Triceps Tendon Anatomic Repair Utilizing the “Suture Bridge” Technique

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Abstract

Keywords

- suture bridge
- triceps
- rupture
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- anatomic

Triceps tendon ruptures are uncommon injuries, but they typically require surgical repair. Multiple primary repair techniques are available, including transosseous, suture anchor, and anatomic repairs. The technique described here, the “suture bridge” repair, provides an anatomic repair of the distal triceps tendon to its footprint. It has the potential advantages of increased load to failure, better footprint coverage, higher load resistance, and allows for early motion.

Introduction

Triceps rupture is an uncommon injury, representing approximately 1% of all tendon injuries.^{1,2} Over a 10-year period, there were only 12 triceps tendon injuries reported in the National Football League.³ Triceps injuries are far more common in males than females and can occur after a fall on to an outstretched hand^{2,4} or acute eccentric loading of the elbow. A triceps rupture occurs most commonly at its distal insertion by way of an avulsion off of its insertion on the posterior olecranon. However, rupture of the muscle can also occur, but far less frequently.⁵ Rupture due to blunt trauma is rare but has also been described in the literature.⁴ Studied risk factors include steroid use, endocrine disorders, renal failure, and metabolic bone diseases.⁶

Diagnosis of a triceps rupture of the distal insertion can be readily made on physical examination in which pain, swelling, and a palpable defect can often be identified just proximal to the olecranon posteriorly. Weakness and/or pain with resisted elbow extension also is common. Diagnostic studies can be ordered to aide in diagnosis and/or characterization of the extent of injury. On plain radiographs, a “flake sign” can be apparent on the lateral view due to avulsion of the distal tendon with a bone fragment.⁴ Magnetic resonance imaging (MRI) is most definitive in diagnosing triceps tendon ruptures and provides the added benefits of better characterizing the severity of the rupture, extent of the retraction, and evaluation of associated soft tissue injuries.

Triceps primary repair techniques can be broken down into three categories: (1) trans-osseous,^{7,8} (2) suture anchor,^{9–11} and (3) anatomic^{12,13} techniques. Results have shown that anatomic repairs also provide greater footprint as well as prevention of tendon breakdown when compared with the transosseous or suture-anchor approaches alone.¹⁴ Other augmented techniques have also been described using Achilles and hamstring grafts.^{15,16}

Anatomy

The triceps tendon is formed from the coalescence of the long, lateral, and short heads of the triceps brachii. Madsen et al described a distinct tendon arising from the medial head deep to the common tendon of the lateral and long heads.¹⁷ It inserts directly on to the olecranon and expands outward and into the anconeus fascia. It has an average width of 23.7 mm and thickness of 6.8 mm.¹⁸ Its primary function is to extend the elbow, thereby opposing the biceps brachii and the brachialis.

Indications/Contraindications

Surgical indications for the “suture bridge” repair technique include acute complete ruptures of the distal triceps tendon in active individuals. Partial ruptures can initially be treated nonsurgically, with favorable outcomes demonstrated with

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immobilization in 30 degrees of flexion for 4 to 6 weeks followed by progressive range of motion.¹⁹ If conservative treatment fails, surgical repair can still be indicated. Nonoperative treatments is reserved best for ruptures in patients with little disability, low demand, or those with major comorbidities contraindicating surgery or inability to participate with a postoperative rehabilitation program.⁶

Contraindications to surgical repair of a triceps rupture include patients with open wounds or infections of the posterior elbow.

Technique

Equipment and Positioning

The “suture bridge” anatomic repair technique for triceps tendons uses (1) number 2 or number 5 nonabsorbable suture, as well as (2) number 2 or number 5 suture anchors, and (2) two 3.5 knotless press-fit anchors. A drill or burr will be required as well. The lateral decubitus position is recommended. A sterile tourniquet can be used only if necessary, but should be avoided if possible as to not limit surgical exposure and triceps mobilization. General or regional anesthesia is also recommended.

Surgical Dissection

The universal posterior approach incision is placed and full-thickness flaps are raised. Typically an incision centered over the olecranon at least 5 cm both proximally and distally to the olecranon tip provides adequate exposure. Care should be taken to protect the ulnar nerve in the cubital tunnel by inadvertent medial dissection. Once the flaps are raised, the ruptured triceps tendon with variable amounts of proximal retraction should be readily apparent.

Tendon Preparation

A limited debridement of the distal triceps is important. Adequate mobilization of the tendon can be achieved via blunt dissection from the posterior humeral shaft with a cob or the surgeon’s finger while distal tension is applied with an Alice clamp (►Fig. 1). It is important not to place anything sharp in between the tendon and the humeral shaft proximally to avoid inadvertent injury to the radial nerve.

Once the tendon is mobilized, a number 2 or 5 nonabsorbable suture is placed retrograde and then antegrade in a running “Krakow” fashion, resulting in two suture tails distally from the tendon end. The tails should be left long, not cut, and tagged (►Fig. 2).

Tendon Repair

Next, attention should be turned to the footprint, the location to which the tendon will be repaired. It is important to debride the footprint down to bleeding bone (►Fig. 3). This can be performed by either a burr or a rongeur. Once debrided, the two suture anchors are placed into the footprint. It is important to drill these suture anchors away from the joint to avoid articular penetration (►Fig. 4). After both anchors are secured into the footprint, the three pairs of suture limbs should be identified and organized. The footprint repair is

Fig. 1 The Alice clamp is attached to the distal end of the triceps tendon. The footprint of the triceps insertion site on the posterior olecranon is colored in purple.

Fig. 2 The triceps tendon has been tagged with a number 2 nonabsorbable suture placed retrograde and then antegrade in a running “Krakow” fashion yielding two suture ends distally.

Fig. 3 The footprint of the triceps insertion site is debrided down to bleeding bone with a rongeur.

performed next with the assistant placing longitudinal traction on the Krakow sutures while each limb of the suture anchors is placed through the tendon distally, but at least 2 cm from the tendon edge. If placed appropriately, the tendon will appear to slightly pass-point the footprint. The limbs of each suture anchor suture is placed in a horizontal fashion through the tendon and repaired with the elbow held in slight extension to maximize repair and overcoverage of the footprint (►Fig. 5A, B). Once repaired in a simple fashion, the footprint will be fully covered.

Next, the actual "suture bridge" suture configuration is arranged. The two Krakow suture limbs are kept on their respective sides, but one limb of each of the repaired suture anchor suture limbs are switched to the opposite side while keeping the other suture limb on its original side (►Fig. 6).

This alignment and crossing will allow the anatomic repair while maximizing compression of the tendon to the footprint and increasing the strength of the repair. The "suture bridge" configuration is then tensioned and locked into place by placing two 3.5 knotless press-fit anchors in the proximal ulnar shaft just distal to the elbow joint. It is important to avoid injury to the joint by drilling the ulnar cortex in different planes away from the elbow joint (►Fig. 7). Once drilled, the three suture limbs are taken through each eyelet of the press-fit anchor. The press-fit anchor is placed following the manufacturer's technique with gentle longitudinal traction placed on all three suture limbs in the eyelet as the press-fit anchor is malleted into place. This is done with the elbow in extension. Tension on the suture limbs should be released once the press-fit anchor is malleted into place. This is then repeated for the other side. It is important that the second anchor is placed in a slightly different plane so as not to cross the first anchor (►Fig. 8).

Postoperative Regimen

Once the repair is completed, it should be tested by stressing it through a passive range of motion of the elbow. Flexion beyond 90 degrees should result in no lift off or pull of the repaired tendon from its footprint. Out of the operating room, the patient should be splinted in full extension with the plaster slab placed anteriorly. This can be converted in-office to a hinged elbow brace kept in a short arc of motion from 0 degree extension to 30 degrees of flexion for the first 2 weeks postoperatively. From weeks 2 to 4 the hinged elbow arc of motion can be increased to 60 degrees of flexion, and then increased to 90 degrees from weeks 4 to 6, and then unlocked fully after 6 weeks allowing for full range of motion. Formal supervised therapy with progressive resistance bands strengthening is also prescribed at 6 weeks. Free weights can be added after the 12 week postoperative mark. However, overall bracing and rate of mobilization postoperatively are flexible and should be based on the quality of the tendon, quality of the repair, job/sport demands, surgeon preference, and patient reliability.

Fig. 4 (A) Two suture anchors are placed in the footprint distal to the articular surface. (B) The yellow arrow indicates the direction of the suture anchor placement relative to the articular surface.

Fig. 5 (A) Note the relationship of the sutures prior to tendon repair. **(B)** The suture anchor sutures were taken through the tendon and each repaired in a horizontal fashion resulting in coverage of the footprint.

Fig. 6 The “suture bridge” suture configuration is arranged by taking the two Krakow suture limbs kept on their respective sides, but one limb of each of the repaired suture anchor suture limbs switched to the opposite side while keeping the other limb in its original position.

Outcomes

So far, we have used this technique in 11 cases, with 9 cases available for follow-up with a minimum of 6 months postoperatively. All cases with minimum follow-up consisted of men with an average age of 53 years (range: 42–64). Seven cases were caused by a fall on the outstretched hand and

arm, and two were caused during weight-lifting exercises. Following repair and rehabilitation as defined previously using the triceps “suture bridge” technique, the resulting average range of motion was -3 degrees of extension (range: -13 to 5) and 156 degrees of flexion (range: 148 – 165). Four cases were workers compensation injuries, yet all four ultimately returned to work without restrictions by an average of 16 weeks postoperatively (range: 12 – 24). There were no cases of late re-rupture, elbow contracture, heterotopic ossification, wound issues, nerve injuries, or reoperation—except for one case requiring early reoperation after the patient fell down the stairs at 5 weeks postoperatively resulting in re-rupture. This patient was repaired again using the same “suture bridge” anatomic repair technique, but the repair was also augmented with a triceps allograft applied over the top of the repair, due to diminished quality of the tendon.

Discussion

The “suture bridge” technique provides several advantages. As an anatomical repair, it provides a higher load failure rate and better footprint coverage (Yeh) than other repair techniques. Yeh et al compared anatomical with transosseous and suture-anchor techniques in cadaveric models. The repairs were studied for footprint coverage, restoration after cyclic loading, and load failures. The footprint coverage of the anatomic repair was vastly superior to that of the transosseous and suture-anchor techniques: 86% compared with 48% and 31% , respectively. Restoration of the footprint was also superior in the anatomic repair, showing essentially no change after cyclic loading. Displacement was highest in the transosseous repair, which has been shown to correlate with poor healing. Last, the anatomic repair was

Fig. 7 (A) The press fit anchor is again drilled distal and away from articular surface of the olecranon. (B) The red arrow indicates the direction of the press fit anchor placement relative to the articular surface.

also reported to have the highest load failure rate, although this was reported as not significant in the literature. The similarity was credited to the failures being localized at the suture or suture anchor interface, signifying the failures having to do with the respective materials being used in the repairs.¹⁴

There are potential complications that warrant consideration relative to this technique as well as to injuries to the elbow in general. Balazs et al reported traumatic re-rupture as the most common complication but no a-traumatic re-ruptures.²⁰ We too believe that re-rupture would likely

be the most common complication of a distal triceps tendon rupture, as was evidenced by our only complication, albeit from an injury during the early postoperative period. In addition, potential complications can include joint stiffness/adhesions, heterotopic bone formation, and wound complications, which are all ubiquitous complications of elbow surgery. Additional potential complications include iatrogenic nerve injury.²¹ In particular, the ulnar nerve medially during triceps footprint repair and radial nerve proximally during mobilization of the triceps muscle belly are susceptible to injury with surgical dissection and tendon mobilization. Also, as with any surgical procedure, postoperative infection is a potential complication as well.

Conclusion

Triceps tendon ruptures are uncommon injuries, but they typically require surgical repair. Multiple primary repair techniques are available, including transosseous, suture anchor, and anatomic repairs. The "suture bridge" repair technique provides an anatomic repair of the distal triceps tendon to its footprint. It has the potential advantages of increased load to failure, better footprint coverage, higher load resistance, and allows for early motion.

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None.

Conflict of Interest

None.

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Fig. 8 Final anatomically repaired "suture bridge" configuration of the triceps tendon.

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