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# Acute and chronic triceps tendon rupture treated with knotless double-row anchor repair: two case reports

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Distal triceps tendon rupture (TTR) is a rare injury and is among the least common tendon injuries.[1] It most commonly presents as an acute injury, with primary repair being indicated for complete ruptures.[7,15,16] Chronic ruptures are both a diagnostic and therapeutic challenge. Although technically demanding, primary repair can be an adequate solution in these cases, but tendon reconstruction is often the only possible treatment.[15,16] Earlier surgical treatment is associated with improved clinical outcomes.[7,16]

While the most common technique for primary repair involves the transosseous tendon repair,[16] anatomic footprint-covering anchor repairs have been gaining prevalence in TTR treatment, mirroring studies for rotator cuff tears.[2,4,6,12,18] Recreating preinjury footprint anatomy with uniform pressure distribution on the repair might be a useful surgical principle, but this hypothesis lacks validity in clinical studies.

We present two case reports of TTR—one acute and one chronic—both treated with primary repair using a knotless anchor double-row technique, with suture tapes and Krakow type sutures, providing anatomic footprint coverage of the distal triceps tendon insertion. We intend to demonstrate excellent clinical results of this technique both in the acute and chronic settings.

## Case report

### *Case 1*

We present the case of a 38-year-old male heavy-laborer—dockworker—with no relevant medical history. He suffered an acute work-related injury during eccentric loading of the triceps, with sudden pain in the olecranon region and loss of elbow extension strength. He was initially evaluated in another institution, with no clear diagnosis. Radiographs and ultrasound in the acute phase were negative for any signs of TTR.

After 6 months of conservative treatment consisting of cessation of heavy labor and a program of rehabilitation, he was admitted in our department for further evaluation. He presented with persistent olecranon pain and tenderness, a palpable gap in the olecranon fossa region, a loss of 10º of terminal elbow extension, and a 3 out of 5 muscular strength of elbow extension. After a computed tomography scan and an magnetic resonance imaging of the elbow, a chronic distal TTR was diagnosed, described as a complete tear of the deep layer and most of the superficial layer, at the level of the tendinous insertion.

A 13-mm bone avulsion fragment was identified, with 40-mm retraction relative to the olecranon. No muscle belly atrophy was reported. The patient was offered a triceps tendon repair or reconstruction, depending on intraoperative findings. After intraoperative assessment, primary repair was performed and is described posteriorly.

### *Case 2*

Our second case was a 35-year-old farmer, with no relevant medical history, suffering an acute work-related injury during eccentric loading of the triceps, with sudden loss of elbow extension strength. After an ultrasound of the elbow, a complete tear of the triceps tendon at the level of the tendinous insertion was diagnosed. The patient was offered a triceps tendon repair.

Institutional review board approval was not required for this case report.

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**Figure 1** Triceps tendon rupture, intraoperative view, case 1—chronic rupture.

**Figure 2** Triceps tendon rupture, intraoperative view, case 2—acute rupture.

## Surgical technique

Surgical technique was identical in both cases.

Surgery was performed under general anesthesia, in lateral decubitus with the aid of an arm holder, and a tourniquet was applied. A straight posterior incision was made.

Subcutaneous flaps were raised both medially and laterally, and the ulnar nerve was referenced. The distal aspect of the triceps tendon was identified, and the tendon rupture was completed in case 1 (Figs. 1 and 2). The distal triceps and olecranon footprint were debrided and freshened to a bleeding bone bed. Development of the lateral and medial intermuscular septa was performed before determining tendon excursion. Direct reattachment of the tendon could be achieved in 90º of elbow flexion, without excessive tension, excluding a reconstruction procedure. A SpeedBridge (Arthrex, Naples, FL) implant system was used to perform a knotless anchor anatomic repair, similar to the technique previously described for the rotator cuff (Fig. 3).[2,13] Two 4.75-mm BioComposite SwiveLock anchors (Arthrex, Naples, FL, USA) with preloaded FiberTape (Arthrex, Naples, FL, USA) and FiberWire (Arthrex, Naples, FL, USA) were used for the proximal row—placed on the proximal end of the footprint site, 1 on the lateral edge (Fig. 4) and another on the medial edge (Fig. 5). These anchors were directed away from the articular surface to avoid joint penetration. Both FiberTape loops were passed from the deep to the superficial part in the triceps tendon—1 laterally and 1 medially—approximately 2 cm proximal from the tendon's distal edge, to maximize surface area coverage of footprint (Fig. 3-A). The two limbs of each FiberTape are linked to a single tail, allowing both limbs to be passed simultaneously with a Scorpion suture passer (Arthrex, Naples, FL, USA). One limb from each FiberWire suture was placed in a Krakow suture fashion through the tendon on its lateral and medial border, using 6 throws on each side. The other limb was passed in the tendon from the deep to the superficial part (Fig. 3-B). Both ends of the suture exited the tendon approximately 2 cm from its distal edge. Two more 4.75-mm BioComposite SwiveLock C anchors are used for the distal row—1 laterally and another medially—just distally to the footprint site (Figs. 6 and 7). Each of these anchors were loaded with 1 strand of FiberTape from each of the proximal anchors and 1 strand of FiberWire from each locking-type Krakow suture, creating 4 FiberTape and 4 FiberWire crossed suture bridges over the tendon footprint, in a knotless fashion (Fig. 3-C and Fig. 8). Tensioning of the strands and distal row suture anchor insertion is performed at 90º of elbow flexion. The stability of the fixation was assessed intraoperatively, and a passive flexion of the elbow of 0-90º was achieved. Postoperatively we allowed for immediate passive motion in the same interval, and after 3 weeks, active assisted mobilization was initiated.

Clinical results after 12 months are presented in Table I (Figs. 9 and 10). No complications were observed.

## Discussion

The triceps is the main extensor of the elbow, and complete rupture invariably requires surgical intervention to restore function.[6] Early surgical intervention is the appropriate treatment for complete rupture of the triceps tendon, although there have been reports of good results with conservative treatment of partial triceps ruptures.[16] There is a high rate of satisfactory outcomes and high functional scores achieved after surgery, most commonly with the transosseous suture repair technique.[8,16,17] Postoperative clinical scores across several studies are approximately 4-10 points for the Disabilities of the Arm, Shoulder and Hand (DASH) and 85-

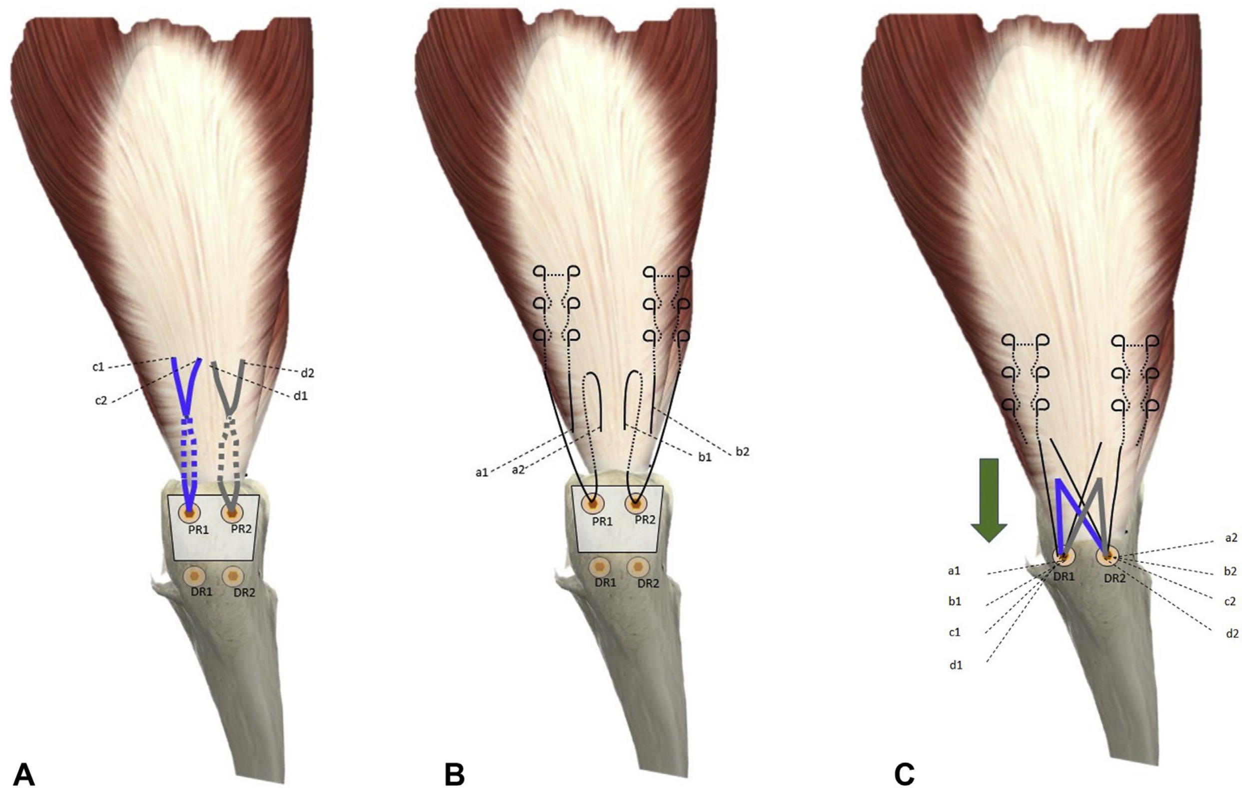


**Figure 3** **(A)** One loop of suture tape from each anchor—PR1 and PR2 (proximal row 1 and proximal row 2)—passes through the tendon from deep to superficial. Each suture tape has 2 limbs—c1 and c2; d1 and d2. The gray trapezoid in the ulna represents the tendon insertion footprint. DR1 and DR2 (distal row 1 and distal row 2) represent the expected location of the distal row anchors. **(B)** One limb from each FiberWire suture is placed in a Krakow suture fashion through the tendon on its lateral and medial border, using 6 throws on each side (a1 and b2). The other limb is passed in the tendon from deep to superficial (a2 and b1). **(C)** The two distal anchors are loaded with the previously passed suture and tape strands: DR1 with sutures a1, b1, and tapes c1 and d1; DR2 with sutures a2, b2, and tapes c2 and d2. The tendon advances, covering the footprint. *Green arrow* represents triceps tendon distalization after repair, achieving footprint coverage.

95 points for the Mayo Elbow Performance Score (MEPS).[7-9] Our results are comparable to those found in the literature.

No complications were observed in our patients. Reruptures are the most feared complication after primary repair of the triceps tendon, being reported as low as 0-7% in some studies and up to 25% in others.[7-9,16,17] Most failures occur in professional athletes or high-demand patients.[8] A persistent strength deficit is another complication, with an incidence of 36% according to Giannicola et al.[8]

The management of the late diagnosis of triceps rupture is still controversial. These typically present a greater challenge, prolonged time to recovery, and worse clinical results compared to acute injuries.[16] Whether primary repair or reconstruction must be performed is yet to be elucidated, with reconstruction being typically used in the presence of bad-quality local soft tissues, tendon retraction, and scarring that preclude an anatomic and tension-free repair.[12,14,16]

In a series of 22 patients by Van Riet et al, 15 patients had a delay in treatment, with 172 days of average time to surgery.[16] Primary repair with transosseous sutures was possible in 6 of these patients, whereas a reconstructive procedure was performed in the remaining 9.[16] A satisfactory result was achieved in only 66% of the patients of the primary repair group, with the authors concluding that this treatment is more reliable when performed within three weeks of trauma.[16] Time to recovery was prolonged—six to twelve months—in contrast to the recovery of patients who presented with an acute injury, in which the majority of elbow motion and triceps strength returned over the first three to four months. Our results regarding functional scores and return to work are identical to those of an acute repair in both cases.

In a study by Giannicola et al of 28 TTR treated with primary repair with transosseous sutures, 5 were chronic.[8] No significant differences in clinical outcomes—measured by MEPS, Modified American Shoulder and Elbow Surgeons questionnaire (M-ASES), and QuickDASH scores—or muscle strength were observed between patients with acute and chronic lesions. However, in chronic cases, the surgical technique was more demanding and required additional surgical steps to allow the tendon reinsertion.[8] The use of a robust construct such as the knotless anchor double-row might bring more confidence to the surgeon dealing with the borderline irreparable chronic TTR, possibly precluding a reconstructive procedure. Owing to low number of chronic TTR described in the literature, with a wide variety of techniques used for its treatment, studies comparing clinical outcomes of repair and reconstruction techniques in this setting are lacking.

Several studies have compared different TTR repair procedures for acute injuries. A retrospective study of 184 acute TTR—one of the largest series to date—compared complications between those treated with anchors versus transosseous suture repair.[11]

**Figure 4** First anchor in the proximal row, placed in the lateral edge of the tendon footprint site.

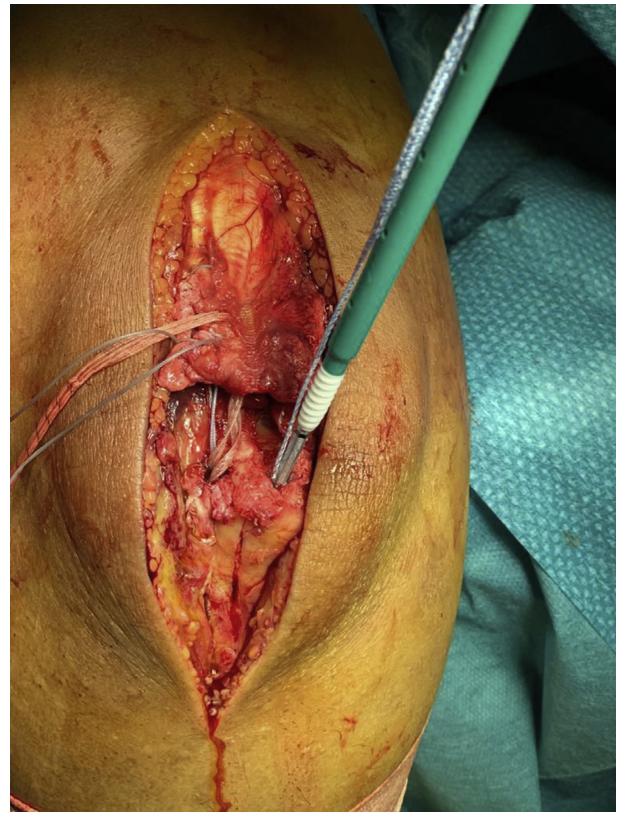

**Figure 5** Second anchor in the proximal row, placed in the medial edge of the tendon footprint site.

Transosseous repair had a significantly higher incidence of reruptures (6.7% vs. 0%), reoperation rate (9.5% vs. 1.4%), and longer release from medical care (4.3 vs. 3.4 months). No difference was found regarding infection rate. This study points toward the superiority of primary anchor repair.[11] This considerably high rate of rerupture and reoperation should lead the surgeon to consider using a more robust technique in the context of revision surgery. We believe the knotless double-row technique might play a role in this setting. Other studies contradict these findings, observing no difference between transosseous and anchor repair regarding MEPS and DASH scores or risk of rerupture.[8,9,17]

These studies usually lack precision in technique comparison because of several different constructs being encompassed in the suture anchor group. This points toward the importance of clinical studies comparing specific constructs. Owing to low incidence of TTR, cadaver studies have been most prominent in comparing different techniques.

A biomechanical analysis of 27 cadavers by Yeh et al[18] compared 3 different repair techniques: the transosseous technique by Van Riet et al,[16] traditionally described as the gold standard, a single-row suture anchor repair technique using two non-knotless anchors in the tendon footprint, and an anatomic double-row repair technique maximizing tendon foot-print coverage.[13,18] Double-row repair best recreated the anatomic footprint of the triceps tendon insertion, covering 86% of its area (compared to 31% in the transosseous and 48% in the single-row anchor techniques) and resulted in the least amount of repair

**Figure 6** First anchor in the distal row, placed laterally, just distal to the tendon footprint site.

displacement and intratendinous rupture after cyclical loading. In terms of load to failure, the authors found that all 3 constructs had statistically similar yield load and peak load.[18] However,

**Figure 7** Second anchor in the distal row, placed laterally, just distal to the tendon footprint site, showing footprint coverage, case 2.

**Figure 8** Final construct, showing footprint coverage, case 1.

long-term function and influence on healing were impossible to assess in a cadaver study.

Another cadaver study yielded similar results.[4] A transosseous technique was compared to a hybrid technique using both bone tunnels and a single knotless suture anchor for distal fixation. Greater displacement with cyclic loading, lower stiffness, and lower yield and peak loads were found with transosseous repair compared to the hybrid repair.[4] Footprint coverage was 22.12% in the transosseous technique and 74% in the hybrid technique. Of the five repair failures occurred during cyclic loading, three were in the transosseous group, and 2 in the hybrid repair group. All failures in the transosseous group occurred by knot slippage. The two failures in the hybrid technique were by fracture of the transosseous tunnel, and another by pulling out of the reluctance transducer. When testing for peak load, all transosseous repairs failed by knot slippage. In the hybrid repair, failure occurred either with fracture through the bone tunnels or with tearing of the tendon, which might be partially attributed to cadaveric tissue quality. No failures occurred at the bone-anchor interface. These findings suggest a superiority of a knotless anchor repair over the classical transosseous technique regarding its fragility points—knots and bone tunnels. It has also been described that multiple suture knots in this region might cause inflammation in the soft-tissue envelope.[4,6]

A cadaver study by Carpenter et al[3] adjusted these techniques by using an equal number of sutures in both and providing a tendon-compressing effect in the transosseous technique similar to the knotless double-row repair. No significant difference in tendon displacement or footprint coverage was found after cyclic-loading, contrasting previous studies.[3]

The usage of suture tapes was based on the principle that a thicker tape could maximize the contact pressure at the tendon-to-bone interface, which might be beneficial to healing.[5,10] Even though more favorable biomechanical properties in terms of contact pressure and ultimate failure load have been shown,[5,10] this has not been proved to translate into better clinical results regarding retear rate, in a rotator cuff model.[10]

Disadvantages of this construct are the theoretical risks of ulnar fracture and ulnoumeral joint penetration, as well as increased surgical costs. However, to our knowledge, no studies have adequately addressed these factors when compared to transosseous suture repair.

Our study is obviously limited by the small number of cases in which this technique was used, implying that there is no guarantee of future reproduction of the excellent results obtained.

## Conclusion

TTR are uncommon injuries, with chronic injuries being typically associated with technically demanding surgeries with potentially unsatisfactory results. Literature guiding their appropriate treatment is lacking. Our case reports suggest that a knotless double-row technique, with suture tapes and Krakow type sutures, providing anatomic footprint coverage can yield excellent results, both in acute and repairable chronic injuries. Several biomechanical studies indicate superiority of knotless anchors compared to transosseous sutures, although no large clinical studies address this issue.

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Patient consent: Consent was obtained from both patients for publication of case report and deidentified images.

**Table 1**
Clinical results after 12 months.

| Case number | Time to surgery | ROM | Elbow extension strength | Return to work | DASH score | MEPS score |
|---|---|---|---|---|---|---|
| Case 1—chronic rupture | 185 d | 0-130° | 5/5 | 3 mo | 4.2 | 85 |
| Case 2—acute rupture | 12 d | 5-125° | 5/5 | 4 mo | 3.3 | 85 |

*ROM*, range of motion.

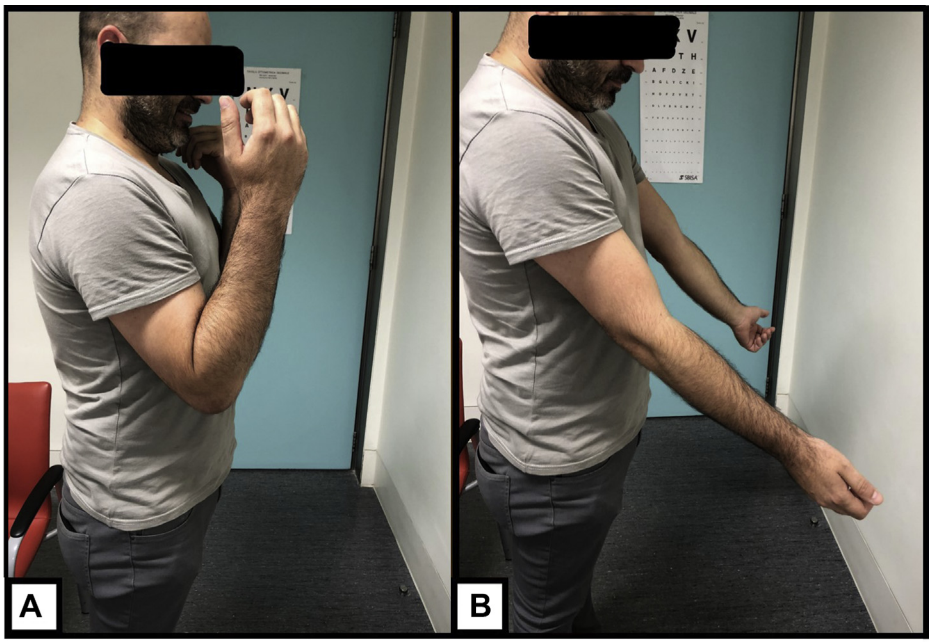


**Figure 9** Case 1: Range of motion in flexion (**A**) and extension (**B**).

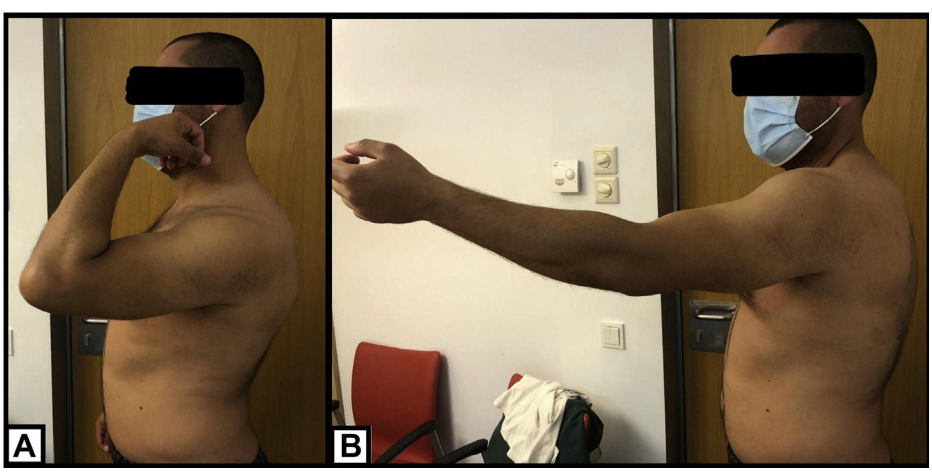


**Figure 10** Case 2: Range of motion in flexion (**A**) and extension (**B**).

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