Triceps Brachii Distal Tendon Reattachment
With a Double-row Technique

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Abstract: Case reports and small series have reported variable results regarding the treatment of choice for patients with triceps brachii tendon ruptures. Early surgical repair has been recommended for acute complete ruptures of the triceps brachii distal tendon to prevent late functional disability. However, controversy exists regarding the optimum surgical technique of reattachment. In addition, various attachment techniques have been described, with none shown clinically to be superior. Therefore, the authors present a technique for triceps brachii distal tendon reattachment following acute complete ruptures and evaluate their results in a series of patients.

Triceps brachii injuries occur almost exclusively at the distal insertion of the triceps brachii muscle. Triceps brachii distal tendon ruptures are rare, accounting for approximately 2% of all tendon injuries and less than 1% of all tendon ruptures of the upper extremity.1 They are more common in men with a mean age of 36 years (range, 7-75 years).2-24 They occur most commonly at the tendo-osseous junction and less commonly intramuscularly or at the musculotendinous junction.2-24 The most common mechanism of rupture is indirect trauma, commonly a fall onto the outstretched hand that causes a forced eccentric triceps brachii muscle contraction. Rarely, ruptures may occur following surgical procedures, such as total elbow arthroplasty, and in skeletally immature patients with incompletely fused or recently fused physis.*

Systemic risk factors for triceps brachii distal tendon ruptures include chronic renal failure with secondary hyperparathyroidism,4-18 hypocalcemic tetania,16 rheumatoid arthritis,17 osteogenesis imperfecta,14 insulin-dependent diabetes mellitus,24 and anabolic steroid use.17-19 Local risk factors for tendon ruptures include local corticosteroid injections, such as those for the treatment of olecranon bursitis, and attritional changes from degenerative arthritis.27,14-20,21 In young and active patients and those with systemic risk factors, improved fixation with augmentation of the tendon’s reattachment may be required at the surgeon’s discretion.

Most patients with triceps brachii tendon ruptures report sudden pain in the posterior aspect of the elbow. In the acute setting, pain during resisted elbow extension, swelling, ecchymosis, and tenderness to palpation over the triceps insertion are the usual clinical findings. An extension lag to active extension of the elbow and a palpable gap are usually seen in complete ruptures, whereas diminished extension strength against resistance implies a partial rupture.27 Occasionally, a lateral radiograph of the elbow reveals a fracture avulsion of the olecranon (called a flake fracture).17 Chronic tendinosis and calcifications of the triceps, fractures of the olecranon and radial head, and avulsion of the medial collateral ligament may also be observed. If the diagnosis is uncertain, ultrasonography or magnetic resonance imaging

*7,12-14,18,19,22,23,25,26
**is useful for localization of the injury and quantification of the extent of the rupture.**

Previous case reports and small series have reported variable results regarding the treatment of choice for patients with triceps brachii tendon ruptures. Nonoperative treatment with splint immobilization for 4 to 6 weeks in $30^\circ$ of elbow flexion has been recommended for patients with triceps brachii distal tendon partial ruptures with negligible loss of extension strength, elderly low-demand patients, and patients in whom surgery is contraindicated because of medical comorbidities.

Following nonoperative treatment, if weakness or pain persist, delayed repair can be performed. However, for nonoperative treatment, complete ruptures must be excluded, and delayed repair has been associated with less reliable reconstructions.

Early surgical repair has been recommended for acute complete ruptures of the triceps brachii distal tendon to prevent late functional disability.

However, controversy exists regarding the optimum surgical technique of reattachment, and various attachment techniques have been described, with none shown clinically to be superior. Therefore, the current study presents a technique for triceps brachii distal tendon reattachment following acute complete ruptures and evaluates the authors’ results in a series of patients.

**Materials and Methods**

The authors retrospectively reviewed data for 11 patients with acute distal triceps brachii tendon ruptures treated with surgical reattachment at the authors’ institutions between January 2008 and April 2010. Patients were 9 men and 2 women with a mean age of 53 years (range, 34-64 years). Six injuries involved the dominant arm. The mechanism of injury was weight lifting in 5 patients, a backward fall in 3, and a fall onto the outstretched hand in 3. No patient reported a history of anabolic steroid use, systemic endocrine disorders, metabolic bone disease, or previous surgery on the involved elbow. Mean follow-up was 21 months (range, 12-40 months), and no patient was lost to follow-up. This study was approved by the institutional review board or ethics committee of the authors’ institutions.

Pain, swelling, ecchymosis, a palpable defect over the triceps’ insertion, and an inability for active extension were common physical findings in all patients. No associated injuries existed. Radiographic findings included calcifications in the triceps brachii distal tendon in 5 patients and a flake fracture of the olecranon in 3 patients. Magnetic resonance imaging documented a complete tear of the distal triceps brachii tendon in all patients.

All patients had primary surgical reattachment of the distal triceps brachii tendon between 8 days and 3 weeks after injury. At surgery, 8 of 11 patients had an avulsion fracture of the olecranon—2 had an avulsion of the central insertion, 2 had a rupture of the medial and central insertions, 2 had complete rupture of all insertions, and 1 had a complete rupture of the tendon at the musculotendinous junction.

**Surgical Technique**

With the patient under general anesthesia, a straight posterior midline incision was performed with the patient in the lateral decubitus position and the arm over a tibial post. Dissection was performed through skin and subcutaneous tissues, identifying the triceps tendon. The edges of the ruptured triceps tendon were debrided, and a #5 Ethibond suture (Ethicon, Inc, Somerville, New Jersey) was inserted through the tendon using a Bunnell stitch technique (Figure 1). Next, Keith Ethicon, Inc needles were drilled through the olecranon in a crossed pattern (Figure 2). To improve fixation, 2 to

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1. References: 1, 2, 3, 7, 14, 17-21, 24, 27, 30-35

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Figure 1: Illustration showing a #5 Ethibond (Ethicon, Inc, Somerville, New Jersey) suture inserted through the tendon using a Bunnell stitch technique.

Figure 2: Illustration (A) and clinical photograph (B) showing the Keith needles (Ethicon, Inc, Somerville, New Jersey) drilled through the olecranon in a crossed pattern.
3 suture anchors were drilled into the olecranon for augmentation of the reattachment; the sutures of the bone anchors were passed through the tendon in a horizontal mattress pattern (Figure 3). The Ethibond suture was inserted into the holes of the Keith needles and advanced through the olecranon by advancing the needles. With the elbow in extension, the tendon was reattached to the olecranon; the Ethibond sutures were tied first, followed by the bone anchor sutures (Figures 4, 5). Stability of the reattachment was evaluated intraoperatively by moving the elbow through its total range of motion. The wound was irrigated and closed in layers.

Postoperatively, the arm was immobilized in a long arm posterior splint in 20° of extension for 2 weeks, followed by a supervised assisted range of motion rehabilitation program, including progressive elbow flexion, full passive extension, and passive/active assisted forearm rotation exercises with the elbow in extension for the next 4 weeks. At 6 weeks postoperatively, active extension of the elbow was initiated, followed by strengthening exercises at 10 to 12 weeks. Unrestricted activity was allowed at 5 months postoperatively.

Follow-up included clinical examination of pain at the reattachment site, triceps brachii muscle strength, range of elbow motion and extension lag from full active extension, patients’ satisfaction, and return to activities of daily living. Pain was determined using a 10-point visual analog scale ranging from 0 (no pain) to 10 (severe and constant pain). Patients’ triceps brachii muscle strength was graded on a 5-point muscle strength scale ranging from 0 (no movement is observed) to 5 (muscle contracts normally against full resistance). Patients’ satisfaction was graded as very satisfied, satisfied, and not satisfied. The range of elbow motion and extension lag from full active extension were measured using a goniometer.

Follow-up data, complications, and reruptures recorded at the last examination were used for the purpose of this study.

**Results**

All patients experienced significant pain resolution, from a mean of 8.5 points (range, 8-9 points) preoperatively to 2.4 points (range, 1-6 points) postoperatively (2-tailed paired t test, \( P=0.0001 \)), and significant improvement of triceps brachii muscle strength, from a mean of 1.63 points (range, 0-3 points) preoperatively to 4.8 points (range, 4-5 points) postoperatively (Wilcoxon signed rank test, \( P=0.001 \)). Elbow range of motion was almost normal in all patients (mean, 136°; range, 120°-150°); mean loss of elbow flexion was 7° (range, 0°-20°), and mean extension lag was 7.3° (range, 0°-15°).

Nine of 11 patients were very satisfied with the operation and returned completely to their preinjury status and activities of daily living. One patient experienced postoperative pain over the olecranon suture knot and moderate
elbow stiffness. The patient was treated with nonsteroidal anti-inflammatory drugs and physical therapy. At last follow-up, he experienced moderate pain (4 points), 10° extension lag, and 4-point triceps brachii muscle strength, and he stated he was satisfied with the operation and returned completely to his previous work. Another patient experienced wound infection and was treated with wound lavage and debridement with uneventful wound healing. At last follow-up, he experienced moderate pain (5 points), 15° extension lag, and 4-point triceps brachii muscle strength; he was not satisfied with the result of the operation. No patient experienced a rerupture of the distal triceps brachii tendon during the study period.

**Discussion**

Rupture of the triceps brachii distal tendon is a rare injury, and treatment guidelines are not well established. Case reports and small series have reported early surgical repair for acute complete ruptures of the triceps brachii distal tendon to prevent late functional disability (Table).3,14,17,18,20,23 Magnetic resonance imaging is useful for determining the percentage of rupture in pre-operative planning; if a tear of more than 50% is shown on magnetic resonance imaging in addition to significant loss of triceps brachii muscle strength, surgical reattachment is also recommended.22

Surgical repair should be performed within 3 weeks of injury.23,31 Delayed repair and chronic ruptures are associated with proximal retraction of the muscle and tendon unit that makes direct reattachment unfeasible.17 In these cases, reattachment should be performed with autologous tendon, allograft, or synthetic ligament augmentation techniques or anconeus muscle rotation.17,23 However, any graft lengthens the native tendon and affects the triceps muscle resting length and contraction strength.26

Most acute injuries can be managed with early surgical direct reattachment of the tendon to the olecranon using various attachment methods.18,23,37 These methods include locking nonabsorbable suture techniques (Krakow, Kessler, or Bunnell), suture repair through olecranon drill holes, suture anchors, Kirschner wires, anconeus muscle rotation, triceps V-Y advancement, triceps tendon rotation flap, braided Dacron sutures (Mersilene tape; Ethicon, Inc, Somerville, New Jersey) and mattress-type sutures, an olecranon periosseous flap, and a reflected slip of fascia from the posterior forearm.4,7,14,18,19,23,30,33

In cases where an avulsed flap of bone from the tendon’s insertion on the olecranon is of reasonable size, fixation with Kirschner wires and a tension band may be attempted.19,33 However, the use of Kirschner wires to augment reattachment may lead to symptomatic hardware necessitating removal.19 Graft reinforcement of the reattachment using the palmaris longus, plantaris, semitendinosus, or Achilles tendon4,7,17,21,22,23,34; anconeus muscle rotation14; a flap from the proximal tricipital aponeurosis4; or forearm

### Abbreviations: deg, degrees; FU, follow-up; ITT, Isokinetic triceps testing; MTS, manual triceps strength; n/a: not available; ROM, range of motion.
fascia may be necessary in patients with local or systemic risk factors for tendon rupture, those with chronic retracted tendons, and when tissue quality is in question.

However, no detailed information is available regarding the outcome and the quality of the tissue used for augmentation in these procedures. The anconeus muscle rotational flap is suitable for the reconstruction of moderately sized defects; for larger defects, Achilles tendon autografts or allografts are recommended. The use of tricipital fascia may further compromise the extensor mechanism.

The current authors concur that early surgical repair is the appropriate treatment for acute complete ruptures of the triceps brachii distal tendon and present a technique of direct reattachment of the tendon using sutures advanced through the olecranon with Keith needles and augmentation of the reattachment with suture bone anchors. The current results showed significant pain relief, improvement of muscle strength, and almost normal elbow range of motion, with a mean postoperative extension lag of 7.3°. Ten of the 11 patients were satisfied with the operative results, although 2 developed complications.

One may argue that using the suture anchors adds complexity and increases operative time. However, the current authors recommend the use of suture anchors as described in the current technique for augmentation and secure fixation of the reattachment, especially in young and active patients and patients with systemic risk factors for tendon ruptures. In most cases, it may not be necessary to perform the larger procedure (ie, suture anchors), and it should only be used to improve on fixation if it is in question.

Limitations of this study were the small number of cases of an unusual injury, the fact that the results were not compared between repairs performed at different time periods after the rupture, the lack of a group of patients in whom a different reattachment technique was performed, and the unavailable Cybex strength data due to the study’s retrospective design.

The surgical results of triceps brachii distal tendon reattachment are generally good. Patients usually regain almost complete range of motion and good triceps strength after adequate rehabilitation. In the early postoperative phase, rehabilitation includes protection of the repaired tendon and prevention of elbow stiffness. Postoperatively, the arm is immobilized in mid-flexion (30° to 45°) for 4 to 6 weeks, followed by progressive range of motion and strengthening exercises. Therapy begins after this period of immobilization with passive range of motion. At 6 weeks, active range of motion is begun. Lifting weights should be avoided for at least 4 to 6 months.

The results after surgical repair of acute ruptures and reconstruction of chronic ruptures are comparable, but patients’ recovery is slower after reconstruction. Potential complications include rerupture (range, 6.25% to 12.5%), ulnar or radial neuropathy (range, 4.4% to 12.5%), prominent hardware, stitch abscess, and elbow contracture. Reruptured tendons can be repaired primarily without further sequelae, although reruptures, delayed repairs, and poor tissue quality may complicate reconstructions. Prominent hardware can be removed after the triceps repair has healed.

In the current series, 2 of the 11 patients experienced complications, including elbow pain and stiffness and infection. Elbow pain was considered a minor complication that resolved completely with nonsteroidal anti-inflammatory drugs and physical therapy. Wound infection was a major surgical complication that should not be attributed to the described technique of reattachment, but rather to a generally encountered surgical complication.

REFERENCES


