Surgical Repair of Distal Triceps Tendon Injuries

Short-term to Midterm Clinical Outcomes and Risk Factors for Perioperative Complications

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Background: Few large-scale series have described functional outcomes after distal triceps tendon repair. Predictors for operative success and a comparative analysis of surgical techniques are limited in the reported literature.

Purpose: To evaluate short-term to midterm functional outcomes after distal triceps tendon repair in a broad patient population and to comparatively evaluate patient-reported outcomes in patients with and without pre-existing olecranon enthesopathy while also assessing for modifiable risk factors associated with adverse patient outcomes and/or revision surgery.

Study Design: Case series; Level of evidence, 4.

Methods: This study was a retrospective analysis of 69 consecutive patients who underwent surgical repair of distal triceps tendon injuries at a single institution. Demographic information, time from injury to surgery, mechanism of injury, extent of the tear, pre-existing enthesopathy, perioperative complications, and validated patient-reported outcome scores were included in the analysis. Patients with a minimum of 1-year follow-up were included.

Results: The most common mechanisms of injury were direct elbow trauma (44.9%), extension/lifting exercises (20.3%), overuse (17.4%), and hyperflexion or hyperextension (17.4%). Eighteen patients were identified with pre-existing symptomatic enthesopathy, and 51 tears were caused by an acute injury. A total of 36 complete and 33 partial tendon tears were identified. Bone tunnels were most commonly used ($n = 30$; 43.5%), while direct sutures ($n = 23$; 33.3%) and suture anchors ($n = 13$; 18.8%) were also used. Perioperative complications occurred in 21.7% of patients, but no patients experienced a rerupture at the time of final follow-up. No statistically significant relationship was found between patient age ($P = .750$), degree of the tear ($P = .613$), or surgical technique employed ($P = .608$) and the presence of perioperative complications.

Conclusion: Despite the heightened risk of perioperative complications after primary repair of distal triceps tendon injuries, the current series found favorable functional outcomes and no cases of reruptures at short-term to midterm follow-up. Furthermore, age, surgical technique, extent of the tear, and mechanism of injury were not associated with adverse patient outcomes in this investigation. Pre-existing triceps enthesopathy was shown to be associated with increased complication rates.

Keywords: elbow; general sports trauma; athletic training; enthesopathy

Injuries to the distal triceps tendon are relatively uncommon, accounting for less than 1% of all tendon injuries.[2] These injuries can vary widely in severity from tendon strains to complete tendon ruptures. Although the treatment of most partial-thickness tears is often nonoperative, more extensive partial tendon ruptures, enthesophyte avulsions, and full-thickness disruptions are usually treated surgically.[17] The most common techniques utilize suture anchors, bone tunnels, and/or primary suture repair, although there is little consensus on the ideal technique for surgical treatment.[3,11,19]

Because of the relatively low incidence rate, the clinical diagnosis of distal triceps tendon ruptures can be challenging and is often delayed or missed completely. Furthermore, these injuries can present in a relatively nonspecific fashion, often with posterior elbow pain, focal

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tenderness, effusion or bursitis, and/or inability to achieve full extension.[18] More specifically, olecranon avulsions typically occur in association with blunt trauma or fall-related mechanisms, weightlifting with an eccentric load, and/or acute on chronic trauma with pre-existing enthesopathy.[11-15] Conversely, traumatic distal triceps tendon tears are most commonly seen in the middle-aged male population, characteristically with the use of performance-enhancing drugs such as anabolic steroids.[9]

Given the paucity of larger scale series, the purpose of this investigation was to evaluate short-term to midterm functional outcomes after distal triceps tendon repair in a broad patient population. Furthermore, we sought to comparatively evaluate patient-reported outcomes in patients with and without pre-existing olecranon enthesopathy while also assessing for modifiable risk factors associated with adverse patient outcomes and/or revision surgery.

METHODS

All consecutive patients undergoing primary distal triceps tendon repair by 6 experienced elbow surgeons at a single medical center between 2008 and 2016 were identified from a retrospectively collected database. Exclusion criteria included patients with complex associated injuries, revision distal triceps tendon repair, and advanced ulnohumeral arthritis. A total of 88 patients met the inclusion and exclusion criteria for this institutional review board–approved study.

Patient demographic data were collected and included age, sex, race, smoking status, insurance status, comorbidities, and body mass index. Patient-reported outcome scores were collected postoperatively. Injury characteristics such as degree of the tear (ie, partial- vs full-thickness), presence of pre-existing enthesopathy and olecranon enthesophytes, mechanism of injury, and time from injury to surgery were gathered through a line-by-line review of the electronic medical record, operative reports, and radiographic imaging. Additionally, the specific surgical technique performed was extracted for further analysis; the procedures were classified into 1 of 3 primary surgical technique categories: transosseous bone tunnel, suture anchor, and primary suture repair groups (ie, soft tissue and/or intratendinous suture repair). The mechanism of injury was stratified into the following categories: direct trauma, overuse, extension/lifting exercises, or hyperextension/hyperflexion. Enthesopathy was defined by the presence of enthesophytes, with or without fragmentation, insertional calcification, or enthesitis identified through a combination of preoperative radiography or magnetic resonance imaging and intraoperatively. Of the 18 patients identified with pre-existing enthesopathy, 11 were identified from magnetic resonance imaging, 6 were identified from radiography, and 1 was identified intraoperatively. Because of inconsistent classification schemes, injuries were arbitrarily labeled as "chronic" if the time from injury to surgery was longer than 30 days.

The primary outcomes of interest were the Single Assessment Numeric Evaluation (SANE) and visual analog scale (VAS) for pain scores at 1-year follow-up postoperatively. Additionally, the Kerlan-Jobe Orthopaedic Clinic (KJOC), Veterans RAND 12-Item Health Survey (VR-12), Mayo Elbow Performance Score (MEPS), and Quick Disabilities of the Arm, Shoulder and Hand (QuickDASH) scores were collected at a minimum of 1 year after surgery. Perioperative complications and secondary reoperations were recorded and reported according to the following categories: persistent pain, neurovascular injury or paresthesia, persistent effusion or olecranon bursitis, symptomatic insertional tendinopathy or enthesophyte formation, and repair dehiscence or failure. Persistent pain was defined as a VAS score of $\geq$5.

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Surgical Technique

Transosseous Repair. This repair was performed utilizing a technique similar to the one described by van Riet et al.[19] With careful attention to the ulnar nerve, the triceps tendon ends were debrided to allow for the exposure of fresh tendinous tissue. A Krackow-type whipstitch with No. 2 FiberWire suture (Arthrex) was first passed through the ruptured tendon, followed by several passes of the whipstitch on alternating ends of the tendon using the same stitch. Two crossing transosseous drill holes were placed through the olecranon, parallel to the joint surface. Each strand of the suture was passed into each drill hole in a proximal to distal fashion and tied to each other over the bone bridge.[20]

Suture Anchor Repair. A double-row repair technique was utilized. After exposure of the triceps tendon and olecranon, 2 suture anchors were placed in the middle of the footprint, approximately 12 mm distal to the proximal tip of the olecranon. Heavy, No. 2 nonabsorbable, high-tensile suture was then passed through the triceps in a running Krackow fashion from proximal to distal. When applicable, side-to-side repair was performed to address longitudinal splitting of the triceps tendon or residual defects after the excision of nonviable tissue.

Primary Repair With Sutures. This technique was reserved for partial tears. Similar to the other techniques, existing enthesophytes and calcification were taken down using a rongeur and curette. After exposure of the remaining triceps tendon, primary soft tissue repair was performed using either horizontal mattress sutures or side-to-side sutures in a figure-of-8 configuration.

Statistical Analysis

Statistical analysis was performed using bivariate analyses including a paired-samples t test, independent t test, 1-way analysis of variance, linear regression analysis, and chi-square analysis. $P < .05$ was considered statistically significant.

RESULTS

Patient Demographics and Injury Characteristics

A total of 88 patients (83 male, 5 female) met the appropriate inclusion and exclusion criteria, and 69 patients (78.4%) were available to provide patient-reported outcomes at a mean follow-up of 4.0 ± 2.5 years postoperatively (range, 365-3650 days). The mean age of the patients at the time of surgery was 48.0 ± 12.5 years (range, 14-74 years); further patient demographics and injury characteristics are listed in Table 1. Complete, full-thickness ruptures of the distal triceps tendon occurred in 36 patients (52.2%), while 33 patients (47.8%) were found to have partial tears. Enthesopathy was identified on 18 ruptures (26.1%), while 51 (73.9%) of the tears had none. Surgery occurred at a median of 49 days after injury (range, 1-3650 days). When organized by injury chronicity, 28 (40.6%) patients underwent surgery within 30 days of the initial injury, while 41 patients (59.4%) underwent surgery at more than 30 days after injury (range, 30 days to 10 years).

Mechanism of Injury

The most common mechanisms of injury were direct elbow trauma (n = 31; 44.9%), extension/lifting exercises (n = 14; 20.3%), overuse (n = 12; 17.4%), and hyperflexion or hyperextension (n = 12; 17.4%). On chi-square analysis, there was no significant difference between the mechanisms of injury with respect to the complication rate ($P = .322$).

Surgical Technique and Perioperative Complications

Transosseous bone tunnels were the most commonly performed surgical procedure (n = 30; 43.5%), while primary suture repair (n = 23; 33.3%) and suture anchors (n = 13; 18.8%) were also used. Of note, 1 Achilles tendon allograft augmentation was performed for severe degenerative tendinopathy, and this patient had significant, persistent pain and ulnar neuropathy at 18-month postoperative follow-up. Two patients underwent unidentified surgical procedures. These three patients were not included in the surgical technique analysis.

In total, 15 (21.7%) patients had complications that included the following: persistent intermittent pain or numbness (n = 8), tendon calcification or thickening (n = 4), subcutaneous adhesions (n = 1), cyst formation (n = 1), or wound dehiscence (n = 1) (Table 2). No patients experienced a rerupture or required surgical revision.

Patient-Reported Outcome Scores

Final patient-reported outcome scores are shown in Table 3. Only 15 (21.7%) patients reported a VAS score of >1, and only 6 patients (9.4%) reported a VAS score of ≥3. A total of 77.4% of patients reported a SANE score of ≥90 at follow-up, and 95.0% of patients reported a SANE score of >75.

Complications

Subanalysis of those patients identified as having preoperative triceps enthesopathy was performed. The enthesopathy patients had a significantly greater complication rate (44.4%) than the patients without enthesopathy (13.7%) ($P = .027$). Analysis of specific complications is shown in Table 3. Further, the patients without enthesopathy exhibited a significantly higher rate of full-thickness avulsions, with 34 (66.7%) full-thickness tears versus 2 (11.1%) for the patients with enthesopathy ($P < .001$). These groups were not statistically different based on demographic factors ($P > .05$).

Age was not shown to have any correlation with the complication rate ($P = .750$), and there was no statistical difference in complication rates between partial and complete tears ($P = .613$). After controlling for demographic variables, analysis by differing surgical techniques revealed

TABLE 1
Demographics and Characteristics According to Presence of Enthesophytes[a]

	Total (N = 69)	Enthesophytes (n = 18)	No Enthesophytes (n = 51)	*P* Value
Age, y	48.0 ± 12.5	46.1 ± 13.1	48.3 ± 12.7	.406
Body mass index, kg/m^2	29.4 ± 4.6	29.5 ± 4.7	30.1 ± 4.6	.237
Complete tear, n (%)	36 (52.2)	2 (11.1)	34 (66.7)	**<.001**
Mechanism of injury, n (%)				
Direct trauma	31 (44.9)	3 (16.7)	28 (54.9)	**.002**
Extension/lifting	14 (20.3)	6 (33.3)	8 (15.7)	.172
Overuse	12 (17.4)	7 (38.9)	5 (9.8)	**.03**
Hyperflexion/hyperextension	12 (17.4)	2 (11.1)	10 (19.6)	.375

[a]Data are reported as mean ± SD, unless otherwise specified. Bolded *P* values indicate a statistically significant difference between patients with enthesophytes versus no enthesophytes ($P < .05$).

TABLE 2
Outcomes According to Surgical Technique[a]

	Total (N = 69)	Bone Tunnels (n = 30)	Direct Repair (n = 23)	Suture Anchors (n = 13)	*P* Value
Age, y	48.0 ± 12.5	49.8 ± 13.1	45.3 ± 12.0	45.0 ± 14.1	.276
Body mass index, kg/m^2	29.4 ± 4.6	29.1 ± 4.3	28.9 ± 4.1	30.8 ± 5.1	.757
Complications, n (%)	15 (21.7)	5 (16.1)	7 (30.4)	1 (7.7)	.215
Persistent pain/numbness	8	3	2	1	
Tendon calcification or thickening	4	1	3	0	
Triceps adhesion	1	1	0	0	
Olecranon cyst	1	0	1	0	
Dehiscence	1	0	1	0	
SANE score	91.2 ± 14.6	90.3 ± 17.1	90.8 ± 13.0	94.1 ± 9.1	.745
VAS score	0.9 ± 1.7	1.0 ± 2.0	0.7 ± 1.2	0.3 ± 0.5	.598
KJOC score	84.5 ± 20.0	86.2 ± 16.7	81.9 ± 25.7	81.7 ± 22.8	.845
VR-12 score	0.8 ± 0.1	0.8 ± 0.1	0.8 ± 0.1	0.7 ± 0.1	.255
MEPS score	90.7 ± 25.8	95.3 ± 11.1	88.1 ± 15.3	84.0 ± 12.5	.2
QuickDASH score	9.7 ± 14.8	10.9 ± 17.1	8.7 ± 14.9	4.0 ± 5.8	.55

[a]Data are reported as mean ± SD, unless otherwise specified. KJOC, Kerlan-Jobe Orthopaedic Clinic; MEPS, Mayo Elbow Performance Score; QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand; SANE, Single Assessment Numeric Evaluation; VAS, visual analog scale; VR-12, Veterans RAND 12-Item Health Survey.

TABLE 3
Outcomes According to Presence of Enthesophytes[a]

	Total	Enthesophytes	No Enthesophytes	*P* Value
Complications, n (%)	15 (21.7)	8 (44.4)	7 (13.7)	**.027**
Persistent pain/numbness	8	4	4	.196
Tendon calcification or thickening	4	3	1	.130
Triceps adhesion	1	0	1	.322
Olecranon cyst	1	1	0	.331
Dehiscence	1	0	1	.322
SANE score	89.9 ± 14.6	80.3 ± 24.8	92.6 ± 8.8	.103
VAS score	0.9 ± 1.7	2.1 ± 2.9	0.6 ± 0.9	.062
KJOC score	84.5 ± 20.0	85.6 ± 17.5	84.2 ± 20.9	.875
VR-12 score	0.8 ± 0.1	0.8 ± 0.2	0.8 ± 0.1	.590
MEPS score	90.7 ± 29.7	84.4 ± 17.0	93.0 ± 11.4	.217
QuickDASH score	9.7 ± 16.3	16.1 ± 21.8	7.1 ± 12.7	.202

[a]Data are reported as mean ± SD, unless otherwise specified. Bolded *P* value indicates a statistically significant difference between patients with enthesophytes versus no enthesophytes ($P < .05$). KJOC, Kerlan-Jobe Orthopaedic Clinic; MEPS, Mayo Elbow Performance Score; QuickDASH, Quick Disabilities of the Arm, Shoulder and Hand; SANE, Single Assessment Numeric Evaluation; VAS, visual analog scale; VR-12, Veterans RAND 12-Item Health Survey.

no statistically significant differences in complication rates or patient-reported outcome scores between patients with and without enthesopathy (Table 3).

Time From Injury

Patients with complications underwent surgery at a median of 60 days after injury, while the patients without complications underwent surgery at a median of 35 days after injury. However, this did not achieve statistical significance ($P = .872$). Linear regression analysis showed that there was no significant correlation between injury chronicity (ie, time from injury to surgery) on any of the analyzed outcome scores: SANE ($P = .542$), VAS ($P = .368$), KJOC ($P = .209$), MEPS ($P = .405$), VR-12 ($P = .118$), and QuickDASH ($P = .482$).

DISCUSSION

While rare, distal triceps tendon tears can lead to significant upper extremity immobility and discomfort.[2] Prior studies have recommended surgical treatment for patients with complete triceps avulsions and also those with partial tears with greater than 50% involvement.[9] The current study sought to describe the short-term to midterm outcomes of surgical repair of distal triceps tendon ruptures and to establish a relationship between patient outcomes and the presence of preoperative distal triceps tendon enthesopathy. Further, this study showed that (1) approximately 80% of patients reported no complications at short-term to midterm follow-up, (2) no patients sustained a secondary retear or repair failure, (3) the presence of enthesopathy was predictive for an increased risk of persistent elbow complaints or postoperative complications, and (4) there was no significant difference in complication rates by age, degree of the tear, or operative technique.

The current series identified an elevated risk for perioperative complications after primary repair of the distal triceps tendon but encouraging functional outcomes and no cases of reruptures or re-repair at midterm follow-up. Of the 69 patients analyzed, only 15 patients reported complications, with the most common being persistent surgical site pain or paresthesia (11.6%). Furthermore, only 6 (8.7%) patients reported more than mild pain (VAS score of $\geq$3), and 4 (4.5%) patients reported a level of performance less than 75% of normal (SANE). Other smaller studies have shown similarly successful outcomes after triceps tendon repair, with rerupture rates less than 7% and patient-reported satisfaction rates ranging from 85.7% to 94.6%.[5,7,8]

The existing literature provides no conclusive optimal surgical technique, as various studies have shown outcomes with the use of transosseous bone tunnels, suture repair, and anchor placement. In a case series of 14 patients who underwent transosseous bone tunnel repair using either a Bunnell- or Krackow-type stitch, van Riet et al[19] reported that 3 of these patients eventually experienced reruptures. Other studies have reported more favorable outcomes using the transosseous repair technique.[6,10,16] Utilizing the suture anchor technique with 5 patients, Bava et al[3] described an encouraging American Shoulder and Elbow Surgeons score of 99.2 at an average of 2.67 years postoperatively. The current study performed a subanalysis of both patient-reported outcome scores and complication rates for each of the 3 major surgical techniques and showed that each of these techniques resulted in similar, favorable patient outcomes ($P > .05$). The current study contradicts the statistical conclusion offered by Horneff et al,[8] who suggested that suture anchor repair is associated with superior DASH scores relative to transosseous repair. However, because of the limited differences between surgical techniques in these 2 relatively large studies, we believe that individual surgeon preference is the most effective way to operatively manage distal triceps tendon tears.[8]

Underlying triceps enthesopathy is thought to be a contributing factor to triceps abnormalities and, potentially, triceps ruptures.[1] Enthesophytes may be a result of remote trauma and/or repetitive mechanical loading, leading to tendon calcification, altered tendon elasticity, and potential impingement. With further eccentric loading and significant inflammatory responses, the tendon may become more susceptible to avulsions and/or ruptures.[4] In the current series, the presence of preoperative distal triceps enthesopathy was associated with a statistically significant increase in the overall complication rate (44.4% vs 13.7%, respectively; $P = .027$). Of note, 88.9% of the patients with enthesopathy had partial-thickness tears, but degree of the tear (partial- vs full-thickness) was shown to have no significant role in complication rates ($P > .05$). In one of the few prior published studies, Alvi et al[1] assessed the long-term outcomes of 11 patients surgically treated for painful olecranon enthesophytes with excision and primary repair. At an average of 34 months postoperatively, their study reported the re-emergence of insertional spurs in 2 of the patients, and well-circumscribed calcification around the distal triceps tendon was noted in 4 of these cases. The high incidence rate of recurrent abnormalities suggests that subsequent tendon thickening, reactive scar formation, calcification, and insertional enthesophytes may contribute to greater surgical site morbidity with primary distal triceps tendon repair. Understanding the significantly elevated rate of complications associated with the presence of preexisting enthesopathy may allow more accurate preoperative patient counseling and a broader understanding of the potential pitfalls during rehabilitation.

Although this study was able to successfully describe the short-term to midterm outcomes of distal triceps tendon repair, several limitations must be noted. Because of the retrospective nature of the study, we did not have baseline preoperative outcome scores or postinjury radiographic imaging findings available for all patients. This limited the ability to determine the exact percentage of tendon involvement for partial tears and further stratify outcomes based on the degree of tendon involvement or tear morphology. Further, the lack of postoperative imaging limited our ability to accurately characterize the rates of soft tissue calcification or secondary enthesophyte formation. While being a single-center study, operative indications and surgical techniques did vary by surgeon. Last, certain confounding variables, such as the use of performance-enhancing drugs or off-label pharmaceuticals, could not be fully controlled for, and nonresponder bias could be present.

CONCLUSION

Despite the heightened risk of perioperative complications after primary repair of distal triceps tendon injuries, the current series found favorable functional outcomes and no cases of reruptures at short-term to midterm follow-up. Further, the presence of enthesopathy was associated with an increased risk for complications after repair of the distal triceps tendon. Finally, age, surgical technique, and extent of the tear were not associated with adverse patient outcomes in this investigation.

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