Results of primary repair of distal triceps tendon ruptures in a general population

A MULTICENTRE STUDY

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Aims

The aim of the study was to analyze the results of primary tendon reinsertion in acute and chronic distal triceps tendon ruptures (DTTRs) in the general population.

Patients and Methods

A total of 28 patients were operated on for primary DTTR reinsertions, including 21 male patients and seven female patients with a mean age of 45 years (14 to 76). Of these patients, 23 sustained an acute DTTR and five had a chronic injury. One patient had a non-simultaneous bilateral DTTR. Seven patients had DTTR-associated ipsilateral fracture or dislocation. Comorbidities were present in four patients. Surgical treatment included transosseous and suture-anchors reinsertion in 22 and seven DTTRs, respectively. The clinical evaluation was performed using Mayo Elbow Performance Score (MEPS), the modified American Shoulder and Elbow Surgeons Score (m-ASES), the Quick Disabilities of the Arm, Shoulder and Hand score (QuickDASH), and the Medical Research Council (MRC) Scale.

Results

A total of 27 patients (28 DTTRs) were available for review at a mean of 47.5 months (12 to 204). The mean MEPS, QuickDASH, and m-ASES scores were 94 (60 to 100), 10 (0 to 52), and 94 (58 to 100), respectively. Satisfactory results were observed in 26 cases (93%). Muscle strength was 5/5 and 4/5 in 18 and ten DTTRs, respectively. One patient with chronic renal failure experienced a traumatic rerupture of distal triceps. One patient (1 DTTR) experienced mild elbow stiffness.

Conclusion

Primary repair of acute and chronic DTTRs in a general population yields satisfactory results in the majority of patients with a low rerupture rate.

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Distal triceps tendon ruptures (DTTRs) are unusual, accounting for less than 1% of tendinous lesions.[1,2] DTTRs usually result from an avulsion from the olecranon, although ruptures at the intramuscular and musculotendinous junction have also been reported.[3-7] While many case reports have been published on DTTRs,[4-6,8-12] few series have analyzed the clinical outcomes of DTTRs, and most of them have been focused on professional athletes or triceps complications associated with previous elbow surgery.[7,13-16] The clinical results and complication rate after primary repair of acute and chronic DTTRs in the general population, excluding professional athletes, have been little investigated.[17-19]

The primary aim of the current study was to analyze the clinical results of primary tendon reinsertion in acute and chronic DTTRs in the general population. The secondary aim was to assess whether possible factors including comorbidity and associate injuries may influence the surgical outcomes.

Patients and Methods

Patient selection and characteristics. As DTTRs are rare, a multicentre study was undertaken. Units performing upper limb surgery were asked to participate in the study, providing they had an adequate database documenting the patient's condition, clinical history, surgical findings, and clinical outcome. Nine centres with experienced elbow surgeons that satisfied the requirements agreed to participate. Exclusion criteria were previous elbow surgery, sharp penetrating injury,

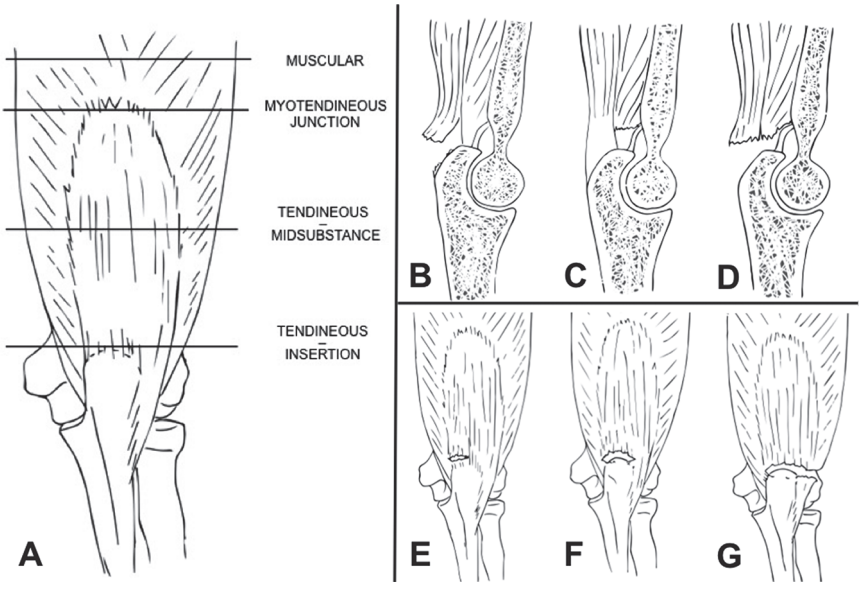

Fig. 1

Illustrations showing the classification of distal triceps tendon ruptures used. a) The tear may occur at the level of the muscle belly, musculotendinous junction, midsubstance of the tendon, or at the level of the insertion. The depth of the tendinous lesion may involve b) the superficial layer with the isolated tear of the lateral and long head tendon (superficial tear); the deeper layer (medial head) may be c) involved alone (deep tear) or d) in association with the superficial tendinous layer (full-thickness tear). The degree of the tendinous or muscular tear allow triceps lesions to be divided into either e) partial or f) complete tears and g) with the involvement of the lateral expansion. Reprinted with permission from **Giannicola G, Bullitta G, Sacchetti FM, et al.** Triceps Repair. In: Pederzini LA, Eygendaal D, Denti M, eds. *Elbow and Sport*. Berlin Heidelberg: Springer-Verlag, 2016:163-179.

and chronic reruptures. Patients in whom an allograft reconstruction was used for the triceps reinsertion were also excluded. As professional athletes differ substantially from the general population in terms of preoperative physical condition, need to recover the elbow function, and personal motivation, they were excluded from the investigation. Of an initial 34 patients identified, 28 patients (29 DTTRs) treated between 1998 and 2015 who fulfilled the inclusion criteria were entered in the study. There were 21 male patients and seven female patients with a mean age at the time of the DTTR of 45 years (14 to 76). One patient had a non-simultaneous bilateral rupture of the triceps tendon (left side in 1998 and right side in 1999). The right arm was involved in 17 patients, while the dominant side was affected in 18 patients. The mechanism of injury was an accidental fall in 19 DTTRs and a forced extension during weightlifting in the remaining ten DTTRs.

The diagnosis of DTTR was initially missed in five patients who were treated at a mean of eight months (4 to 13) after the injury. The remaining 24 DTTRs underwent surgery at a mean of eight days (1 to 30) after injury. The preoperative radiological investigations included a coronal- and lateral-view radiograph in all DTTRs, an ultrasound examination in nine, and MRI in 18. In three patients with an associated fracture, a CT scan was performed.

The DTTRs were classified, according to a classification system, on the basis of the operative report (Fig. 1).[21] In all the patients, the DTTR occurred at the level of the olecranon insertion (Table I).

Associated injuries and comorbidities. Seven patients had associated injuries of the ipsilateral upper limb, including three Mason Type III radial head fractures, one Mason Type II radial head fracture, one terrible triad, one simple elbow dislocation, and one proximal humeral fracture. Four patients had substantial comorbidities; three were receiving prolonged corticosteroid treatment for chronic asthma, polymyalgia rheumatica, and rheumatoid arthritis, respectively, while the fourth patient was suffering from chronic renal failure.

Surgical technique. A longitudinal posterior incision was performed slightly lateral or medial to the prominence of the olecranon. The ulnar nerve was identified and protected, although not decompressed or transposed in acute cases. The edges of the ruptured tendon were debrided and small bone fragments excised. The triceps footprint on the olecranon was debrided and cruciate drill holes were made in 22 DTTRs where transosseous locking sutures were used. In seven patients, two metallic suture anchors were implanted in the triceps footprint, with the tendon being reattached by tying the suture with the elbow in full extension. In two cases in which the transosseous suture did not ensure a stable reinsertion, suture anchors were added to strengthen the triceps tendon repair.

In four of the five chronic patients, marked retraction and degeneration of the tendon was present. This was treated by an

Table I. General characteristics, type of lesion, surgical procedure, final muscle strength, and complications of the all patients

Patient no.	Age (yrs)	Side	Gender	Mechanism of rupture	Range lesion-surgery (days)	Type of lesion	Associated lesions	Type of surgical treatment	Muscle strength MRC grade	Complications
1	54	Right	Male	Accidental fall	395	Full thickness	No	Transosseous suture	4/5	No
2	14	Left	Male	Accidental fall	2	Full thickness + lateral expansion	No	Transosseous suture	4/5	Slight extension elbow stiffness
3	53	Right	Male	Accidental fall	120	Full thickness + lateral expansion	No	Transosseous suture	4/5	No
4	48	Left	Male	Weightlifting	150	Full thickness + lateral expansion	No	Transosseous suture	5/5	No
5	21	Right	Male	Weightlifting	1	Full thickness + lateral expansion	No	Transosseous suture	4/5	Transient adverse reaction to stitches
6	20	Right	Male	Accidental fall	1	Superficial complete	Radial head fracture	Transosseous suture + ORIF radial head	4/5	No
7	35	Left	Male	Accidental fall	9	Superficial complete	Simple elbow dislocation	Suture anchors + LCL and MCL reinsertion	5/5	No
8	19	Left	Male	Weightlifting	365	Superficial complete	No	Transosseous suture	5/5	No
9	35	Left	Male	Accidental fall	8	Superficial complete	No	Transosseous suture	5/5	No
10	35	Right	Male	Accidental fall	1	Full thickness	No	Suture anchors	5/5	Rerupture after 1 mth
11	73	Right	Female	Accidental fall	2	Superficial partial	No	Transosseous suture	N/A	N/A (patient lost at follow-up)
12	76	Right	Female	Accidental fall	1	Superficial partial	Radial head fracture	Transosseous and anchor suture + radial head arthroplasty	4/5	No
13	39	Right	Female	Accidental fall	1	Full thickness	Radial head fracture	Suture anchors + radial head arthroplasty	4/5	No
14	63	Right	Female	Accidental fall	1	Full thickness	Proximal humerus fracture	Transosseous and anchor suture + ORIF with nail	5/5	No
15	52	Left	Male	Weightlifting	15	Full thickness	No	Transosseous suture	4/5	No
16	43	Right	Male	Weightlifting	15	Full thickness	No	Transosseous suture	4/5	No
17	21	Left	Male	Accidental fall	1	Full thickness	No	Transosseous suture	5/5	No
18	38	Right	Male	Weightlifting	10	Full thickness	No	Transosseous suture	5/5	No
19	41	Right	Male	Weightlifting	23	Full thickness	No	Transosseous suture	5/5	Keloid
20	47	Right	Male	Accidental fall	30	Full thickness	No	Suture anchors	5/5	No
21	65	Right	Male	Accidental fall	20	Deep complete	No	Suture anchors	5/5	No
22	75	Left	Female	Accidental fall	2	Full thickness	No	Suture anchors	5/5	Wound dehiscence
23	30	Left	Male	Accidental fall	15	Superficial complete	No	Transosseous suture	5/5	No
24	49	Right	Male	Weightlifting	5	Full thickness	No	Transosseous suture	5/5	No
25	48	Left	Male	Weightlifting	2	Full thickness	No	Transosseous suture	5/5	No
26	41	Right	Male	Weightlifting	10	Full thickness	No	Suture anchors	5/5	No
27	71	Left	Female	Accidental fall	210	Full thickness	No	Transosseous suture	5/5	No
28	50	Right	Female	Accidental fall	15	Full thickness	Terrible triad	Transosseous suture + radial head arthroplasty, coronoid capsulodesis, and LCL reinsertion	5/5	No
29	45	Left	Male	Accidental fall	1	Superficial complete	Radial head fracture	Transosseous suture + radial head arthroplasty	4/5	No

MRC, Medical Research Council; ORIF, open reduction and internal fixation; LCL, lateral collateral ligament; MCL, medial collateral ligament; N/A, not available

extended release of the triceps muscle from the posterior aspect of the humerus, the intermuscular septum, and subcutaneous tissue. In all these five cases, a prior decompression of the ulnar and radial nerves was conducted to allow musculotendinous mobilization (Fig. 2).

Postoperative treatment. Postoperative management entailed between three and six weeks of immobilization in a cast or a hinged brace in 26 of the 29 DTTRs. In the first two weeks, the position of immobilization ranged from full extension to 90° of flexion depending on the suture tension observed after the tendon reinsertion. According to the initial position flexion was increased progressively to obtain 90° of flexion within five weeks of surgery.

In 26 of the 29 DTTRs, passive exercises started after three to four weeks. In the remaining three elbows, passive exercises were allowed after the second postoperative day. In every DTTR active extension, exercises commenced between seven and eight weeks after surgery, whereas exercises against resistance were allowed after three to four months. Heavy manual works and sports activities were allowed six months after surgery.

Clinical assessment. All the patients were recalled for a follow-up when the clinical evaluation and functional results were evaluated by the administration of the Mayo Elbow Performance Score (MEPS),[22] the modified American Shoulder and Elbow Surgeons Score (m-ASES),[23] and the Quick Disabilities of the Arm, Shoulder and Hand score (QuickDASH).[24] The recovery of triceps strength was assessed using the scale for muscle strength-testing approved by Medical Research Council (MRC scale), which is based on a 0 to 5 scale.[25] Postoperative and follow-up radiographs were analyzed to assess intraoperative and postoperative complications, including fractures, anchor pullout, heterotopic ossification

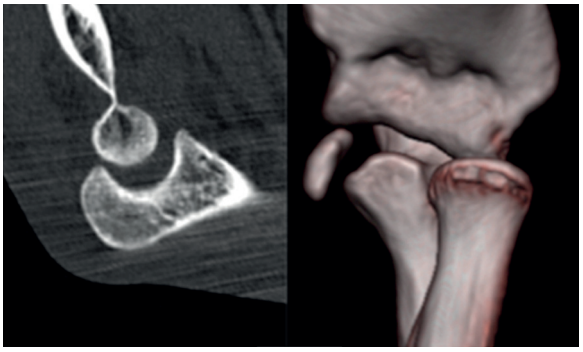

Fig. 2a

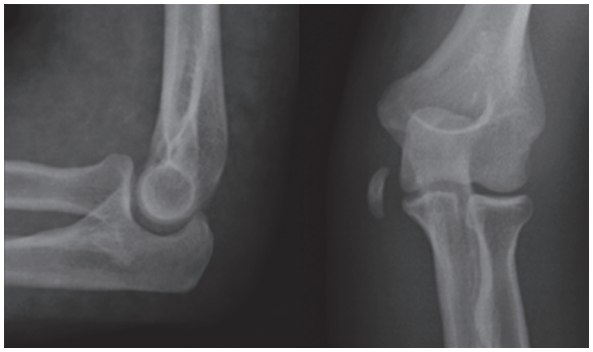

Fig. 2b

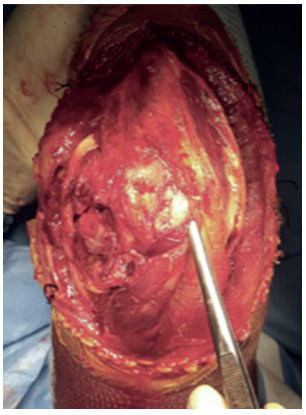

Fig. 2c

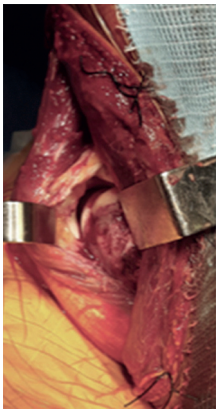

Fig. 2d

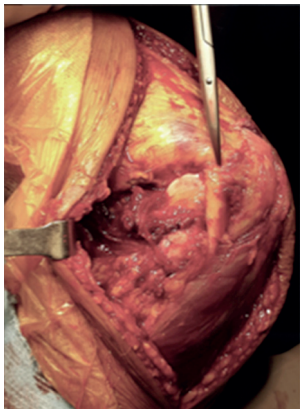

Fig. 2e

Fig. 2f

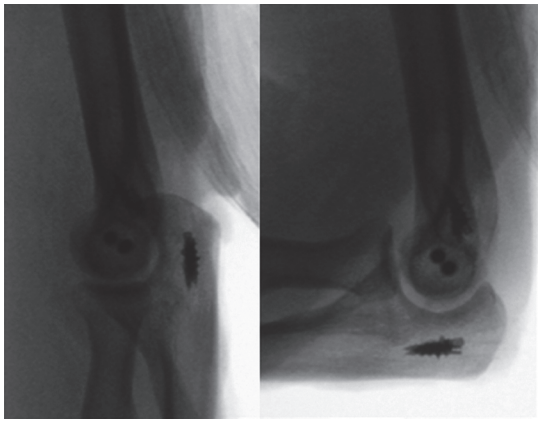

Fig. 2g

A 35-year-old male patient who sustained a simple elbow dislocation following a fall in a foreign country, where the reduction was performed in a local emergency room. a) Preoperative CT scans and b) radiographs performed in our institution show persistent elbow subluxation with the presence of a loose body due to a previous elbow trauma that had occurred at the age of 11 years. c) to e) Intraoperative photographs showing complete superficial rupture of the triceps tendon, and lateral collateral and medial collateral lesions. f) Intraoperative radiograph showing the use of suture anchors for ligamentous and tendinous repair. g) Intraoperative fluoroscopy showing articular congruency during flexion-extension.

(HO), olecranon osteophytes, and any further complication related to the associated acute osseous and ligament lesion.

Statistical analysis. Statistical analysis included the Kolmogorov–Smirnov test to compare the functional results of acute and chronic patients (i.e. those operated up to 30 days from injury and those thereafter), patients with or without associated injuries and with partial or complete muscle strength recovery. A statistically significant difference was considered for p-values < 0.05.

Results

Clinical evaluation. All patients except one were available for the follow-up evaluation. The patient who did not attend the last follow-up died of a medical condition unrelated to the elbow surgery. The mean follow-up in the remaining 27 patients (28 DTTRs) was 47.5 months (12 to 204).

The mean MEPS and QuickDASH scores were 94 (60 to 100) and 10 (0 to 52), respectively. The mean m-ASES was 94 (58 to 100). Range of movement in flexion-extension and pro-

nation-supination was full in all but one patient (one DTTR). According to the Mayo Elbow Performance Index (MEPI),[22] results were excellent in 21 DTTRs, good in five, and fair in two. Of the two patients (two DTTRs) in whom the MEPI was fair, one was a 77-year-old patient affected by polymyalgia rheumatica with an associated Mason type III radial head fracture; the second patient was a 63-year-old man who had an associated humeral head fracture.

The clinical evaluation of muscle strength recovery yielded a score of 4/5 in ten DTTRs and 5/5 in 18 DTTRs. Incomplete muscle strength recovery was associated with a full thickness tear in seven DTTRs, a complete superficial tear in two, and a partial superficial tear in one. In addition, four of the ten DTTRs with incomplete restoration of strength had an associated radial head fracture, and two had a high comorbidity. Of the DTTRs with complete muscle strength recovery, 13 had a full thickness tear, four had a complete superficial tear, and one had a full deep tear. Additionally, three of these 18 had associated injuries and two had a high comorbidity.

No significant differences in clinical outcomes were observed between patients with acute and chronic lesions (MEPS, $p = 0.37$; m-ASES, $p = 0.39$; QuickDASH, $p = 0.061$) and between patients showing partial and full recovery of muscle strength (MEPS, $p = 0.75$; m-ASES, $p = 0.51$; QuickDASH, $p = 0.057$). A significant difference was observed in the MEPS between patients with associated injuries (mean MEPS, 83 (60 to 100)) and those without (mean MEPS, 98 (85 to 100)) ($p = 0.046$), whereas no significant differences were observed in the m-ASES ($p = 0.067$) and QuickDASH ($p = 0.057$).

The demographic features, type of injury, surgical procedures, and clinical results are reported in detail in Table I.

Clinical complications. Two major complications were observed. One patient (one DTTR) in whom a suture anchor was used and who was affected by chronic renal failure sustained a rerupture caused by a fall one month after surgery. The rerupture was repaired primarily without further sequelae and the patients reported a good result at follow-up. A second patient aged 14 years developed a 20° loss of extension. This patient had a triceps rupture associated with a positive flake sign. An osteophyte of the olecranon and a dystrophic ossification of the tendon were observed on the CT scan after three years.

There were several minor complications. In one patient (one DTTR), a transient adverse reaction to the subcutaneous stitches (pain, reddening, and swelling) occurred; he was treated with nonsteroidal anti-inflammatory drugs, antibiotics, and rest, which led to the complete resolution of the symptoms. In one patient (one DTTR) with rheumatoid arthritis, a surgical wound dehiscence occurred and required repeated medication up to healing for about two months. The last patient had a reoperation to excise a keloid scar.

Discussion

The current investigation has shown that primary reinsertion of acute and chronic triceps tendon ruptures yields satisfactory clinical results in the vast majority of a general population. An incomplete recovery of muscle strength, which did not affect the clinical outcome, was observed in about one-third of patients, particularly when the triceps rupture was associated with other upper limb trauma.

DTTR is a rare injury. In reviewing 1014 tendon ruptures, Anzel et al[1] reported a prevalence of 0.8% of DTTR. More recently, a higher prevalence of triceps tendon tears (3.8%) was found in an MRI investigation, suggesting that the number of triceps tendon injuries is likely to be underestimated.[2] Professional athletes, including football players and bodybuilders, are more likely to sustain a DTTR than the general population, possibly due to their training regimen and the use of locally injected steroids, particularly in the case of olecranon bursitis or oral anabolic steroids.[7,9,13,16] Adolescent athletes with incompletely fused or recently fused physes and patients with congenital or metabolic disorders may also be susceptible to triceps tendon lesions.[4,11,26,27]

Surgery is considered the treatment of choice in acute and chronic complete or near-complete triceps tendon tears, as well as in a complete muscle belly or musculotendinous junction with a significant gap. The surgical treatment is also preferred in acute partial tears in high-demand patients or in cases in whom non-surgical treatment has failed.[5,10,15,21] However, as DTTRs mostly occurs among high-level athletes, the results of primary repair of acute triceps ruptures are mostly related to professional sports players,[6,7,9,13,16] while very few data are available on DTTRs in the general population.[4,15,17,20] In the largest case series of DTTRs in patients not involved in high-level sports activities, consisting of 16 patients with an associated fracture of the radial head, the clinical outcomes were not reported.[17] Recently, two studies reported on patients treated for DTTRs; however, only eight and seven patients were analyzed, respectively.[19,20]

The current investigation includes 29 DTTRs and represents, to the best of our knowledge, the largest series analyzing DTTRs in a general population. According to a DTTR classification, most of the lesions were insertional,[21] complete, and full-thickness avulsions affecting both the superficial and deep tendon layers. Isolated complete superficial and deep lesions were observed in six (21%) and one (3%) of our cases, respectively. In two cases (7%), the lesion was partial and involved the superficial tendon. The lateral expansion was involved in four cases (14%) and was always associated with a complete and full-thickness tear. Midsubstance tendon, musculotendinous junction, and muscle belly lesions were not found in this series. This finding may suggest that proximal lesions mostly affect professional athletes or patients with metabolic disorders, as previously reported,[4,6,16] whereas in the healthy general population the insertional lesions are most common.

Satisfactory clinical outcome was reported in 26 cases (93%), with no significant difference between patients with different types of lesions. As different types of injury were equally distributed in patients whether or not a full recovery in strength occurred, it can be inferred that, at least in the general population, the type of DTTR does not affect the prognosis. However, further investigations using a classification system like that adopted in this study are needed to analyze whether the

type of injury may affect the treatment and prognosis of triceps lesions.

Despite the high rate of satisfactory outcomes and the high functional scores achieved, a strength deficit persisted in ten DTTRs. Interestingly, six out of ten of these DTTRs were associated with additional injuries and/or comorbidities, compared with only five (28%) of those who fully recovered their muscle strength, a finding that suggests associated diseases may exert a negative effect on the clinical outcome.

Reruptures are the most common complication following primary repair of the triceps tendon, being reported in up to 25% of patients. However, most of the failures occurred in professional athletes or high-demand patients.[7,11,13,28] Balazs et al[28] reported a complication rate of 25% in a large, high-demand, military population affected by triceps ruptures that had been treated surgically. Traumatic rerupture due to falls was observed in 12.5% of cases within four months of surgery. In our study, a rerupture occurred in only one patient (3%), a much lower proportion than those observed in professional athletes. This patient suffered from chronic renal insufficiency and the rerupture was due to an anchor pullout following a fall one month after surgery. In similar patient populations, Sierra et al[18] and Kose et al[19] reported a rerupture rate of 6% and 0% in 16 and eight patients, respectively. Neumann et al,[20] in a series of seven patients, observed one early traumatic rerupture of the tendon due to the pullout of anchors. These findings suggest that reruptures in the general population are rare events while the high incidence of rerupture in professional athletes indicates that high-level sports activities may play a role in their aetiology. Steroid treatments and metabolic diseases may be predisposing factors to tendon rerupture, as occurred in our series.[4,13,29] Finally, since the majority of reruptures reported in the literature occurred within the first four months following surgery and were associated with a fall or heavy activities, a return to sports or manual work activities should be discouraged in the first six months after surgery, particularly in patients with additional risk factors.

The second complication found in this series was a mild elbow stiffness observed in a skeletally immature patient aged 14 years. The triceps tendon lesion in children is an extremely rare injury that has previously been reported in two patients treated with surgical and conservative treatment, respectively.[26,27] The clinical results were satisfactory in both patients, with no complications being reported.

The management of the late diagnosis of triceps rupture is still controversial and whether primary repair or reconstruction with augmentation has to be performed is yet to be elucidated. A missed diagnosis of DTTR in acute phase is not uncommon and, in a series of 22 patients, a delayed diagnosis occurred in 15 cases[15] in whom surgery was performed a mean of 172 days after injury. A primary repair was possible in only 40% of the cases, while a surgical reconstruction was needed in the remaining patients. As a satisfactory result was achieved in only 66% of the patients of the primary repair group, the authors concluded that the primary repair of the triceps tendon guarantees satisfactory results within three weeks of trauma but is less reliable in chronic cases.[15] In our series, the five patients in whom the diagnosis of DTTR was missed were treated in chronic phase with primary repair. All five patients achieved satisfactory clinical results with no significant differences in the clinical outcomes between the acute and chronic groups. However, in chronic cases, the surgical technique was more demanding and required additional surgical steps to allow the tendon reinsertion, including a wide release of the triceps heads from the bone, septa, and subcutaneous tissue, and the identification and protection of the ulnar and radial nerves.

This study has certain limitations. In particular, the retrospective nature of the multicentre study may affect the accuracy of data collection. However, due to the rarity of DTTRs, makes prospective investigation challenging. Second, our mixed-patients population included acute and chronic lesions and those with and without associated injuries. However, as in all patients, a primary tendon repair was performed, which allowed us to assess possible effects on the surgical outcomes of the time interval between injury and surgery and the presence of associated lesions.

In conclusion, primary repair of acute and chronic lesions of the distal triceps tendon in the general population yields satisfactory clinical results with a very low incidence of rerupture. A slight deficit of muscle strength with no clinical relevance may occur in about one-third of the cases. In chronic lesions, the surgical treatment requires an extensive release owing to tendon retraction. Nevertheless, even in this difficult group, a satisfactory result may be expected after tendon reconstitution. Associated traumatic lesions and comorbidity seem to affect the full recovery of muscle strength.

Take home message:

- Few studies report the results of distal triceps ruptures (DTTRs) in the general population.
- Primary repair of acute and chronic DTTRs in the general population yields satisfactory results.
- Low rerupture and complication rate for surgically treated DTTRs.

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