Chronic Distal Triceps Brachii Tendon Ruptures. A Systematic Review of Surgical Procedures and Outcomes

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SUMMARY

Background. Chronic and neglected ruptures of distal triceps brachii tendon (TBT), for different reasons, are rarer than acute ruptures. We aimed to review the literature about their surgical treatment and outcome to better understand how to address this kind of rare tendon injuries.

Sources of data. Published articles in English in PubMed, Scopus and Google Scholar up to December 2019 about chronic ruptures of distal TBT. Twenty-one papers were included following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Areas of agreement. In cases of neglected rupture or re-rupture of the distal TBT surgical treatment is required.

The macroscopic quality of the residual stump rather than the timing of intervention is the key point in the choice of a specific surgical procedure, included autograft or allograft.

Areas of controversy. Several surgical procedures are described to restore the tendon anatomy and function. The quality of the current literature could not afford definitive conclusions on which procedure guarantee the best results.

Growing points. Studies comparing different surgical treatments need to be further investigated. If found to be significant, preventive and therapeutic strategies should subsequently be developed.

KEY WORDS
Distal Triceps Brachii Tendon; rupture; rerupture; inveterated rupture; chronic rupture; surgery

INTRODUCTION

The distal TBT rupture is a rare injury. Most of the case series reported are sport-related, the main mechanism seems due to uncoordinated contraction of the triceps against flexed elbow such as from a fall on an outstretched arm, or for a direct trauma on elbow with associated open or closed fracture (1). Although a trauma is often described in the past medical history, intrinsic predisposing factors for tendon ruptures are well known such as: rheumatoid arthritis, systemic lupus erythematosus, hyperparathyroidism, diabetes mellitus, chronic renal disease and they need to be investigated in each patient (2–5). Regarding drugs related injuries fluoroquinolones (6), anabolic steroids (7,8) and local steroids injections are considered iatrogenic causes of TBT ruptures.

Distal TBT rupture may involve different anatomical regions: a) proximally at the origin of the lateral head of the triceps, b) at the triceps muscle belly, c) at the musculotendinous junction, d) in the tendon *per se*, or e) an avulsion from the bony footprint of the olecranon (9–11).

The diagnosis is merely clinical; the mechanism of injury may help to consider it. Bruising and swelling along the posterior aspect of arm with limited or lack of extension are the main symptoms. In some patients, a palpable gap at the rupture site may be present. It is reported that several patients did not receive a diagnosis on initial assessment (12). The missed diagnosis is the main cause of delayed intervention and neglected tendon tears. Radiographs of the elbow allowed to find flecks of avulsed osseous mate-
A computed tomography scan can be helpful in excluding associated bony injuries. Magnetic resonance imaging (MRI) and ultrasounds are useful in those patients in whom the lesion is partial (13). The complete tear features by large fluid-filled gap in the T2-weighted image between the retracted stump of the TBT and the olecranon (14). MRI is useful to assess muscle quality, especially for chronic ruptures, and may help determine if a graft procedure is required (15). The treatment of the acute ruptures of distal TBT is well established (1,16). A chronic rupture of a tendon can be defined as a rupture with a delay in diagnosis or treatment for more than 6 weeks. Specifically for distal TBT ruptures has been observed that the degenerative evolution of the tendon occurred slower than other tendon ruptures such as those affecting the Achilles tendon (17). When muscle-tendon retraction is caused by delayed diagnosis or when the remaining available tissue is limited because of previous surgery or infection, the direct sutures techniques are not feasible. Therefore, different augmentation procedures have been developed, which allowed theoretically rebuilding of the elbow extensor mechanism (6-12). There is lack of prospective randomized trials due to small sample of patients for these procedures thus their results do not lead to a standard surgical treatment.

In case of chronic ruptures of distal TBT we observed different approach by authors not only in the choice of the graft but even in the indication of specific procedure. For example, Singh et al. used the extensor carpi radialis longus and palmaris longus tendon grafts in a case of 7 cm gap (19). Wagner et al. used the plantaris tendon in a case of 4 cm gap (11).

For the mentioned reasons we performed a review of the literature about the treatment of the chronic, neglected and re-ruptures of distal TBT. To our knowledge, no systematic review of such studies has been conducted to clarify the best surgical procedures and outcomes.

Our PRISMA checklist is presented in an online supplement (figure 1). We wished to try to assess:
• risk of factor for chronic of distal TBT ruptures;
• surgical procedures;
• post-surgical outcomes and complications;
• return to sport or daily activity.

We performed a meta-analysis of the literature about the treatment of chronic and re-ruptures of distal TBT. We included case series and case reports. We excluded: acute ruptures cases, reviews and studies on cadaveric specimen and animal models.

SOURCE OF STUDIES AND SEARCH STRATEGY

We performed a systematic search (up to December 2019) in the PubMed, Scopus and Google Scholar electronic databases of articles concerning the chronic and re-ruptures of distal TBT and the surgical techniques, published in English only. The search strategy covered all the cases of TBT chronic ruptures surgically treated. In addition, we recorded complications and functional outcomes. In the search strategy, we used different combinations of the following key terms and MesH terms: Triceps Brachii Tendon, rupture, re-rupture, inveterate rupture, neglected rupture, chronic rupture, delayed rupture, surgery.

We considered chronic ruptures from 60 days after the injury. We only considered for inclusion in the present meta-analysis published articles that had considered the association between surgery and chronic rupture in humans.

STUDY SELECTION AND ELIGIBILITY CRITERIA

Two orthopedic residents performed the search and evaluated the articles independently. A researcher experienced in systematic reviews solved cases of doubt. At the beginning of the procedure, each examiner read the abstracts of all the articles, selected the relevant ones according to inclusion and exclusion criteria previously determined, and then compared the results with the other examiner. After 4 weeks, the same studies were read again to establish the agreement of the researchers on the selection. No disagreement was observed among the investigators.

DATA COLLECTION

One reviewer extracted the data from the full-text articles to Excel spreadsheet structured tables to analyze
the study in a descriptive fashion. The second researcher independently double checked the extraction of primary data from all the articles. Doubts and inconsistencies were followed and solved by discussion. The following information was extracted from articles: mechanism of injury, mean range time before surgery, type of lesion/re-rupture, associated injuries and comorbidities, type of surgery, muscle strength recovered after surgery, complications.

RESULTS
After our initial literature search, a total of 303 potentially relevant citations were identified. After removal of duplicates, 270 articles remained. Title and abstract review excluded an additional 129 articles about the basis of the irrelevant pathology or non-English language. A total of 21 articles were eventually included in the present review. Each of them used different surgical procedures and different
Table I. Characteristics of the meta-analysis.

<table>
<thead>
<tr>
<th>Nr. of Reference</th>
<th>Nr. patients</th>
<th>GENDER (M-F)</th>
<th>MEAN AGE</th>
<th>MECHANISM OF RUPTURE</th>
<th>Mean range time before surgery (days)</th>
<th>TYPE OF LESION/ RERUPTURE</th>
<th>ASSOCIATED INJURIES &amp; COMORBIDITIES</th>
<th>TYPE OF SURGERY</th>
<th>MUSCLE STRENGTH</th>
<th>COMPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>(21)</td>
<td>5</td>
<td>4 Males 1 Female</td>
<td>M: 43.5 F: 71</td>
<td>- 3 Accidental fall - 2 Weightlifting</td>
<td>248</td>
<td>- 2 Full thickness; - 2 full thickness + lateral expansion; - 1 Superficial complete</td>
<td>None</td>
<td>All transosseous suture</td>
<td>-1: 4/5 - 4: 5/5</td>
<td>None</td>
</tr>
<tr>
<td>(22)</td>
<td>1 Male</td>
<td>52</td>
<td>Weightlifting</td>
<td></td>
<td>60</td>
<td>Full thickness at tendo-osseous junction with small fragment avulsion from olecranon</td>
<td>None</td>
<td>Transosseous suture</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(23)</td>
<td>1 Male</td>
<td>38</td>
<td>Fall during sport practice</td>
<td></td>
<td>270</td>
<td>Partial tearing of the insertion of the TT to the olecranon</td>
<td>None</td>
<td>Semitendinous graft with double row config + 2 suture anchors + 2 transosseous suture</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>(24)</td>
<td>2 Males</td>
<td>36.5</td>
<td>- 1: Fall in the shower - 1: Diving for volleyball</td>
<td></td>
<td>90</td>
<td>Full thickness tear of the medial portion of TT</td>
<td>One CS injection in one patient</td>
<td>Ipsilateral palmaris longus graft using Pulvertaft weave and passed through 2 bone tunnels in proximal ulna</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(25)</td>
<td>2 Males</td>
<td>25.5</td>
<td>Accidental fall on outstretched hand</td>
<td></td>
<td>210</td>
<td>Old TT avulsion with tendon retraction</td>
<td>None</td>
<td>-1: V-Y plasty + 1 suture anchor; -1: V-Y plasty + transosseous suture</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>(19)</td>
<td>1 Male</td>
<td>25</td>
<td>1 year history falls</td>
<td></td>
<td>365</td>
<td>Old TT avulsion of a fleck of bone from olecranon with a gap of 7cm</td>
<td>None</td>
<td>Extensor carpi radialis longus and palmaris longus tendon doubled stranded grafts in a Pulvertaft weave in the tendon and passed through a bone tunnel in the olecranon</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>(26)</td>
<td>2 Males</td>
<td>25</td>
<td>- 1: Fall on outstretched hand while cycling; - 1: Injury during football</td>
<td></td>
<td>2950</td>
<td>- 1 TT rupture with bony fragment avulsed from olecranon; - 1 Partial lesion of the medial part of triceps</td>
<td>Medical collateral ligament injuries (valgus instability)</td>
<td>-1: suture anchors in the olecranon; -1: transosseous suture non-absorbable; -2: reconstruction of the MCL with palmaris longus graft</td>
<td>5/5</td>
<td>None</td>
</tr>
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</table>

*TT = triceps tendon, CS = corticosteroid*
<table>
<thead>
<tr>
<th>Nr. of Reference</th>
<th>No. patients</th>
<th>GENDER</th>
<th>MEAN AGE (M-F)</th>
<th>MECHANISM OF RUPTURE</th>
<th>Mean range time before surgery (days)</th>
<th>TYPE OF LESION/RERUPTURE</th>
<th>ASSOCIATED INJURIES &amp; COMORBIDITIES</th>
<th>TYPE OF SURGERY</th>
<th>MUSCLE STRENGTH</th>
<th>COMPLICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>(4)</td>
<td>7</td>
<td>5 Males 2 Females</td>
<td>M: 55.8 F: 46.5</td>
<td>- 2: fall on outstretched hand; 5 after - Surger total elbow arthroplasty (TEA)</td>
<td>-4:225-3; not specified</td>
<td>Chronic insufficiency with retraction of medial and central part of the triceps</td>
<td>None</td>
<td>- 4: anconeus rotation flap + transosseous suture (3 pt with TEA and 1 previous fall); - 5: allograft with Achilles tendon with calcaneal fragment after V-shaped osteotomy of olecranon + transosseous suture</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(27)</td>
<td>1</td>
<td>Male</td>
<td>39</td>
<td>Fall on outstretched hand</td>
<td>70</td>
<td>Full thickness triceps rupture</td>
<td>Avulsion of elbow ulnar collateral ligament and flexor pronator muscle origin ipsilaterally</td>
<td>Ipsilateral palmaris longus tendon graft + krackow to secure the TT + 2 bone tunnels + 2 suture anchors</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(28)</td>
<td>1</td>
<td>Male</td>
<td>53</td>
<td>Injury during barbell exercise at the gym</td>
<td>93</td>
<td>Full thickness TT tear with 5 cm of gap</td>
<td>None</td>
<td>Achilles tendon allograft with bone block fanned out with 2 Fiber wire in krackow configuration to the TT + 4 sutures wire weave to the native tendon + 2 bone tunnels and 2 suture anchors</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>(29)</td>
<td>1</td>
<td>Male</td>
<td>25</td>
<td>Injury during contact sport</td>
<td>330</td>
<td>Neglected full thickness TT rupture</td>
<td>None</td>
<td>ST autograft passed in a bone tunnel in the olecranon + pulloraft weaved with proximal and distal part of the muscle</td>
<td>(5/5)</td>
<td>None</td>
</tr>
<tr>
<td>(30)</td>
<td>1</td>
<td>Female</td>
<td>19</td>
<td>1st injury: Fall on outstretched hand while rollerblading 2nd injury: 1 month later new fall in the same manner</td>
<td>240</td>
<td>Triceps insufficiency with small fragment avulsed from the olecranon</td>
<td>None</td>
<td>Non absorbable sutures using a modified Kessler technique woven in distal portion of triceps passed in two bone tunnels</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(31)</td>
<td>1</td>
<td>Male</td>
<td>26</td>
<td>Bodybuilding during bench press</td>
<td>75</td>
<td>Full thickness TT rupture</td>
<td>Anabolic steroid use</td>
<td>Krakow sutures + 2 bone tunnels + 3-5 augmentation absorbable sutures</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>Nr. of Reference</td>
<td>N° patients</td>
<td>GENDER</td>
<td>MEAN AGE (M-F)</td>
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<td>Mean range time before surgery (days)</td>
<td>TYPE OF LESION/ RERUPTURE</td>
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<td>MUSCLE STRENGTH</td>
<td>COMPLICATION</td>
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<tr>
<td>(32)</td>
<td>1</td>
<td>Male</td>
<td>32</td>
<td>Powerlifting injury</td>
<td>365</td>
<td>Complete rupture of the TT at the musculotendinous junction</td>
<td>Adhesions of the triceps aponeurosis to the medial epicondyle and a subluxing ulnar nerve with perineural fibrosis at the cubital tunnel</td>
<td>Sutures + Neurolysis of the ulnar nerve</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(33)</td>
<td>1</td>
<td>Male</td>
<td>19</td>
<td>Fall on outstretched hand during rugby</td>
<td>120</td>
<td>Triceps medial head rupture with 1cm of GAP</td>
<td>Small bone fragment located distal to the medial humeral epicondyle</td>
<td>Figure of eight suture into a bone tunnel + non-absorbable suture + polyester mesh augmentation</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(34)</td>
<td>1</td>
<td>Male</td>
<td>42</td>
<td>Fall on outstretched hand during football match</td>
<td>3650</td>
<td>Full thickness rupture of TT with multiple microcalcification</td>
<td>None</td>
<td>ST and Gracile autograft in a pulvertaft weave to the disrupted tendon + 3 transosseous anchor sutures + 2 bone tunnels</td>
<td>Not specified</td>
<td>None</td>
</tr>
<tr>
<td>(11)</td>
<td>1</td>
<td>Male</td>
<td>61</td>
<td>Fall on outstretched hand while roller-skating</td>
<td>150</td>
<td>TT rupture at the musculotendinous junction, with 4 cm of GAP</td>
<td>Insulin-dependent diabetes mellitus nephrolithiasis, and essential hypertension.</td>
<td>V-Y plasty + use of the plantaris tendons as an interweaving graft</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>(35)</td>
<td>1</td>
<td>Male</td>
<td>36</td>
<td>History of surgery on his elbow 2 years before, a loose body removal through an Outerbridge-Kashiwagi procedure + traumatic ruptures of the triceps tendon twice more treated with tendon allograft</td>
<td>Not specified</td>
<td>Partial defect of the triceps with significant thinning of the portion of intact tendon</td>
<td>None</td>
<td>Autologous hamstring graft with 2 oblique tunnel in proximal ulna</td>
<td>22 ft-lb of peak torque in extension compared with 60 ft-lb at this unjured side</td>
<td>None</td>
</tr>
<tr>
<td>Reference</td>
<td>N° of patients</td>
<td>GENDER (M-F)</td>
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<td>COMPLICATION</td>
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</tr>
<tr>
<td>(36)</td>
<td>1 Male</td>
<td>49</td>
<td></td>
<td>1st injury: hyperflexion of his left elbow</td>
<td>Not specified</td>
<td>Re-rupture of the previously repaired tendon</td>
<td>Bilateral below-knee amputation (prosthesis ambulator) + history of triceps</td>
<td>Two sets of Krackow sutures + bone tunnels + hamstring graft woven in a Bunnell configuration + bone tunnel</td>
<td>5/5</td>
<td>None</td>
</tr>
<tr>
<td>(3)</td>
<td>15 M: 46.5</td>
<td>3 Females</td>
<td>F: 47.3</td>
<td>1 Fall skiing; 1 snowmobile; 4 wheelchair transfer; 1 fall on ice; 1 ORIF x 2; 1 infected ORIF site; 1 fall stairs; 1 fall roller skates; 1 motor vehicle accident + ORIF; 1 fall soccer; 1 skiing pole placement; 1 tractor accident</td>
<td>Mean time repair: 153.5</td>
<td>Mean time reconstruction: 164.88</td>
<td>- 1 medial and central defects (repair); - 2 complete avulsion (repair); - 1 partial thickness avulsion (repair); - 2 central defects (repair); - 2 central defect (reconstruction); - 2 complete avulsion + retraction (recon); - 2 central defect delamination (recon); - 1 medial defect, absence of mediolateral olecranon (recon); - 1 medial defect (recon); 1 complete avulsion (recon).</td>
<td>None</td>
<td>- 6 repair: 5 Bunnell stitch and 1 krackow stitch; - 9 reconstructions: 3 ligament augmentation device, 1 palmaris and Achilles tendon, 1 bilateral palmaris longus, 1 plantaris, 1 latissimus dorsi flap, 1 anconeus slide, 1 semitendinosus.</td>
<td>- 1 Neurol. Weakness; - 1 Limited ROM due to PTOA (osteoarthritis post traumatic); - 1 Unable to work overhead; - 1 Quadriplegic</td>
</tr>
<tr>
<td>(37)</td>
<td>1 Male</td>
<td>37</td>
<td></td>
<td>12-year history of weakness and deformity to his left arm following a work-related injury acquired while he restrained a patron.</td>
<td>430</td>
<td>Rupture TT + avulsion of the lateral and long heads of the triceps</td>
<td>Previously had multiple primary extensor tendon repairs to the ipsilateral hand</td>
<td>Acellular dermal allograft (ADA) + nonabsorbable suture material; via 3 transverse bone tunnels + 1 suture</td>
<td>Mean elbow extension strength was 31.16 lbs and 72.8% of the contralateral side</td>
<td>Not specified</td>
</tr>
</tbody>
</table>
protocols, making statistical data analysis impossible. Study selection, retrieval and inclusion and exclusion reasons are shown in the flowchart above (figure 1). The number of the reference, the methods and the data collected from the included articles are shown in the table I. This systematic review included forty-eight patients.

DISCUSSION

Risk of factor for re-rupture of the triceps tendon
A medical history is important to make the right diagnosis and the best decision. Risk factors found, were: male gender (85%) with mean age of 37 years old while females patients were older (mean age of 45 years old), metabolic disease (2%), anabolic steroid use (2%), local injections of corticosteroid (6%) (5,7), sports such as weight lifting, skiing, football, rugby, volleyball (45%) or those sports that cause an elbow stress. (38) Testosterone administration can lead to alterations of biomechanical properties of tendons (39), reduction of elastic properties (40), tendon dysfunction and fibrosis, with a higher incidence of spontaneous tendon ruptures (41). Other associated lesions of the medial compartment were found (10%) and comorbidities like diabetes mellitus (2%) and nephrolithiasis (2%).

The most frequent mechanism of injury was a fall on outstretched hand (21%) especially during contact sport or an unsuitable movement during weight lifting.

Type of lesion or re-rupture
The distal TBT ruptures found were: at the muscle-tendinous junction (4.1%), partials ruptures (31.2%), full-thickness ruptures (41.6%), avulsion (20.8%) and re-ruptures (2%). Paniago et al. (23) used a semitendinosus (ST) autologous graft 270 days after the injury, McMillian et al. treated a rupture after 90 days, while Herrick et al. (32) only used direct sutures one year after. Thus we observed that there was no relation between time of surgery and use of graft. The quality of the distal stump after removing all the calcification and the non-healing tissue resulted the most important factor that contributed to the choice of the surgical technique. The signs of macroscopic bad quality of residual tendon stump as degenerations and calcifications (23,24,28,34), large loss of tendon substance (19,29) are the main features which suggest the use of a grafts.

Surgical procedures
In this meta-analysis we found that in the 45% of patients was used a graft (autograft or allograft). Furthermore, we found use of trans-osseous sutures (69%), suture anchors (27%), anconeus flaps (5%) and V-Y technique (6%) often in combined manner (24).

The autologous semitendinosus (ST) graft was the most used: Weistroffer et al. used this graft in one patient affected by a re-rupture (36) whereas other authors used it in patients with a chronic lesion (23,29,34,35). While Singh et al. preferred extensor carpi radialis longus and palmaris longus tendon in a doubled stranded grafts (19), Wagner et al. performed an augment after a distal TBT rupture with the plantaris tendon (11) and Scolaro et al. preferred only ipsilateral palmaris longus in two chronic distal TBT ruptures (24). McMillian et al. and Sanchez - Sotelo et al. used an allograft of Achilles tendon in 4 patients with large deficiency of TBT and an anconeus flap in one patient with moderate deficiency (4,28). Among allografts, the Achilles tendon is the most used and its availability avoids the risks associated with the harvest of an autograft. Among autografts, the ST graft has superior strength, cross-sectional area and length (36) then the other autologous grafts.

Post-surgical outcomes and complications
In this meta-analysis twenty-one (44%) patients recovered all muscle strength, six patients (12%) recovered 4/5 muscle strength and two had deficit of strength. In eight patients, the muscle strength at the follow-up was not reported. This is important and it might be a parameter of treatment efficacy. Sollender et al. found that all patients were able to resume normal activities, although to minimal residual weakness of elbow extension compared to the contralateral elbow (7). In one case Biodex testing showed 22 ft-lb of peak torque in extension, compared to 60 ft-lb on his uninjured side (35).

We suggest using scores as DASH or ULFI score in order to compare the efficacy of the different types of treatment. We found that surgical procedures in chronic distal TBT repair might have more complications than acute surgical repair. For example as a 10° terminal restriction of elbow flexion (42), a 5° extension loss, ulnar nerve entrapment, confirmed with EMG, posterior interosseous nerve palsy occurred in one patient who underwent simultaneous radial head fracture fixation, but regained its normality after 3 months post-operatively (31), olecranon bursitis (43), wound infection. One patient was dissatisfied at the end of the follow-up (16).

CONCLUSIONS
This systematic meta-analysis has some limitations. All the included studies were case reports and case series, therefore the level of evidence was low. This could be justified by
the rarity of the injury. The latter consideration limited final recommendations but highlighted the necessity for higher level studies comparing non-surgical and surgical treatment to produce definitive recommendations and different type of surgery. However, for relatively infrequent conditions such as chronic distal TBT ruptures, accumulation of a moderate volume of level IV evidence as presented in this systematic review may be sufficient for recommend surgical treatment for patients with appropriate clinical and imaging characteristics. There was also slight uniformity in patient demographics, treatment protocol, and outcome reporting. Finally, in some studies, the raw data concerning range of motion and/or strength were absent, so stratification into the satisfaction category was deduced using author’s descriptors rather than objective data. We suggest to use autografts, in case of bad quality of the stump with a gap over 3 cm rather than allografts because are cheaper and always available. Among autografts, the use of ST allowed good outcomes. Without comparative studies it is impossible conclude which is the best procedure. We try to support more scientific evidence in the choice of the surgical procedures, standard outcome scales and rehabilitation protocols.

**CONFLICT OF INTERESTS**

The authors declare that they have no conflict of interests.

**REFERENCES**


25. Yazdi HR, Qomashi I, Ghorban Hoseini M. Neglected triceps tendon avulsion: case report, literature review, and a new


