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Distal triceps ruptures

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- Distal triceps ruptures are rare injuries due to the special anatomical features of the muscle and tendon–bone junction.
- This injury typically occurs at the tendon–bone junction due to an eccentric contraction of the muscle.
- The treatment is controversial, especially in partial ruptures; surgical repair is indicated for complete ruptures of the distal triceps tendon.
- Several repair techniques have been described for acute complete ruptures.
- Chronic ruptures often require reconstruction rather than direct repair.

Keywords: triceps; distal rupture; anatomy; aetiology; diagnosis; treatment; transosseous repair

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Introduction

The triceps muscle, as indicated by its name, includes three heads. The long head originates from the infraglenoid tubercle of the scapula, while the medial and lateral heads originate from the proximal humerus. These three heads join together at elbow level and attach to the olecranon to form one of the strongest tendons in the body. It covers the whole posterior aspect of the arm, and its rupture is very rare.

In 1959, Anzel et al examined 1014 tendon ruptures in their study; the rate of triceps rupture was 0.8%.[1] Triceps tendon rupture is more frequent in those between 30 and 50 years of age, and is twice as frequent in males.[2]

In this review, a comprehensive approach to triceps rupture is presented in light of the current literature.

Footprint anatomy

In general, a triceps rupture occurs as a detachment of tendon from the bone. Musculotendinous junction or intramuscular ruptures are very rare; therefore the characteristics of this tendon–bone junction have been examined in detail in the literature. The attachment of the triceps tendon to the olecranon has been shown to be spread over a large area, rather than a specific point of contact.[3] In their cadaveric study, Yeh et al determined an insertional footprint area of the triceps on the olecranon of 466 mm^2 with a width ranging 1.9 cm-4.2 cm.[3] The footprint was described as dome-shaped, with the largest part measured distally and the longest part measured at the centre (Fig. 1). The tendon extends from distal to lateral on the anconeus muscle and ends by fusing with the fascia; this lateral extension leads to a larger width of tendon than that of the olecranon, and gives an additional force to the tendon.[4]

Aetiology

Triceps tendon rupture results from overloading on the extended elbow, or an abrupt eccentric contraction of the muscle. The most frequently-reported mechanism in the literature is a fall on the hand with the elbow in extension. It is more frequently seen in American soccer players than other sports groups.[5] However, weightlifting is also a high-risk athletic activity.[6] Risk of triceps rupture is especially high in weightlifters and body building athletes, in part due to the potential use of anabolic steroids.

The potential for triceps rupture is higher in patients with diseases affecting collagen structure and tendon quality when compared to the normal population. These diseases include chronic renal insufficiency requiring dialysis, rheumatoid arthritis, systemic lupus erythematosus (SLE), diabetes, Marfan's syndrome, osteogenesis imperfecta, and metabolic bone diseases leading to hyperparathyroidism. Chronic olecranon bursitis increases the risk of triceps tendon rupture since it causes chronic inflammation around the tendon.[2]

Patients undergoing elbow arthroplasty are also at risk for triceps rupture, particularly if the surgeon prefers 'triceps-off' exposure during elbow replacement, as it increases considerably the risk of tendon rupture during the early post-operative period.

Diagnosis and evaluation

As with many other tendon ruptures, patients describe a sound (a 'pop') at the anatomical detachment site of the tendon, and state that they felt the detachment occur. Swelling and ecchymosis are frequently seen at the posterior aspect of the elbow. A remarkable gap can be palpated at, or proximal to, the olecranon tip. Although a significant

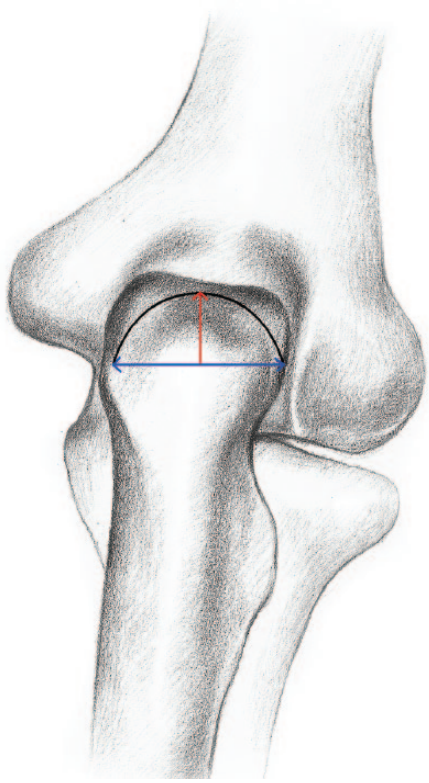


Fig. 1 The dome shape of the triceps footprint on the olecranon.

reduction in extension strength is normally present, complete loss of active extension is seen in only 20% of cases. The presence of an intact lateral expansion of the tendon may allow active extension (albeit weak), even in complete rupture. This may lead to misdiagnosis, or delayed diagnosis of the rupture.[7]

Viegas described a modified Thompson test to diagnose a rupture. Just as in Achilles tendon tear examination, lack of elbow extension after proximal compression of muscle mass can suggest a diagnosis of complete rupture, and an intact lateral extension of the tendon may lead to a false–negative result.[8]

A diagnosis is made from the patient history and clinical examination, while imaging methods are used to confirm the diagnosis and to detect additional injuries. Additional pathologies such as fracture of the radial head and distal humerus may accompany triceps ruptures. It should be borne in mind that due to the pain of an accompanying fracture, it can be difficult to make a proper clinical examination for the triceps tendon.

In isolated triceps ruptures, no pathological sign is seen on the radiographs. However, small bone fragments detached from the olecranon may be seen on lateral radiographs in cases with avulsion of the tendon ('fleck' sign) (Fig. 2).

Fig. 2 Pathognomonic finding of the triceps rupture: the 'fleck' sign.

Partial and complete ruptures, may be distinguished by ultrasound and magnetic resonance (MR) imaging.[9] Although USG is a fast, inexpensive method of imaging, its dependence on experience is a disadvantage. MR imaging is currently the most commonly-used, gold standard imaging method for differential diagnosis of triceps ruptures. The study of an MR image will readily show the integrity of the tendon or the site of the tear[10] (Fig. 3).

Treatment

The main factors to be considered when deciding suitable treatment for a triceps rupture are: the site of the rupture, the extension strength, the patient's expectation and the medical status of the patient. As a general approach, conservative treatment is primarily considered in partial ruptures affecting less than 50% of the tendon. When deciding on the treatment of partial ruptures affecting over 50% of the tendon, patient expectations and the medical status of the patient are the main factors for consideration. Conservative treatment is again considered in patients with a sedentary lifestyle and in those with lower expectations, while surgical treatment may be preferred in patients with higher expectations and a requirement for full extension strength.[11] In complete ruptures, surgical treatment is the approach of choice, unless the patient is at high-risk for operative treatment.[11]

In contrast to this general approach, there are publications advocating surgical treatment in partial ruptures, stating that conservative treatment may delay surgical repair and result in the need for late reconstructive procedures.[10] In a case series by Van Riet et al, no improvement could be seen in nine of 15 partial triceps ruptures following conservative treatment, and six cases required reconstruction.[10]

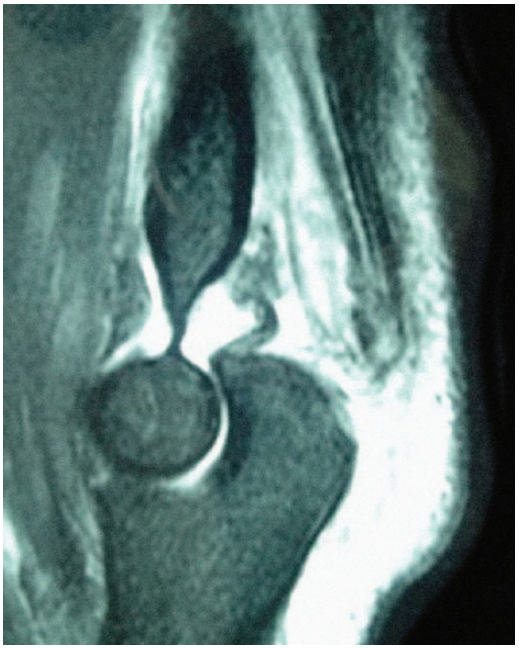


Fig. 3 MR imaging of triceps rupture from the insertion of the olecranon.

Conservative treatment

Conservative treatment is preferred in partial tendon ruptures that feature less than 50% tendon involvement and triceps muscle ruptures, and consists of immobilising the elbow until healed followed by range of motion and final strengthening exercises.

Following immobilisation with the elbow at flexion of 30° by splint or brace for between four and six weeks, flexion is gradually increased with an adjustable angle elbow brace. Full range of motion is targeted within 12 weeks, and then exercises to increase extension force strength are introduced. Full extension strength should be achieved between six and nine months post-treatment.[12]

Although conservative treatment results are successful, it is important to keep in mind that a partial rupture may progress to a complete rupture. In their case series, Mair et al analysed the results of their non-operative treatment in ten professional American football players with partial triceps ruptures, and six players returned to their sport without any weakness within a mean of five weeks; however, extension weakness was seen in three players following the treatment, and surgical treatment was required in one player due to progression to a complete rupture.[3]

Surgical treatment

The aim of surgical treatment is primary repair of the tendon. Primary repair is recommended preferentially in partial ruptures or acute ruptures seen within the last three weeks.[2] The transosseous cruciate technique, suture anchor technique and, recently, transosseous equivalent technique are among the preferred methods of primary repair.

The method most frequently reported in the literature is the transosseous cruciate repair method described by Yeh.[5,10] In this method, the tendon is grasped by Bunnel or Krackow sutures, and the sutures are tied in a crossed fashion through bone tunnels performed at the footprint.

In the suture anchor technique, which is less frequently preferred, sutures coming from 4.5 mm suture anchors placed in the centre of the footprint are passed through the tendon and tied.[13]

The transosseous-equivalent repair technique recently described by Yeh et al is similar to a double row transosseous equivalent repair which has been described for rotator cuff repair in the shoulder. Two anchors are placed at the proximal end of the footprint to form the proximal row, and the distal row is formed by knotless anchor sutures passing from two proximal anchors. In their cadaver study, Yeh et al biomechanically compared these three repair methods; there was no significant difference between load at yield and peak load with these three methods; however, the contact area achieved by transosseous-equivalent repair was larger and permitted less relative movement at the repair site during loading.[13]

With respect to clinical results of primary repair, van Riet et al reported three re-ruptures after complete recovery from the first rupture in their 14 cases of transosseous triceps repair; two were revised by direct repair.[10] In the literature, there exist small case series and case reports of successfully-treated patients following transosseous repair.[14-16]

Authors' preferred technique

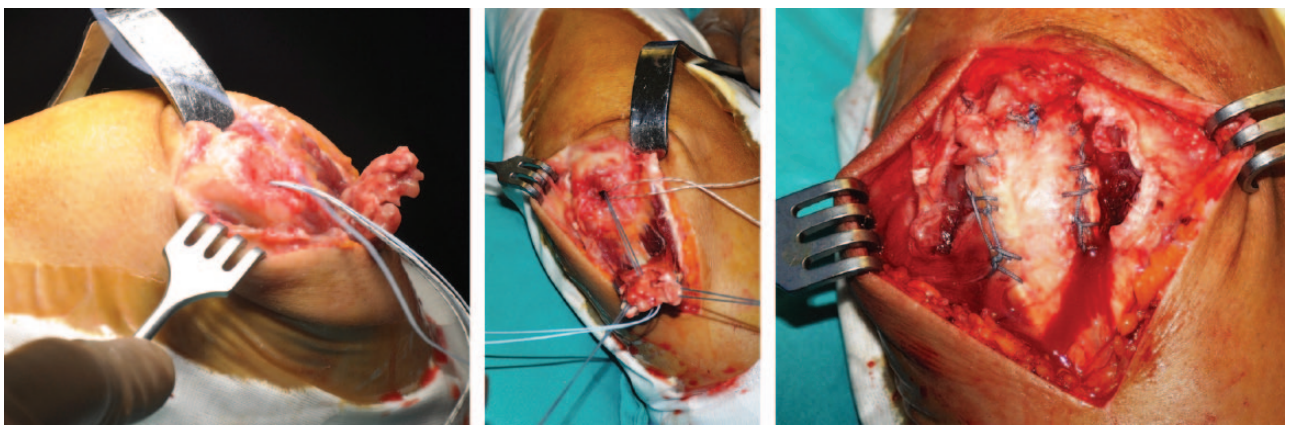
In our case series were nine patients with triceps ruptures (six total and three partial), treated surgically. Partial ruptures with more than 50% tendon involvement were treated by conversion to complete rupture. The transosseous cruciate technique was performed in seven ruptures, whereas the suture anchor technique was utilised in two repairs. (Fig. 4; Fig. 5).

Following primary repair after two weeks of immobilisation in 30° of flexion, range of motion exercises were introduced, with the aim of a full movement range by week six. Active extension is permitted six weeks after the repair, and strengthening exercises are started at week twelve. A return to sporting activities without any limitation is allowed at the end of month five.[17]

In our series, after six weeks, full range of motion was achieved in eight patients. In one patient, elbow stiffness developed due to heterotopic ossification (HO), and required HO excision.

(a) (b) (c)

Fig. 4 a) Exposure of the ruptured triceps through the posterior approach. b) Grasping of the tendon with double-locked Krackow sutures. c) Final fixation of the triceps with transosseous repair.



(a) (b) (c)

Fig. 5 a) The insertion of the anchor in the centre of the footprint of the triceps tendon. b) Grasping of the tendon with the sutures leading from the anchor. c) Final fixation of the tendon with the suture anchor technique.

Reconstruction

Reconstruction is preferred instead of primary repair in complete ruptures untreated within the first six weeks following rupture. Anconeus rotation flap, Achilles tendon allograft, plantaris or hamstring allografts may be used during reconstructive procedures. In their case series of seven triceps reconstructions, Sanchez-Sotelo et al performed an anconeus rotation flap in four of seven patients, and applied reconstruction with Achilles tendon allograft in three patients. Anconeus rotation flap was unsuccessful in one case; however, good and excellent functional results were reported in the other six patients.[18] According to their study, Sanchez-Sotelo et al recommend anconeus rotation flaps in cases with healthy tendon ends without any large tendon defect, and they recommend Achilles tendon allograft in cases with tendon defect.[18]

In the series of Van Riet et al, primary repair after 63 days of rupture was compared to reconstruction performed after 163 days. The authors report that reconstruction was associated with lower peak strength, with a slower return to normal activities.

The authors recommend early diagnosis and primary repair[10].

Complications

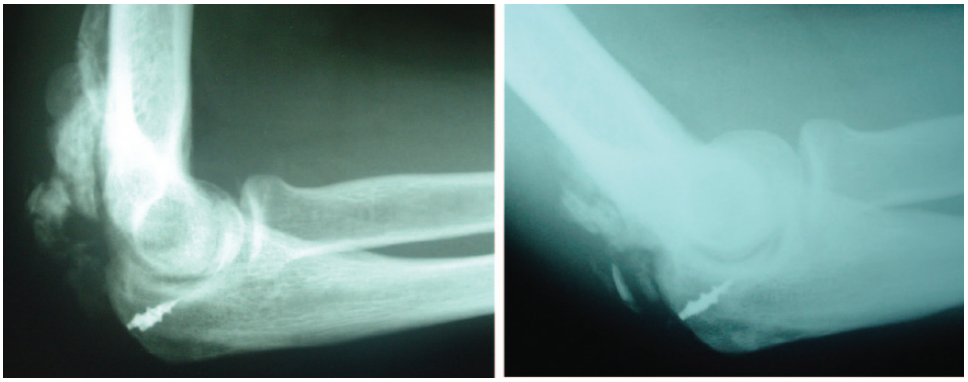
Complications are not frequent following surgical treatment of triceps rupture. The most frequent complication is flexion contractures of between 5° and 20°, as seen in 10% of cases. In cases with difficult passive extension during the surgery, a night splint at full extension may be used after surgery.[17]

Due to thin subcutaneous tissue at the tendon insertion site, wound problems and infections are potential complications. Re-rupture is a rare complication following primary repair, and may be treated with revision repair or reconstruction.

Although not reported previously in the literature, heterotopic ossification at the posterior elbow with stiffness developed in one of our patients. The case was treated with surgical excision of the heterotopic ossification and capsular release (Fig. 6).

Conclusions

Triceps ruptures are uncommon tendon injuries. They may be due to overloading on the elbow at extension and eccentric contraction. Such injuries are especially frequent



(a) (b)

Fig. 6 a) Heterotopic ossification (HO) after suture anchor repair of a triceps rupture. b) Same elbow after HO resection.

among weightlifters and elite athletes using anabolic steroids. Although the diagnosis is made clinically, MR imaging will determine the shape and location of the rupture and appropriate treatment method. Primary repair may provide good results with acceptable extension loss; however delayed diagnosis may lead to the need for reconstruction and reduced functional results compared with primary repair. The transosseous cruciate method is most frequently used in primary repair. However, transosseous equivalent anatomical repairs have been used more frequently in recent times.

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CONFLICT OF INTEREST

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