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ORIGINAL ARTICLE

Effect of untreated triangular fibrocartilage complex (TFCC) tears on the clinical outcome of conservatively treated distal radius fractures

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Abstract
Objective The purpose of this study was to investigate the effect of untreated triangular fibrocartilage complex (TFCC) tear on the clinical outcome of conservatively treated distal radius fractures.
Materials and methods This prospective study comprised 47 consecutive patients who presented at our clinic between January 2009 and January 2010 with displaced radius distal fracture and were treated with closed reduction and casting. During the first 15 days of treatment, all patients underwent wrist MR imaging to detect traumatic TFCC tears. At the final follow-up, all patients were evaluated with Mayo wrist function score and wrist radiographs. Patients were divided into two groups according to presence of TFCC tear, and two groups were analyzed statistically.
Results The mean follow-up period was 38.9 ± 3.5 months (range 36–48). TFCC tear was detected in 24 cases, and remaining 23 cases had no TFCC tear. Both groups were statistically similar regarding age ($p = 0.574$), gender ($p = 0.108$), dominant side involvement ($p = 0.339$), fracture type ($p = 0.709$) and immobilization period ($p = 0.514$). According to Mayo wrist score, excellent results were obtained in 21 (44.7 %) cases, good in 16 (34.0 %) and satisfactory in 10 (21.3 %). No significant difference was observed between groups in wrist function scores ($p = 0.451$). Radiographic measurements were similar between groups (radial length $p = 0.835$, volar til $p = 0.464$, radial inclination $p = 0.795$).
Conclusions Traumatic TFCC tears which are frequently seen together with distal radius fractures do not affect the long-term functional results. Therefore, further diagnostic tests and treatment of TFCC tears in patients with stable distal radius fractures may be unnecessary. However, it should be borne in mind as a reason for continuing wrist pain and instability after distal radius fractures despite proper radiologic recovery.

Keywords Radius distal fractures · Triangular fibrocartilage complex · Conservative treatment

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Introduction

In the treatment of distal radius fractures, providing anatomic reduction in the distal radius (reconstruction of radial height, radial tilt, radial inclination and integrity of the joint surface) and protection of obtained reduction until the completion of fracture union play a key role in achieving successful functional outcomes [1–5]. Several factors such as type and stability of the fracture, concomitant injuries,

age and expectations of the patient are taken into consideration when deciding which treatment method should be selected for a particular patient [1, 3, 5]. Currently, a wide variety of treatment methods are used in the treatment of distal radius fractures. Closed reduction and casting, closed reduction and percutaneous pinning, open reduction and fixation with plate and screws (dorsal or volar) or external fixation (bridging or non-bridging) is the most commonly used treatment methods [1–3, 5, 6]. Although distal radius fractures are very common, no consensus has yet been reached on the ideal treatment method that gives the best functional results and no evidence-based treatment algorithm has been established.

There are several studies that report satisfactory results with both surgical and conservative treatment methods. In some patients, despite good radiologic results have been obtained, functional impairments particularly the wrist pain, instability and restriction of motion have been observed [7, 8]. Thus, it has been proposed that providing anatomic integrity per se will not be sufficient for a good functional result, and soft tissue injuries associated with distal radius fractures may have an effect on the final clinical outcome. Depending on the severity and mechanism of injury, various soft tissue injuries may accompany distal radius fractures. The most frequently encountered of these injuries is the triangular fibro-cartilage complex (TFCC) tear [2, 7]. TFCC tears have been detected up to 80 % of patients with displaced distal radial fractures [9–12]. However, in stable fractures, in which an appropriate anatomic reduction has been provided with closed reduction and casting, TFCC tears are often not taken into account. The hypothesis of this study was that distal radius fractures with a TFCC tear have worse clinical results compared to those lack it. The purpose of this study was to investigate the effect of untreated TFCC tear on the clinical outcome of conservatively treated distal radius fractures.

Materials and methods

This prospective study comprised 52 consecutive patients who presented at our clinic between January 2009 and January 2010 with displaced radius distal fracture and were treated with closed reduction and casting. Any case of open fracture, pathological fracture, polytrauma patients or those with neurologic or psychiatric problems which would prevent them following the rehabilitation program were excluded from the study. Furthermore, patients with previous history of ipsilateral hand, wrist and upper extremity fractures, and disease or abnormality of the upper limb which would preclude clinical and functional evaluations were also excluded. This prospective study was carried out in accordance with the ethical standards laid down in the 1964 declaration of Helsinki and its later amendments. All patients gave their informed consent prior to their inclusion in the study.

All patients underwent closed reduction and casting under conscious sedation at initial admission, and post-reduction radiographs were evaluated according to the following reduction criteria; radial shortening <2 mm, change in radial inclination <5°, change in radial tilt <10° and 1–2 mm articular step-off [1, 3]. Fractures that we could not achieve in these acceptable reduction criteria or fractures initially accepted as unstable such as radial styloid fracture, volar or dorsal Barton fractures, or unstable Smith fractures were also excluded, and surgical treatment was chosen for those patients. The wrist was immobilized in long-arm plaster cast with elbow in 90° of flexion in neutral position and wrist in ulnar deviation and flexion. The fracture displacement and healing were monitored weekly and patients who had loss of reduction were remanipulated, and cast was changed. The long-arm cast was switched to short-arm cast upon completion of 4 weeks, and elbow motion including flexion extension and rotational movements were started and encouraged. After the completion of radiographic and clinical union, the cast was removed and wrist rehabilitation was started. All patients had home-based physiotherapy and performed ROM exercises at home. To strengthen the grip strength, they used sponge ball clenching as many as they can perform. To obtain wrist range of motion (ROM), gradual flexion, extension, ulnar and radial deviation exercises were told.

During the first 15 days of treatment, all patients underwent wrist MR imaging. MRI was performed on a superconducting 1.5 T MRI unit (Philips Gyroscan ACS-NT, Netherlands). Patients were examined using a local receiver coil surrounding the wrist that placed at the patient's side. Receive-only surface coils were used for image acquisition. Matrices varying 192 × 256 to 256 × 512 and fields of view varying from 10 to 15 cm were used. Control T1-weighted (TR 450 ms, TE 20 ms) transverse, coronal (510–14 ms flip angle 25) and sagital T2 SPIR (TR 3413 ms, TE 90 ms) images were obtained with all images slice thickness of 3 mm/interslice gap 0.3 mm. Wrist MRI was evaluated by two independent radiologists who were specialist on musculoskeletal radiology at separate times, and any discrepancy was subsequently resolved by consensus. The traumatic TFCC tears were evaluated according to Palmers classification and distal radial fractures according to the Frykman classification [13]. Direct radiographic measurements were performed on antero-posterior and lateral wrist projections and included volar tilt, radial length and radial inclination. Normal values were defined as between −2 and 28° for radial volar tilt, 16–30° for radial deviation and 8–14 mm

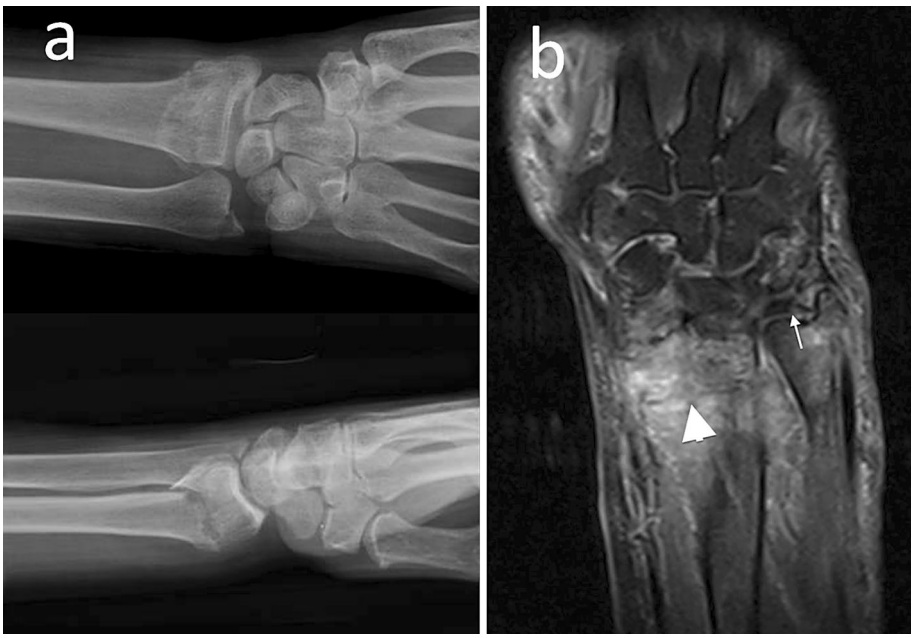

Fig. 1 **a** Antero-posterior and lateral wrist radiographs of a 43-year-old male showing distal radius fracture. **b** Coronal T2-weighted wrist MRI of the same patient showing the fracture (*thick arrow*) and TFCC tear (*thin arrow*)

for radial length. The wrist ROM was measured with a goniometer and compared with the healthy contralateral wrist. The grip strength of both hands was measured with a hand dynamometer according to the recommendations of American Society of Hand Therapists. The Mayo wrist function scoring system was used in the evaluation of the functional results [14].

Continuous variables were stated as mean and standard deviation and categorical variables as percentages and frequency distribution. Patients were divided into two groups according to presence of TFCC tear, and two groups were analyzed statistically. Mann–Whitney *U* test and χ^2 tests were used to compare the independent samples. A p value <0.05 was accepted as significant.

Results

Of the 52 patients, five patients were lost in follow-up, and analyses were performed on the remaining 47 patients (28 female, 19 male) who complied with calls to follow-up examinations (90.3 % follow-up rate). The mean age of the patients was 55.6 ± 12.1 years (range 24–87). The mean follow-up period was 38.9 ± 3.5 months (range 36–48). A TFCC tear was determined in 24 cases (Group A), and remaining 23 cases (Group B) had intact TFCC (Fig. 1). According to Palmer classification, five cases had Type 1A, 17 cases had Type 1B, one case had Type 1C and one case had complex TFCC tear. Both groups were statistically similar regarding age ($p = 0.574$), gender ($p = 0.108$), dominant side involvement ($p = 0.339$), fracture type ($p = 0.709$) and immobilization period ($p = 0.514$) (Table 1). According to Mayo wrist score, excellent results were obtained in 21 (44.7 %) cases, good in 16 (34.0 %) and satisfactory in 10 (21.3 %). No significant difference was observed between groups either in total functional scores or in separate analyses of each part of the score. Final radiographic evaluations and measurements were similar between groups for each parameter. Results are summarized in Table 2.

Table 1 Comparison of demographic and clinical caharacteristics

Variable	Group A (*n*:24)	Group B (*n*:23)	Significance (*p* value)
Age (years ± SD)	54.6 ± 11.4	56.6 ± 13.0	0.574
Sex (M/F)	7 M/17F	12 M/11F	0.108
Dominant side involvement (D/ND)	8D/16 ND	10D/13ND	0.339
Frykman classification			
Type 1	–	1	0.709
Type 2	–	1	
Type 3	3	3	
Type 4	–	1	
Type 5	5	6	
Type 6	3	1	
Type 7	3	3	
Type 8	10	7	
Immobilization period (days ± SD)	49.0 ± 8.7	47.5 ± 6.9	0.514

M male, *F* female, *D* dominant, *ND* non-dominant

Table 2 Summary of results at the final follow-up

Variable	Group A (*n*:24)	Group B (*n*:23)	Significance (*p* value)
Follow-up (months ± SD)	39.1 ± 3.8	38.6 ± 3.1	0.620
Radiology (final follow-up)			
Volar tilt (degree ± SD)	0.8 ± 9.0	3.0 ± 11.3	0.464
Normal versus abnormal volar tilt	16 N/8AN	19 N/4AN	0.180
Radial length (mm ± SD)	8.2 ± 4.1	7.9 ± 5.3	0.835
Normal versus abnormal radial length	18 N/6AN	14 N/9AN	0.234
Radial inclination(degree ± SD)	17.7 ± 6.0	17.2 ± 7.8	0.795
Normal or abnormal radial inclination	19 N/5AN	17 N/6AN	0.467
Mayo wrist score (final follow-up)			
Pain intensity	22.0 ± 2.5	22.8 ± 2.5	0.319
Range of motion	18.7 ± 6.12	17.1 ± 4.9	0.339
Grip strength	20.6 ± 5.3	20.2 ± 5.1	0.791
Functional status	22.7 ± 2.5	23.2 ± 2.4	0.451
Total score	84.1 ± 8.4	83.4 ± 7.6	0.770

N normal, *AN* abnormal

Discussion

In this study, the effect of untreated TFCC tear on the clinical outcome of conservatively treated distal radius fractures and its natural course were investigated. Results of this study showed that untreated TFCC tears do not affect the final clinical outcome in the treatment of stable distal radius fractures that were treated in accordance with proper reduction criteria. Therefore, advanced imaging techniques used to detect the TFCC tears were found to be unnecessary at initial admission. Thus, further aggressive acute treatment of TFCC tears does not seem to be justified. However, in patients with continuing wrist pain despite an adequate radiologic recovery, TFCC tears should be kept in mind, and proper further diagnostic testing should be constituted and further treatment should be planned.

Benefits of detection and aggressive treatment of TFCC tears accompanying distal radius fractures is still controversial. There are few studies which have followed up untreated TFCC tears accompanying distal radius fractures in current literature. Mrkonjic et al. [12] followed 51 patients who had TFCC tear which was detected by arthroscopy but left untreated. In their series, only one patient had to undergo surgical treatment for chronic wrist pain and instability after a mean duration of 13- to 15-year follow-up. Although, a standard treatment protocol was not applied to patients in that study and there was no control group without a TFCC tear, these findings are consistent with our study.

On the other hand, there are studies suggesting that TFCC tear seen together with distal radius fracture causes instability of the wrist and this is the reason for chronic pain, instability and functional impairment. Cheng et al. [7] examined 22 patients treated for chronic wrist pain following distal radius fracture and determined TFCC tear as the main etiology in 10 patients, almost half of the patients. There are also cadaver studies showing that TFCC tears cause radio-ulnar instability [15, 16]. Authors who have considered TFCC tears have an effect on functional results have recommended using wrist arthroscopy both for monitoring the congruity of the joint surface reduction and simultaneous treatment of TFCC tears. These authors claim that this strategy (simultaneous treatment of both bony and soft tissue injuries) gives the best clinical outcome and reported excellent results [17–19]. However, those studies did not include a patient group that was left untreated.

Some authors claim that not only the presence of TFCC tear but also the type of tear is significant over the functional outcomes. Lindau et al. detected 43 TFCC tear out of 51 patients with distal radius fractures and followed these patients for 1 year. At the end of a 1-year follow-up period, radioulnar instability was determined in seven patients of 32 patients with partial or peripheral TFCC tears and in 10 of 11 patients with total TFCC tears. Lower functional result scores were obtained from patients with instability [11]. A standard treatment method was not used in that study; some patients were treated conservatively, some with external fixator and some with open reduction internal fixation.

This study has some strengths and limitations. The current study differs from previous studies in that a single treatment method was used on all patients, thus variables which may affect the functional results regarding treatment method was eliminated. Furthermore, most of the other variables which may affect functional results were also similar between groups. Relatively small number of patients was examined and all types of TFCC tears were

placed in the same category. In this series, no patients gave a history of previous wrist complaints and/or history of trauma; however, there may be some cases that have previous asymptomatic TFCC pathologies. In a study by Iordache et al. [20] in asymptomatic volunteers, TFCC tears were found in 22.3 % of wrists and an additional 37.8 % of the volunteers had TFCC signal abnormalities. Therefore, not all TFCC pathologies can be attributed to the injury at the time of distal radius fracture.

In conclusion, traumatic TFCC tears which are frequently seen together with distal radius fractures do not affect the long-term functional results. Therefore, further diagnostic tests and treatment of TFCC tears in patients with stable distal radius fractures may be unnecessary. However, it should be borne in mind as a reason for continuing wrist pain and instability after distal radius fractures despite proper radiologic recovery. Further studies with large number of patients are required to delineate which patients and which type of TFCC tears should be addressed for simultaneous surgical repair at the time of injury.

Conflict of interest Authors have no conflict of interest to disclose.

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