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Original article

Impact of TFCC injuries combined with distal radius fractures on long-term results of hand function: a comparative study

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Abstract

Introduction Fractures of the distal metaepipheseal fractures of the radius (DMER) have a leading place in the overall structure of upper limb injuries. DMER fractures are frequently associated with soft- tissue injuries of the wrist joint, and namely, the triangular fibrocartilage complex (TFCC). The additional use of arthroscopy of the wrist joint in the treatment of patients with a DMER fractiures reduces the duration of recovery of patients and improves the result of their treatment. **The aim** of the study was to determine the effect of arthroscopic surgical treatment of TFCC injuries during bone osteosynthesis for DMER fractures on the functions of the upper extremities (extension/flexion of the hand, hand grip strength, pronation/supination of the forearm, DASH index). **Materials and methods** The study included 68 patients with DMER fractures, who were divided into 2 groups, depending on the treatment of the fracture. After reduction and osteosynthesis, all patients underwent arthroscopy of the wrist joint. If TFCC injury was detected, either a debridement or a TFCC suture was performed. **Results** TFCC injury was detected in 61.7 % (n = 42). Debridement was performed in 42.9 % (n = 18); suture using the inside-out technique was performed in 47.6 % (n = 20); one patient underwent reinsertion. After 6 months, the function of flexion and extension of the hand was significantly worse in patients with combined TFCC and DMER injuries, but after 12 months, the indicators were similar. The strength of the hand grip and the rotational function of the forearm did not differ between the subgroups. The subjective assessment of DASH after 6 months was worse in the group with TFCC injury, but after 12 months the results were similar. **Conclusion** Surgical treatment of TFCC injury in intra-articular fractures of the distal radius contributes to the restoration of the upper limb function to a premorbid level 12 months after surgical treatment.

Keywords: distal radius, fracture, injury, triangular fibrocartilage complex, arthroscopy

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INTRODUCTION

Fractures of the distal metaepiphysis of the radius (DMER) occupy a leading place in the structure of fractures of the upper limb [1, 2]. DMER fractures are associated with damage to the soft tissues of the wrist joint, especially the triangular fibrocartilage complex (TFCC) [3–6]. Recovery of soft-tissue injuries is extremely important, since they may lead to instability of the wrist joint and chronic pain syndrome [3, 7]. It has been described that arthroscopic support during osteosynthesis of DMER fractures improves the treatment outcome (both objective and subjective) and helps to reduce the period of patient’s rehabilitation [3, 8, 9].

The triangular fibrocartilaginous complex (TFCC) is a structure located on the ulnar side of the wrist [10]. It consists of cartilaginous and ligamentous elements that provide axial load transfer and stability of the distal radioulnar joint.

The first mention of the term "TFCC" was published by Palmer and Werner in 1981. The authors divided what seems a homogeneous structure into the central articular disc, dorsal and volar radiocarpal ligaments, meniscus homologue, ulnar collateral ligament, and the sheath of the extensor carpi ulnaris [11].

Blood is supplied to TFCC mainly by three arteries: the palmar and dorsal branches of the ulnar artery, the dorsal branch of the anterior interosseous artery, and the palmar branch of the anterior interosseous artery [12]. It was experimentally established that these vessels feed 10 to 20 % of the disc periphery [13]. The peripheral (palmar, ulnar, and dorsal) portions of the TFCC are supplied by those arteries that provide healing to these anatomical regions. On the contrary, it is better to use debridement in tears of the central and radial parts of the TFCC due to the low density of the vascular bed.

TFCC performs three important functions. It stabilizes the distal radioulnar joint, takes up to 20 % of the axial load on the wrist, and acts as an ulnar stabilizer of the wrist [10].

Injury to the TFCC, whether chronic or acute, results in pain on the ulnar side of the wrist [14]. However, taking into account the anatomical diversity of this area, differential diagnosis is very often difficult in pain syndrome [15–17].

TFCC lesions can occur in three different areas. In the horizontal plane, which is the peripheral part or its insertion, the injury is usually associated with a fall onto an extended forearm and an axial load.

The incidence of TFCC injuries, according to the literature, averages 43 % (range, 17–60 %) [18,19]. Attempts to identify prognostic factors of such soft-tissue injuries, among which radiographic parameters and fracture type were studied, did not lead to significant success [18].

A classification of injuries was described by Palmer et al. and distinguishes between traumatic (class 1) and degenerative (class 2) lesions. However, TFCC injuries are often combined and may not always fit into the classification described by Palmer.

Acute TFCC tears are subdivided into central cartilaginous disc perforation without distal radioulnar instability (type 1A); TFCC injury due to ligament avulsion from the fossa or fracture through the styloid process of the ulna (type 1B); distal avulsion at the beginning of the ulna-lunate, ulna-capitate, and ulna-triquetral ligaments (type 1C); radial evulsion (type 1D).

Degenerative TFCC tears have several patterns: TFCC wear and tear (degeneration) and thinning (type 2A), TFCC wear with chondromalacia lunate and/or ulna (type 2B), TFCC perforation with chondromalacia lunate and/or ulna (type 2C), perforation TFCC with lunate and/or ulnar chondromalacia and semilunar-triquetral ligament rupture (type 2D), TFCC perforation with chondromalacia of the lunate and/or ulna, semilunar-triquetral ligament perforation and ulnar arthritis (type 2E).

The influence of concomitant injuries of the wrist joint on the results of DMER fracture treatment was studied by Swart et al. in 42 patients [18]. Twelve months after the operation, the authors did not find any significant differences in subjective DASH score (Disabilities of the Arm, Shoulder and Hand) and objective assessments (range of motion, hand grip strength) between the groups of patients with and without soft- tissue injury. The researchers concluded that LSLI and TFCC lesions do not lead to serious consequences 12 months after surgery. Despite this, there is no consensus on the impact of LSLI and TFCC lesions on the long-term outcome of treatment.

The neutral forearm position in the frontal, sagittal, and axial MRI views is most commonly used to diagnose TFCC injuries and determine the need for diagnostic arthroscopy. MRI occupies a leading role in the diagnosis of TFCC lesions; however, the use of this method is impossible in intra-operative conditions [20–23].

Interosseous ligament and TFCC injuries may not be seen on plain radiographs, while arthroscopy during fracture fixation is able to detect such soft-tissue injuries. According to del Piñal et al., many partial ruptures of the navicular-lunate ligament can transform into a complete rupture in the early onset of movement in the joint in the postoperative period. Arthroscopy, on the other hand, may identify this injury and enables the surgeon to restore it even in the acute period [9, 24].

Purpose of the study was to determine the effectiveness of arthroscopic surgical treatment of TFCC injuries during plating of DMER fractures on the functions of the upper limb (extension/flexion of the hand, hand grip strength, pronation/supination of the forearm, DASH score).

MATERIALS AND METHODS

The study was approved by the local ethics committee of the State Budgetary Institution of Health Loginov MKNTS DZM (protocol No. 2/2013 dated 01.02.2013). The recruitment of patients was carried out in the period from 2012 to 2020 at the clinical bases of the Faculty for Fundamental Medicine of the Moscow State Lomonosov University.

Inclusion criteria for the study were age ≥ 18 years; isolated fracture DMER; ≤ 7 days since the injury; comminuted intra-articular nature of the DMER fracture with displacement of the articular surface of the radius ≥ 2 mm; the possibility of performing arthroscopy of the wrist joint.

Criteria for exclusion from the study were Gustilo-Anderson type II-III open fractures; pathological fractures of DMER; repeated fractures of DMER; decompensated comorbidities.

A total of 68 patients were included in the study. Upon admission to the hospital, all patients underwent radiography of the wrist joint in two standard (frontal and lateral) and oblique projections. If the patient had a multi-comminuted fracture, CT of the wrist joint was performed (n = 22, 32.3 %).

The patients included in the study were divided into two groups of 34 patients each. The study included patients with type B and type C fractures according to the AO/ASIF classification [25]. The characteristics of the patients are presented in Table 1.

In patients of the first group, the wrist joint was fixed with an external fixator upon admission to the hospital, followed by joint distraction up to 3–5 mm. Next, plating osteosynthesis and arthroscopic control were performed. In the second group, patients underwent closed manual reduction of fragments at the first stage, after which a dorsal plaster splint was applied from the upper third of the forearm to the metacarpophalangeal joints. A few days later, the patients' wrist joint was fixed with an external fixator. Next, large fragments were reduced with wire fixation and then arthroscopy was performed.

While performing arthroscopy, the TFCC was examined for the presence of lesions. In the first group, they were detected in 58.8 % (20 out of 34 patients), in the second in 64.7 % (22 out of 34). For both groups, they were found in 61.7 % (42 out of 68) patients. The distribution of patients depending on the type of TFCC injury according to Palmer is presented in Table 2. No TFCC injury was detected by arthroscopy in 41.2 % (14 out of 34 patients) of the first group and in 35.3 % (12 out of 34 patients) of the second group; total only 38.3 % (26 out of 68) of patients.

For TFCC injury detected in some patients (7 in the first and 11 in the second group; 18 in total), debridement was performed. In particular, hemarthrosis was eliminated, small fragments of cartilage, elements of the soft tissues of the joint and bones were removed. Some patients (11 in the first group, 9 in the second group; 20 in total) underwent TFCC suture using the inside-out technique, as shown in Figure 1 [26]. In one patient from the second group, a complete detachment of TFCC was detected, for which reinsertion was performed.

Table 1

Demographic and clinical characteristic of the patients included in the study

		Group 1 (n = 34)			Group 2 (n = 34)		
Demographic characteristics							
Average, age, years		50.05 ± 14.11			51.28 ± 17.48		
Age range, years		18–78			19–80		
Gender	Females, n	12			14		
	Males, n	8			8		
AO/ASIF fracture type							
Type B fracture, n		20			19		
B1-B2-B3, n		2	6	12	1	8	10
Type C, n		14			15		
C1-C2-C3, n		3	6	5	5	6	4

Table 2

Distribution of patients according to the type of TFCC injury (arthroscopic findings)

Type TFCC injury (Palmer)	1A			1B			1C		
Subgroup of patients with TFCC injury	Group 1 (n = 20)	Group 2 (n = 22)	Total (n = 42)	Group 1 (n = 20)	Group 2 (n = 22)	Total (n = 42)	Group 1 (n = 20)	Group 2 (n = 22)	Total (n = 42)
Number of patients, n (%)	7 (35.0)	8 (36.4)	15 (35.7)	6 (30.0)	6 (27.3)	12 (28.6)	7 (35.0)	8 (36.4)	15 (35.7)
TFCC suture	4	4	8	3	2	5	4	3	7
TFCC reinsertion	–	–	–	–	1	1	–	–	–
Debridement	3	4	7	2	4	6	2	5	7

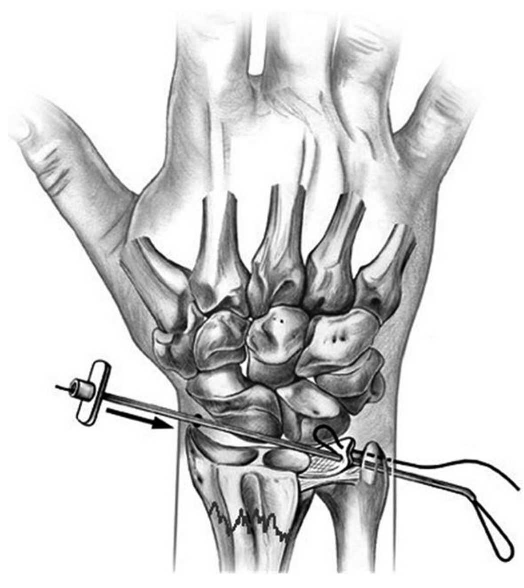

Fig. 1 TFCC inside-out suture [26]

Hand function was assessed by objective and subjective parameters six and 12 months after surgery. Objective indicators were the strength of the hand grip and the range of motion in the joint. The index of hand function after surgery was expressed as a percentage of the index of a healthy limb. The DASH questionnaire was used for subjective assessment. An excellent result was the range from 0 to 15 points; for good- from 16 to 29 points; for borderline (or fair result) from 30 to 39 points; a score > 40 points corresponded to a poor result.

Objective and subjective long-term outcomes of treatment in subgroups of patients with and without TFCC injury in groups were compared. A comparative analysis between debridement and TFCC suture was not performed due to a small number of patients for separate statistical processing.

Statistical analysis was carried out using the Statistica version 12.5 and Jamovi version 2.2.2. The Mann-Whitney U-test was used to determine differences in outcomes between subgroups with associated TFCC injury and DMER fracture and isolated DMER fracture. Spearman's correlation analysis was used to determine the dependence of the type of TFCC injury according to Palmer on the type of fracture according to AO/ASIF.

RESULTS

There was no correlation between TFCC injury according to Palmer and DMER fracture type according to AO/ASIF: Spearman correlation coefficient Rho = 0.1 (p = 0.12).

When evaluating the rotational movements of the forearm (pronation and supination), flexion and extension functions, and hand grip strength, there were no significant differences between patients with and without TFCC injury in DMER fractures. The critical value of $p < 0.05$ was not reached in statistical analysis after 6 and 12 months. However, comparing such objective parameters as flexion and extension of the wrist, significantly worse indicators of function were revealed in the group of patients who had TFCC lesions detected by arthroscopy compared with patients who did not have this injury. At 12 months, the scores were similar between the groups.

At 6 months post-surgery, subjectively better functioning (DASH questionnaire) of the injured limb was reported by those patients who did not have concomitant damage to the TFCC. 69.2 % of patients (n = 18) without TFCC injury had “good” or “excellent” DASH results, while those with injury had 47.6 % (n = 20). At 12 months, DASH scores were similar between the two groups: 76.9 % (n = 20) and 76.2 % (n = 32), respectively.

Results and statistical analysis are presented in Table 3.

Table 3

Objective and subjective findings in patients with an association of DRF and TFCC injury and only with a DRF at 6 and 12 months after surgery

Limb function (% from the healthy side or points)	Mean ± standard deviation		Mann–Whitney U test, p-value
	Association of TFCC injury with DMER fracture		
	yes (n = 42)	no (26 from 68)	
Strength of hand grip, 6 months	78.94 ± 11.22	75.26 ± 12.47	0.65
Strength of hand grip, 12 months	91.44 ± 8.49	90.47 ± 8.48	0.72
Hand extension, 6 months	66.13 ± 8.75	74.85 ± 9.25	0.01
Hand extension, 12 months	80.83 ± 8.45	83.20 ± 7.87	0.58
Hand flexion, 6 months	69.04 ± 8.26	81.74 ± 9.93	0.03
Hand flexion, 12 months	88.91 ± 7.63	90.01 ± 8.04	0.52
Forearm pronation, 6 months	74.6 ± 8.40	75.1 ± 9.54	0.72
Forearm pronation, 12 months	88.1 ± 8.99	90.6 ± 2.12	0.70
Forearm supination, 6 months	72.3 ± 11.0	74.4 ± 8.22	0.66
Forearm supination, 12 months	93.7 ± 6.10	93.5 ± 5.63	0.67
DASH, 6 months	15.8 ± 3.85	11.42 ± 2.46	0.01
DASH, 12 months	8.95 ± 2.12	8.32 ± 3.11	0.06

DISCUSSION

Despite the fact that concomitant injury to the TFCC in a DMER fracture occurs in 35–70 % of cases, there is no unequivocal opinion on the impact of this injury on the outcome of patient treatment [5, 18, 27, 28].

As a rule, the anatomical integrity of the radius is a primary objective for restoration, and often the treatment of soft tissue injuries of the wrist joint falls into the background [5]. The authors of the works published on the topic of traumatic ruptures of TFCC describe an increasing use of surgical methods, especially in patients with a high level of physical activity (athletes, military personnel, etc.) [6]. Thus, Ko J.F. et al. concluded about the importance of arthroscopic treatment of TFCC ruptures in athletes [7]. In the work of Papapetropoulos P.A. et al. arthroscopic treatment of TFCC injuries in professional athletes was defined as the "gold standard" [29]. Most authors agree that the advantages of arthroscopy are its minimal invasiveness and the possibility of anatomical restoration of soft-tissue injuries, including the TFCC, which determines the stability of the radioulnar joint. However, analyzing long-term results, the authors also stated the persistence of pain in the area of the wrist joint [29].

Не достигнут консенсус и в вопросе необходимости выполнения шва TFCC при различных типах его повреждения по Palmer. Большая часть исследователей, изучавших данную проблему, считает, что разрывы по типу 1A по Palmer не требуют выполнения шва [30]. Однако разрывы по типу 1B-1D «могут потребовать хирургического лечения», что также не является строго рекомендованным [29, 31]. В исследовании Lindau T.R. и соавт. показано, что полный периферический разрыв TFCC у пациентов с переломами ДМЭЛК приводит к сохранению нестабильности в дистальном лучелоктевом суставе через год после операции, что значительно влияло на субъективную оценку пациентом результата лечения [32].

No consensus has been reached on the need to perform a TFCC suture for various types of injury according to Palmer. Most researchers who studied this problem believe that Palmer type 1A tears do not require a suture [30]. However, ruptures of type 1B-1D "may require surgical treatment", which is also not strictly recommended [29, 31]. The study by Lindau T.R. et al. shows that a complete peripheral rupture of the TFCC in patients with DMER fractures leads to the persistence of instability in the distal radioulnar joint one year after surgery, which significantly affected the patient's subjective assessment of the treatment result [32].

Our study shows that the results, both objective and subjective, assessed after 6 months are worse in those patients who have a combined TFCC injury and a DMER fracture. This can be explained by the fact that, despite the minimally invasiveness of the interventions performed, the volume of the operation still extensive. Therefore, the trauma increases and in the future may affect the satisfaction by the outcomes. On the other hand, all parameters were similar in patients of both groups after 12 months post-surgery. The rehabilitation period completed and the patients returned to normal physical activity.

CONCLUSIONS

1. Arthroscopy of the wrist joint is able to evaluate the possibility of surgical repair of TFCC in case of its combined injury with DMER fractures. Surgical treatment of TFCC injury in intra-articular fractures of DMER contributes to the restoration of the function of the upper limb to its original level 12 months after surgical treatment.

2. TFCC tear does not affect forearm rotational function and hand grip strength at 6 and 12 months, but impairs flexion and extension function at 6 months postoperatively. However, a complete recovery of the function of the upper limb was noted in surgical treatment of TFCC injuries after 12 months, which allows returning to the initial level of activity.

3. Injury to the TFCC worsens the subjective assessment of limb function (DASH) 6 months after surgical treatment, but there are no statistical differences in the subjective assessment of the function of the upper limb after 12 months.

4. There is no relationship between the type of TFCC injury according to Palmer and the type of DMER fracture according to AO/ASIF.

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