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Management of Distal Biceps Tendon Ruptures

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Abstract- Distal biceps tendon rupture is a fairly uncommon injury but the incidence has risen with the associated increase in recreational activities in the 40 to 60 year old age group. The injury usually occurs from a single traumatic event whereby there is a forceful eccentric contraction of the biceps in the flexed elbow. Management considerations include conservative versus surgical management, and if surgery is chosen, the surgical approach: one-incision versus two-incision, and the choice of fixation technique which includes: suture anchors, bone tunnels or the endobutton. Surgery is indicated in patients who require maximum flexion and supination strength for vocational and recreational activities. The following article discusses the evolution of surgical management and the complications associated with the one and two incision approaches.

Keywords: *distal bicep, rupture, tendon.*

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Management of Distal Biceps Tendon Ruptures

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I. Introduction

Surgical repair is the treatment of choice for younger, more active individuals who have rupture of the distal biceps tendon. Surgery allows for restoration of anatomy, which gives the best chances of regaining full elbow flexion and forearm supination (1). Surgery has evolved from a non-anatomic approach to an extensile single incision to a two-incision technique to a modified one-incision technique (2, 3).

II. Discussion

Rupture of the distal biceps brachii tendon is an uncommon injury (4, 5, 6, 7). The incidence of the injury has been calculated at an average of 1.24 per 100, 000 people (8). As populations get older, with an increasingly active lifestyle, this incidence is likely to increase (9). It occurs mainly in the 40 to 60 age group (5, 6, 10) and its occurrence in females is very rare (4, 5, 8).

Injury tends to occur during intentional lifting or reaching activities (6, 8). It has been speculated that an individual is more likely to use their stronger dominant extremity for strength or support which accounts for the higher incidence in the dominant arm (8, 10). The classic mechanism of injury involves a single traumatic event to a flexed arm causing forceful eccentric contraction (4, 5, 10, 11) The patient then experiences an acute episode of sharp pain, followed by a dull aching pain. Ecchymosis and change in the muscle contour are often present and there is a hollow in the antecubital fossa compared with the contra-lateral elbow (4, 5, 10, 11, 12). Elbow flexion weakness may be subtle, but forearm supination may be more dramatic (4, 5, 10).

Most complete ruptures occur at the radial osseous insertion of the tendon. A few cases involve the musculotendinous interval (10). A detailed understanding of the distal biceps anatomy is necessary to anatomically repair tendon ruptures and re-establish normal tendon kinematics (10). The long and short head of the biceps are innervated by the musculocutaneous nerve, the distal biceps tendon spirals in a predictable manner. The twisting is said to aid in supination. The posterolateral fibres insert superiorly on the bicepital tuberosity and the anteromedial fibres insert inferiorly (13). Thus, the short head attaches inferiorly on the tuberosity and the long head attaches superiorly (10, 13). Kulshreshtha et al (13) proposed that the significant factor responsible for deficits in strength and range of motion is the failure to reproduce the complex arrangements of the tendon fibres.

Areas of interest with regards to managing these injuries include:

1. Conservative versus surgical management.
2. The surgical approach: one-incision versus two-incision.
3. Choice of fixation technique: suture anchors, bone tunnels or endobutton (14).

Operative treatment is indicated in the active patient, especially in light of the inferior results yielded with conservative treatment (12, 15, 16) including the decreased ability to use a screwdriver or baseball bat (5, 16). Some patients do achieve acceptable function, if they are low demand. These patients do not notice functional deficiencies such as an inability to perform repetitive elbow flexion and forearm supination activities as well as loss of endurance (4, 5). Contra-indications to surgery include: patient unwilling or unable to comply with rehabilitation, unwilling to undergo reconstruction, medical illness which preclude surgery and injuries which limit function of reconstructed upper extremity (4). Surgery is indicated in patients who require maximum flexion and supination strength for vocational and recreational activities (11, 17).

The original description of the surgical repair of a distal biceps tendon rupture was in 1898 (18). Numerous modifications have evolved with the goal of minimizing incision length and number of incisions, while minimizing complications (18). Historically non-anatomic repairs (where the biceps tendon is not reattached to the radial tuberosity) have been described, in which the biceps tendon was tenodesed

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to the brachialis. The procedure provided relief in terms of antecubital fossa pain and is technically easy to perform (4). Tenodesis to the brachialis was developed to avoid nerve injury (18, 19). It has been found to be a suboptimal procedure in the majority of patients who require supination strength and endurance (4, 6, 16). Surgical techniques have evolved from a nonanatomic approach to a two-incision approach to newer one-incision techniques including suture anchors, cortical buttons and interface screws (3, 20). The ideal biceps tendon repair ought to have high fixation strength, allow minimal gap formation and maintain mechanical stability until solid healing occurs (19, 21). Ideally the procedure should be easy, have a low complication rate, and allow for immediate elbow flexion and extension and forearm pronation and supination (21). Currently, the two most commonly used techniques involve anatomic attachment of the biceps tendon onto the radial tuberosity using either a one or two incision approach (18, 19). The clinical decision as to whether to perform a single or double incision has evolved over time (10). The surgeon now must choose between a single anterior incision and a modified two-incision technique (10). Reinsertion of the bicepital tendon in the radial tuberosity has been shown to give the patient the best functional outcome when compared to other treatment options (16, 15, 21, 22). Despite the description of several repair methods, using one or two-incisions, each technique has been associated with complications (18, 19, 23).

Earliest anatomic repairs were performed using a single extensive volar incision (9, 12, 20, 24). Extensive dissection was required to perform fixation techniques using mersilene tape, sutures or screws with plastic washers (5). This wide exposure of the radial tuberosity caused an increased risk of iatrogenic injury to the radial nerve (9). The most dreaded complication of distal biceps tendon repair is injury to the posterior interosseus nerve, where loss of function results in an inability to extend the digits (23). Luckily most are neuropraxias which resolve in less than eight weeks. To reduce this complication rate, the dissection to the tuberosity should be done with the forearm in supination, to get the nerve lateral to the plane of dissection (23).

The two-incision technique described by Boyd and Anderson (20) was introduced in order to reduce the incidence of neurological injury which was associated with the extensile volar approaches. In this technique, the tendon which is identified via the volar incision is reattached to the radial tuberosity which is exposed via the dorsal approach (20). Silk is sutured into the tendon and passed through drill holes and tied (20). The Boyd technique and its subsequent modifications have been found to be effective in restoring ROM and strength thus allowing return to premorbid function (9). Moosmayer et al (22) however stated that in using the Boyd technique, they endorsed the procedure, but stated that one should expect a slight decrease in strength and ROM. Although Boyd's technique had decreased the incidence of nerve injury, an increased rate of heterotopic ossification (HO) and radioulnar synostosis (25, 26) was associated with this surgery.

Heterotopic ossification is one of the most feared complications of repair of distal biceps tendon rupture as it may result in complete loss of forearm rotation in severe cases (23). Heterotopic ossification is much more common following 2-incision techniques than 1-techniques (23). Kelly et al (26) stated that radioulnar synostosis is the most frequently expressed concern of the 2-incision approach. Motion limiting HO may be caused by damage to the proximal portion of the interosseus membrane, haematoma formation between the ulna and the radius, bone debris in the surgical area and stimulation of the ulna periosteum (25). In an attempt to reduce HO rates associated with Boyd's' technique, Morrey et al (15) modified this technique by avoiding subperiosteal dissection of the ulna. They instead used an extensor muscle splitting approach. Other recommendations included wound drainage to reduce haematoma formation and to avoid spreading of bone dust (15). Kelly et al (26) adopted these recommendations and had no cases of synostosis. Exposure of the ulnar periosteum may contribute to radioulnar synostosis (5, 14, 26). Austin et al (14) noted that patients with synostosis tended to have scars near the ulnar crest and thus must be avoided. Cil et al (27) had two out of twenty one patients with HO and no cases of proximal radioulnar synostosis which he attributed to minimal posterior dissection and the use of two mini incisions. Following Morrey et al (15), Bourne further modified the two-incision technique by using a blunt, curved haemostat to pass the tendon down the original tunnel to the posterolateral surface (28) .Once the haemostat is palpated, the second incision is made over the instrument tip. Bourne (28) felt that his modification also reduced the rate of HO. Despite various modifications to the original two-incision technique, HO still occurs in muscle splitting techniques and in rare cases, after single incision which suggests a multifactorial aetiology (23).

The two-incision technique was introduced in an attempt to avoid neural injury has not totally eliminated this problem (23, 26). Kelly et al (26) had an eight percent rate of neural injury, where the lateral antebrachial cutaneous and superficial radial nerves were the most frequently injured. Both are at risk laterally when a long Henry incision is used anteriorly (26). All surgical techniques require an anterior incision in the antecubital flexion crease to retrieve the distal biceps tendon (23). Dissection through soft tissue requires identification and protection of both nerves. The repaired tendon sheath must pass deep to the nerve. Inadvertent

injury or excessive retraction may cause painful neuroma or parasthesias down the anterolateral aspect of the forearm (23). Kelly et al (26) also noted that no nerve injuries occurred with a small anterior incision and recommended the anterior incision to be 2.5 – 4.0 cm to avoid nerve injury. Moosmayer et al (22) using the conventional Boyd technique had two out of nine cases with deep branch of the radial nerve palsy. They theorized that this was due to compression of the nerve between the Homan retractor and the radius in the dorsal incision and advised that no soft tissue should be interposed.

Austin et al. (14) concluded that the two-incision technique has a low complication rate with the majority of complications resolving early and completely. He felt patient specific variables do not appear to be associated with the rate or type of complications. D'Arco et al. (17) controlled for hand dominance and found no difference in return to premorbid activity levels and radiographic findings when comparing conventional with the modified Boyd-Anderson technique, thus deeming both techniques as efficacious for repair of distal biceps tendon ruptures.

Kelly et al (26) found that when repair was performed greater than ten days post injury, overall complications increased from 22% to 41%. This is attributed to the increased anterior dissection needed to identify the bicepital tunnel and to mobilize the retracted tendon. Kelly et al (26) concluded that the two-incision technique is safe when done early with limited anterior dissection. Austin et al. (14) noted a 24% complication rate in 84 patients who underwent a modified Boyd approach with the vast majority resolving spontaneously, There was one re-rupture in this series and they found one other case in his literature review. Cil et al (27) noted no re-ruptures despite early active ROM following a modified mini two-incision distal biceps repair. Both methods are strong enough to withstand current rehabilitation protocols (21).

Recently the more favoured surgical approaches to repair distal biceps tendon rupture are the two-incision modified Boyd-Anderson technique or the limited single anterior incision using suture anchor fixation (18).

The increased popularity of suture anchors have coincided with several new technique for repair, all of which have been found to provide adequate fixation while ensuring excellent outcomes with minimal complications (9, 12, 28). These newer techniques have simplified the single incision volar approach (12). Of the single incision techniques, suture anchors are the most widely used (9).

Chronic cases have tissue atrophy, scar formation and tendon retraction which may limit direct repair and necessitate graft use e.g. free tendon autografts such as semitendinosis, flexor carpi radialis, palmaris longus, fascia lata or allograft Achilles tendon (4, 6, 7). The presence of an intact laceratus fibrosus is more important than chronicity as there is little tendon retraction if this is intact (4). Despite these factors, the surgical approach to a chronic distal biceps tendon rupture is similar to that of an acute injury (4). The lateral cutaneous nerve may become entrapped within reactive inflammatory tissue, thus special care during dissection is mandatory (23). Despite this risk, Rantanen & Orava (6) advocated anatomic repair in chronic cases because they had only one nerve injury, which had caused lengthy deficit, in 147 cases in their review which included both single and two-incision techniques.

With increasing demands of middle aged patients, surgical techniques continue to be refined to optimize outcome with the shortest return to activity (3). The recent literature focuses on new techniques along with biomechanical studies comparing these methods (3). The introduction of suture anchors for distal biceps rupture has led to the Orthopaedic community coming full circle with there being a renewed interest in the anterior single incision approach over the past few decades (10, 12, 24). Use of suture anchors may obviate the need for a second incision and has limited the need for extensive dissection, but still requires meticulous preparation of the tissues and sound anatomical knowledge (6, 12, 19). Although the approach does not dictate the fixation method used, transosseous suture fixation is typically combined with the two-incision techniques, whereas alternative fixation methods such as the suture anchor or the endobutton technique are combined with the one-incision technique (18).

Suture anchors are an attractive alternative to bone tunnels via the two-incision approach for surgeons who prefer the one-incision technique and are uncomfortable doing a single incision bone tunnel. Although biomechanical studies, in general, have not favoured suture anchors, they do not disprove their clinical usefulness (9). The goal is limited dissection and avoidance of complications seen with the two-incision techniques (9). Despite this apparent biomechanical disadvantage, Limpisvasti & Singer (29) via a five cm anterior approach utilizing three suture anchors (or two if the tendon is small) in their primary repairs and four flexor carpi radialis reconstructions, found no clinical signs of residual weakness nor functional impairment. The most common complication was transient neuropraxia of the lateral antebrachial cutaneous nerve.

In literature reviews of biomechanical studies, they found that the endobutton considerably performed better than other repair methods, but the minimum load and stiffness necessary for a satisfactory outcome are not known (21). In the clinical portion of their review, most patients had suture anchors or transosseus repairs and their conclusion was that it allows for a more cosmetic result, decreased blood loss and decreased surgical time. Those who favours the modified two-

incision approach argue that exposure of the radial tuberosity are safer and easier and gave better functional outcome (24). Numerous studies have reported success with using single incision and double incision techniques (24). Only one study prospectively reviewed both techniques (30). Nine patients underwent a single incision; ten underwent the modified Boyd and Anderson technique. At one year follow-up the one-incision group gained more flexion (142.8 versus 131.1°). There were 44% complications with one-incision, as compared with ten percent complication rate with a two-incision technique, however most were transient paraesthesias. The differences between the groups were relatively minor with the two-incision group showing more rapid recovery of the flexion strength. Chavan et al (21) in his literature review found no difference in overall complications between the two-techniques but found a significantly higher incidence of forearm rotational loss with the two-incision approach and a significantly greater number of unsatisfactory results with the two-incision technique. Frequently authors fail to state in their description of either the one or two-incision technique, the difficulty in attaining exposure of the operative site while maintaining correct forearm and elbow position. The surgeon may need one or two dedicated assistants to carry out these procedures successfully (11).

Boyd and Anderson's approach have almost eliminated HO and radio ulnar synostosis whereas suture anchors significantly decreased the risk of iatrogenic nerve injury during a single incision approach (10). There is no clinical evidence indicating superiority between the various fixation methods (10, 14, 24). A randomized prospective study is required to demonstrate superiority of one technique versus the other (24). Regardless of the type of incision or fixation used, the aim of anatomical surgery is to promote tendon ingrowths into the bone. However, it is not known if early active or passive range of motion delays or facilitates tendon reattachment to bone at the repair site (27). There is little consensus on the rehabilitation guidelines after distal biceps tendon repair (27, 31). Commonly used rehabilitation protocols in the post operative period including protecting the repaired tendon, preventing elbow stiffness and adaptation to one handed activities of daily living. The period of immobilization varies between one and six weeks with most authors emphasizing immobilization for two to three weeks followed by passive ROM especially during elbow flexion and forearm supination (27). Cil et al (27) did the first clinical study to examine the ability of a two-incision suture repair to withstand early active motion. Although full elbow flexion strength is fully achieved, full supination strength is often not achieved after single or double incision techniques. This may be due to difficulty in achieving anatomic restoration of a more pronated foot print using a single incision.

A two-incision technique offers good visualisation but evaluation of the trough for the tendon reinsertion limits the pulley or cam effect of the bicepital tuberosity, thus reducing supination moment arm (27). Amin et al in a study published in 2016, conducted an extensive systematic meta-analysis of the complications following the single-incision versus the double- incision approach. Eighty-seven articles were included, and it was noted that the lateral antebrachial cutaneous nerve neuropraxia was the most common complication in the single-incision group (9.8%) and heterotopic ossification was the most common complication in the double-incision group (7.2%). They found that rerupture rates were higher in the single-incision group in addition to the expected higher rates of nerve injury.

III. Conclusion

When reviewing the clinical evidence in the literature, the data demonstrates good to excellent results with both procedures. The literature is leaning towards more favourable results in the double-incision technique however surgeon preference, training and comfort level with the approaches will influence the surgeons' decision as to which technique to use.

Declaration of conflict of interest

There are no financial, institutional and personal relations that could potentially bias the information presented above.

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