatomic study demonstrated that in 10 of 17 specimens two distinct distal tendons (distal extensions of the long and short head muscle bellies) were easily identified receiving equal musculocutaneous innervation and attaching separately to the radial tuberosity. The long head distal tendon was noted to be crescentic, deep and insert proximally, while the short head distal tendon was consistently oval, superficial and inserted distally.[viii] (Figure 1)

The tendon insertion averages 23mm distal to the articular margin, is located on the posterior/ulnar aspect of the tuberosity and is oriented 30 degrees anterior to the coronal plane when the arm is fully supinated.[ix] With the arm in full supination, the center of the tuberosity averages 45 degrees anterior to horizontal in the plane of the forearm and the posterior margin of the tuberosity averages 15 degrees anterior to horizontal in the plane of the forearm. Based upon these anatomic properties, the tendon inserts at approximately 30 degrees anterior to horizontal in the plane of the forearm (half way between the posterior margin and the tuberosity center) in full supination. This location can make a single incision repair difficult if there is any rotational deficit limiting full supination.

Similarly, if a single incision technique is performed a more anatomic repair can be achieved if the fixation instrument (anchors, Endobutton {Arthrex, Naples, FL}, etc.) is directed slightly radial during insertion. (Figure 2)

Surgical Anatomy

An understanding of the relevant surgical anatomy is essential to safely and efficiently perform a distal biceps repair. The musculocutaneous nerve innervates the biceps and brachialis and then continues on in the interval between these two muscles as the lateral antebrachial cutaneous (LABC) nerve. It provides sensation to the lateral forearm. It should be carefully identified and protected during a distal biceps repair since 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 re-route the distal biceps anterior to the nerve.

The radial nerve runs between the brachialis and 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. While the nerve is not routinely exposed during surgery, constant awareness of it and its distal posterior interosseous branch should be present while placing retractors posterolateral to the radial tuberosity. We prefer to not hook instruments, like Hohman retractors, posterior to the radius, but rather utilize 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 prior to 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 in order to obtain sufficient mobilization of the biceps to achieve a repair without significant tension.

Epidemiology

Classically this injury has involved the dominant extremity of male laborers in the fourth and fifth decades of life. It has typically been associated with eccentric contraction of the biceps with the elbow in mid flexion.[x] 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.[xi]

Safran and colleagues more accurately characterized the incidence of this injury as well as defining the possible role of smoking in predisposing patients to ruptures. They found an incidence of 1.5/10,000 in ages 30-39, 0.5/10,000 in 40-49, and 0.7/10,000 in 50-59. The patients were 93% male, and 50% of the cases occurred in patients aged 30-39. The dominant extremity was involved in 86% of cases, and an eccentric contraction preceded all injuries. Smokers had a greater than seven-fold increased risk of rupture.[xi]

Etiology

The etiology of distal biceps tendon injuries is multifactorial including mechanical failure, tendon degeneration and limited vascularity. Mechanical factors include the relative interosseous impingement caused by full pronation, which may lead to degeneration from repetitive compression.[vi] Additionally 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.[viii] Tendons perform the worst when obliquely loaded during eccentric contraction thereby potentially predisposing the distal biceps to rupture compared to other tendons without a similar loading pattern.[xii]

Tendon degeneration has been implicated in numerous anatomic sites as a cause for tendon rupture including the distal biceps. Kannus and colleagues 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, while inflammatory findings accounted for the remaining 3%. However in the age-matched cadaveric controls, degenerative changes were found only in 34% of specimens.[xiii]

Finally, a relative hypovascular zone of the distal tendon has been proposed as 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, although musculotendinous injuries have also been described.[vi] [xiv] Consequently, given the common location of tendon ruptures, the zone of limited vascularity is unlikely to have a significant affect 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. Also, intact tendons may become symptomatic due to 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.[xv] The hook test is performed with the arm abducted and internally rotated with the elbow flexed 90 degrees. The examiner's finger is then used to "hook" the biceps tendon from lateral to medial in the antecubital fossa. (Figure 4) If the tendon can be hooked, at least some portion of the tendon is intact.[xv] In a cohort of 45 patients undergoing surgical exploration of the distal biceps tendon, the Hook Test was 100% sensitive and specific in diagnosing a complete distal rupture. The authors reported that sensitivity and specificity were higher for the Hook Test than an MRI (92% sensitive, 85% specific) in diagnosing a complete rupture in their series.[xv] 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 but have been reported.[xiv] Presenting clinical findings are similar to those of tendinitis or partial rupture. MRI is useful in differentiating musculotendinous injuries from partial ruptures. Patients with musculotendinous injuries typically do very well with non-operative management.[xiv]

Patients with acute ruptures typically develop pain and swelling in the distal arm associated with ecchymosis and a traumatic event. Range of motion is limited, and a palpable defect is present in the antecubital fossa 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 similar history as those with acute ruptures, but on a delayed basis. After recovery from the initial pain of injury, supination weakness and early biceps muscle fatigue may persist. A palpable mass located in the distal arm associated with a palpable defect and an abnormal Hook Test provides further evidence confirming the rupture. MRI or ultrasound may be quite helpful in these cases to evaluate the level of tendon retraction. An intact lacertus fibrosis can limit proximal migration of chronically ruptured tendons. Significant retraction may limit the ability to perform a direct repair leaving a tenodesis to the brachialis or a salvage reconstruction utilizing a soft tissue graft as the only possible surgical options.

Treatment – Partial Ruptures

Partial ruptures should be initially treated nonoperatively. The vast majority of partial ruptures are a result of degenerative changes of the distal biceps associated with a traumatic injury. These may be either single events or smaller, repetitive insults. Anti-inflammatory medications can decrease symptoms, but they are unlikely to improve the underlying pathology. Activity modification and physical therapy are also reasonable nonoperative treatments.

When nonoperative options have been exhausted, release of the remaining distal biceps tendon, debridement of the biceps tuberosity and reattachment is the surgical option of choice. This may be achieved via an anterior or posterior approach. A series of seven patients treated with anterior repair had “uniformly good results” with two patients sustaining transient lateral antebrachial cutaneous palsies.[xvi] A posterior approach via a longitudinal split in the extensor digitorum communis and the supinator has been described for complete debridement and refixation via transosseous tunnels. Six of eight patients in the series were “completely satisfied” with their outcome.[xvii]

Treatment – Acute Rupture

The rationale for acute repair of distal biceps ruptures stems primarily from two studies reporting persistent weakness and fatigue of elbow flexion and forearm supination without repair. Both studies evaluated strength with isokinetic dynamometry. In one study, 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. The operative group was found to have mildly increased levels of performance in these trials.[xviii] Another study demonstrated a 30% loss of flexion strength and a 40% loss of supination strength compared to the contralateral extremity in the nonoperative group. With anatomic repair, patients recovered near-normal strength.[xix]

Operative technique – Acute Repair

Two-Incision technique

In 1961 Boyd and Anderson first described the two-incision approach for anatomic repair of the distal biceps tendon.[xx] It has been modified numerous times, but the essential principles of the repair remain unchanged. The repair begins with a small transverse incision in the antecubital flexion crease. 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 sufficient excursion is achieved, 2 braided, non-absorbable sutures are placed into the tendon in a running-locking fashion. A clamp is placed around the tuberosity through the interosseous membrane while great care is taken not to disturb the ulnar periosteum. A second dorsal incision is made overlying the now-subcutaneous clamp, and dissection is carried down to the radial tuberosity. A trough is prepared in the tuberosity with a high-speed burr, 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.

Single-Incision technique

Single incision techniques are also in widespread use and are gaining popularity with improvements in implants utilized for tendon repair. When performing a single anterior approach, it is important to recall that the true anatomic insertion is difficult to access, even in full supination. (Figure 2) The approach begins with a transverse incision two fingerbreadths distal to the antecubital flexion crease. (Figure 5) Several large veins of the antecubital venous complex will need to be mobilized, and often ligated, in order 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 lateral antebrachial cutaneous nerve. (Figure 6) Blunt dissection is carried down to the radial tuberosity between brachioradialis and 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 utilized 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. Secure fixation of the tendon is then achieved utilizing suture anchors or an Endobutton (Arthrex, Naples, FL).

<u>Suture Anchors</u>

Two cortical anchors are placed in the tuberosity perpendicular to the cortex, one distally and one proximally. (Figure 7) One limb of the nonabsorbable, braided No. 2 suture from one anchor is then placed into the distal 3-4 cm of the tendon in a running-locking fashion. One limb of the No. 2 suture from the other anchor is then run in a Bunnell fashion into the tendon. (Figure 8) The elbow is placed in 30 degrees of flexion, and the suture for the distal anchor is held taught while the proximal suture is tied. The distal suture is then tied. (Figure 9 and Figure 10)

Endobutton (Arthrex, Naples, FL)

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 degrees ulnarly to avoid the posterior interosseous nerve.[xxi] The guide pin is overdrilled with the appropriate drill as provided by the device manufacturer. All remaining soft tissue is removed from the tuberosity. The Endobutton sutures are placed in a running-locking fashion in the distal 3-4cm of the tendon. The sutures are tied over the button leaving a 3 mm gap between the knot and button so it can traverse the far cortex. The forearm is flexed to 90 degrees and supinated prior to passing the "kite string" sutures through the posterior cortex and soft tissues with the guide pin. The kite string sutures are then manipulated to "flip" the button into the transverse position and lock the tendon into the tuberosity. (Figure 11) The kite string sutures are then pulled through the button and out of the skin.[xxii]

Treatment – Chronic Ruptures

In the chronic (greater than 4 weeks from injury) setting, the tendon may retract significantly and require grafting for anatomic reconstruction. With advances in surgical technique and fixation implants, anatomic reconstructions augmented with a graft are becoming easier to perform. Nonanatomic reconstructions should still be considered in these cases with the final decision regarding surgical treatment based individually upon the patient's needs, functional deficits and expectations. While preoperative imaging may aid in the decision to perform a primary repair or reconstruction, the final decision is made intraoperatively. 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 been recommended if the tendon can be reapproximated with 45 to 90 degrees of elbow flexion. [xxiii] [xxiv] [xxv]

If primary repair is not feasible, the two surgical options available include tenodesis to the brachialis muscle or extension of the remaining distal biceps tendon with a tendon graft. Numerous grafting options and fixation methods have been described. Several authors have noted the successful use of transosseous tunnels, suture anchors, and Endobuttons (Athrex, Naples, FL) in combination with achilles allograft, semitendinosus allograft/autograft, and flexor carpi radialis autograft. [xxv] [xxvi] [xxvii] [xxviii] [xxix] (Figure 12 and Figure 13) Nonanatomic reconstruction via tenodesis to the underlying brachialis can be clinically successful, especially in recovering flexion strength. It is essential to properly tension the biceps muscle otherwise pronounced weakness can result. Flexion strength has been reported as equal to that of anatomic repair, but half of the tenodesis patients suffered 50% loss of supination strength. Endurance in flexion and supination did not differ significantly whether patients underwent acute repair or tenodesis.[xxx]

Biomechanics

Considering the numerous fixation options currently available for repairs, an understanding of the biomechanics of various repair techniques is essential in determining the optimal surgical construct. Both load-to-failure and cyclic load-displacement testing of various fixation constructs have been performed in cadaver models. Some authors have reported that Endobutton (Arthrex, Naples, FL) fixation is the strongest biomechanical construct when compared to suture anchors and bone tunnels. [xxxi] [xxxii] [xxxiii] [xxxiv] [xxxv] Other investigators have found interference screw fixation superior to both suture anchors and transosseous techniques. [xxxvi] [xxxvii] Still other authors have found no meaningful difference between these various fixation methods.[xxxviii]

Mazzocca et al evaluated various distal biceps repairs including transosseous tunnels, suture anchors, tenodesis screw fixation and an Endobutton in a single cadaveric study. They found no significant difference between methods in cyclic displacement with a range of 2.25mm to 3.5mm in all specimens. They determined average loads-to-failure to be 439N for the Endobutton, 381N for suture anchors, 310N for transosseous tunnels, and 231N for the tenodesis screw.[xxxiv] The Endobutton load-to-failure was significantly greater than all other tested constructs. No other relationships between constructs reached statistical significance. While significant differences can certainly be demonstrated in the lab, 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.[xxxiv] Active elbow flexion in cadaveric specimens has been shown to require only 25N for flexion to 30 deg, 35N for flexion to 90, and 67N for flexion to 130.[xxxi] The largest specimen in this study required 123N for full elbow flexion.[xxxi] Consequently, the load-to-failures reported by Mazzocca et al in the weakest construct still far surpasses the in vitro forces required for immediate active range of motion.

The effect of reinsertion site location on the ability of a repair to restore the normal flexion and supination force imparted by the biceps tendon has also been examined in a cadaver model. In the native state, the radial tuberosity acts as a cam to increase supination torque. If the tendon is not reinserted anatomically into the posterior tuberosity, a theoretical loss of the cam effect could result. In a cadaveric study, one elbow specimen from a matched pair underwent a single incision anterior repair with transosseous fixation while a two-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.[xxxviii] 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 demonstrated the success of the single 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 degrees in all parameters. Disability of the Arm, Shoulder and Hand (DASH) scores were not significantly different than those of normal controls. No re-ruptures or heterotopic ossification was reported.[xxxix] Another single surgeon series with suture anchors found 7 good and 46 excellent results according to Andrews-Carson scores. No patients reported fair or poor results.[xl]

A series of 21 patients treated with a two-incision technique demonstrated mean flexion-extension of 0-141, pronation-supination of 74-75, and an average DASH of 3.6. Both isometric and dynamic flexion strength improved to mildly greater than the normal side, while isometric and dynamic supination returned to within 11% of the normal side.[xli] In another series of 45 patients treated with the two-incision technique, all patients "without a complication" regained normal motion and neurological function according to retrospective review.[xlii] A review of thirteen patients documented that flexion strength of 91% and supination strength of 84% of the contralateral side was regained. Average motion loss of 3 deg pronation, 8 deg supination, and 6 deg extension was reported.[xliii]

Rehabilitation

Traditionally early, protected passive motion has been utilized postoperatively after repair. Recently several authors have challenged this idea with the institution of more aggressive postoperative therapy protocols that include early active motion. Cheung et al utilized a postoperative protocol beginning with immediate passive motion in a hinged brace limited between full flexion and 60 degrees. The extension block is increased by 20 degrees every two weeks until full extension is achieved. No re-ruptures or complications were reported[xliii.] A more aggressive protocol has been advocated in which no extension block is required. Twenty-one patients underwent two-incision repair and were treated postoperatively in a sling for 1-2 days, then allowed full active motion with daily activities and a 1-lb weight restriction for six weeks. At minimum two-year follow-up, there were no clinical disabilities or tendon ruptures.[xli]

Outcomes of chronic injuries

As previously mentioned, significant delays in treatment typically predispose patients to an increased risk of postoperative complications [xlii] [xliv]. However patients with chronic ruptures treated operatively can achieve significant improvements in both function and strength. In a series of patients averaging 119 days from injury, patients treated nonoperatively demonstrated a persistent loss of 20% of forearm supination and elbow flexion strength. Those treated with a semitendinosus autograft augmented reconstruction regained normal supination and flexion strength compared to a group of uninjured controls. Neither group demonstrated a change in endurance strength.[xxix]

Other investigators have reported similar encouraging results for reconstructions of chronic ruptures. Supination and flexion strength typically recover to 80-90% of normal, and motion recovers to near normal. When compared with chronic ruptures that were primarily repaired, supination strength was mildly decreased in comparison to those who underwent reconstruction with a graft.[xxv] [xxviii]

Complications

Several authors have reported complications after acute repair with a single incision technique. In a single surgeon series of 53 cases, patients sustained one wound complication, two transient paresthesias of the lateral antebrachial cutaneous nerve, and one posterior interosseous nerve palsy that resolved in six weeks.[xxxix] In a different series of 53 patients, no infections or re-ruptures were reported but mild motion limitation due to heterotopic ossification was found in 4%. A transient radial nerve palsy occurred in 2% of the patients.[xl]

A series of 74 patients, treated with a two-incision, transosseous tunnel technique and not stratified by chronicity, revealed a complication rate of 31%. Six patients had persistent anterior elbow pain, five had sensory paresthesias, four had heterotopic bone formation, three had a loss of rotation and three had superficial infections. Additionally one patient suffered a re-rupture, and one patient developed complex regional pain syndrome. When stratified by chronicity, the overall complication rate was found to be 24% in acute ruptures (fewer than ten days), 38% in subacute ruptures (ten to 21 days), and 41% in delayed ruptures (greater than 21 days).[xliv] It is important to note that these authors included persistent anterior elbow pain as a complication, and this has not been typically reported as a complication by most other investigators. Another study of 45 cases found that 27% of patients sustained a complication. Seven nerve complications, three functional synostoses, one re-rupture and one case of complex regional pain syndrome were identified. Patients treated within fourteen days of injury suffered a 20% complication rate, while patients treated after 15 days from injury suffered a 40% complication rate. While the trend towards fewer complications in interventions performed in the first two weeks was not significant, the authors found the procedure technically much easier to perform within fourteen days of injury.[xlii]

The increased complexity of operative intervention for chronic ruptures would seem to suggest an increased rate of complication. However, The authors comparing operative to non-operative treatment reported no infections, radial nerve palsies, heterotopic ossification or ruptures in the seven patients treated surgically.[xxix] In a series of four patients undergoing Achilles tendon allograft reconstruction, no complications were noted at average three-year follow-up.[xxviii] One patient in a series of seven patients with Achilles allograft reconstruction developed heterotopic ossification that did not limit motion. No other complications were encountered in the series.[xxv] 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.

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 the patient and surgeon. In a series of eight patients status post two-incision repair that developed radioulnar heterotopic ossification, motion was severely limited. All patients had been treated with a primary repair within fourteen days of injury. Flexion ranged from 115 to 135 degrees, rotation averaged 25 degrees and was absent in two patients. All patients underwent an open resection of heterotopic ossification at an average of six months after primary repair. Postoperative treatment after resection included immediate continuous passive motion, 700 cGy external beam radiation on postoperative day one and oral indomethacin for three weeks. Postoperative testing at an average of 57 months revealed average flexion to 135, supination to 86, and pronation to 65 after resection. These range of motion values were found to be no different than acute repair controls[xlv].

Conclusion

Distal biceps tendon rupture is a relatively unusual injury typically reported in the dominant extremity of middle-aged males. Clinical findings are the mainstay of diagnosis, but MRI or ultrasound imaging can provide additional information. Either an anterior single-incision or a two-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 the time of injury. Tendon retraction associated with chronic ruptures can present the surgeon with a difficult problem. Advanced soft tissue imaging adds helpful information about the level of biceps tendon retraction and possible reparability. If the tendon can be reapproximated safely at less 45 to 90 degrees of flexion, then primary repair may be performed. If not reconstruction or tenodesis is warranted. Reconstructions performed through single or dual incisions with allograft or autograft have been reported to successfully restore both motion and power.

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