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Arthroscopic assissted repair of triangular fibrocartilage complex tears

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Abstract
Background: The TFCC is one of many structures on the ulnar aspect of the wrist. TFCC is a critical component of wrist mechanics, serving important functions in both load transmission and DRUJ stability. TFCC tears are common sources of ulnar-sided wrist pain which are frequently diagnosed simply as wrist sprains. Purpose: This study to assess functional outcome of arthroscopic repair of TFCC tears.
Methods: During the period between May 2015 and February 2017, we conducted a prospective study to assess functional outcome of arthroscopic management of TFCC tears. The study includes ten patients with torn TFCC (age between 18-60 years). Athletes and non-athletes with failure of conservative treatment in alleviation of patient's Symptoms after 3 months. They underwent arthroscopic Repair. Presurgery and postsurgery the visual analogue scale (VAS) was recorded for each case. Patient-rated wrist and hand evaluation (PRWHE) scores were determined at baseline (before arthroscopy) and after arthroscopy. The mean duration of follow-up was 10.93 months.
Results: The VAS improved from a mean of *6,58*to a mean of*1,8* and Mean PRWHE total score declined from 49 of 100 at baseline to 25of 100.
Conclusion: This study proves that arthroscopic management of TFCC injuries results in a predictable satisfactory functional outcome.

Keywords: TFCC – DRUJ - wrist arthroscopy – central tears- peripheral tears

Introduction

Triangular fibrocartilage (TFC) injuries are increasingly recognized as a cause of ulnar-sided wrist pain and may be particularly disabling in the competitive athlete. They may be the result of acute trauma or repetitive use, such as racquet sports [1]. The differential diagnosis includes lunotriquetral instability, distal radioulnar joint (DRUJ) ligament injury, tendinosis of the flexor or extensor carpi ulnaris (ECU) tendons, and ulnar-carpal abutment [2].

The TFCC is the primary stabilizer of the DRUJ [3] and is formed by the discus articularis proper, the ulnocarpal ligaments, the soft tissue, and the distal radioulnar ligaments that converge from separate origins on the radius to attach onto the ulna at the foveal region at the base of the ulnar styloid and along the ulnar styloid process itself [4] (Fig. 1). From a vascular injection study of the TFCC, we know that the peripheral margin of the TFCC is well-vascularized [5].

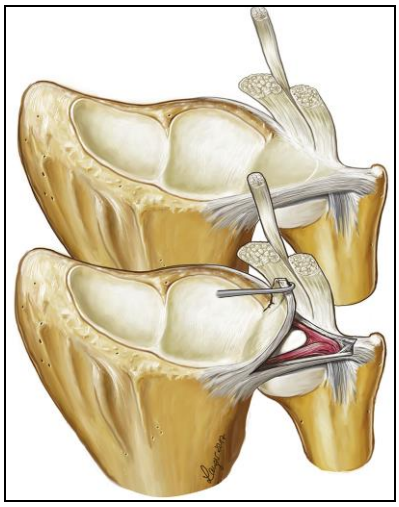

Fig 1: The upper part of the figure displays a dorsal view of the TFCC with the distal radioulnar ligaments inserting into the styloid and the palmar distal radioulnar ligament in close relationship to the ulnocarpal ligaments. In the lower part of the figure, the discus articularis proper is elevated and the foveal insertion of the distal radioulnar ligaments, the ligamentum subcruentum, is shown [4].

The vascular supply of the TFCC arises from terminal branches of the anterior and posterior interosseous arteries and

has direct implications on the healing potential of TFCC injuries [6]. The central and radial portions of the complex are a vascular and are considered the debridement zone [6, 7].

Both the palmar and dorsal portions of the peripheral margin of the TFC, as well as the radioulnar ligaments, are well vascularized and are considered the repair zone [6, 7].

Injury of the TFCC was cited as the most common cause of ulnar-sided wrist pain [8, 9]. A systematic review reported a prevalence of TFCC abnormalities in symptomatic wrists ranging from 39% to 70% in patients between 50 and 69 years old [10].

Another study showed that up to 78% of distal radius fractures had associated TFCC injuries detected by arthroscopy in patients 20 to 60 years old [11]. The mechanism of injury commonly involves abrupt forceful rotation, or loading and distraction injury to the ulnar wrist and forearm [11]. Loading of the wrist in extreme extension and pronation or supination was the most common mechanism reported in a series and was verified in 2 cadavers by Coleman in 1960 [12].

This frequently occurs in a fall on the outstretched upper extremity, Moritomo and colleague [13] in 2010 also noted that wrist hyperextension with forearm rotation was the most common injury mechanism. They further correlated the surgical findings of TFCC tear with mechanism of injury and suggested that forced wrist extension resulted in excessive traction of the ulnocapitate ligament, which in turn avulses the deep palmar radioulnar ligament from its foveal insertion. The second mechanism of injury was forceful rotation, in which hyperpronation was suggested to result in first an injury of the superficial dorsal radioulnar ligament and then the foveal insertion. Degenerative tears, which commonly result in attrition and perforation of the TFCC, were suggested to be caused by chronic repetitive loading of the wrist [12], particularly in ulnar deviation and pronation.

Palmer categorized TFCC injuries as either traumatic (Palmer 1) or atraumatic (Palmer 2) [6, 12]. Traumatic injuries result from torsional disruption of the DRUJ ligaments, which causes instability between the distal radius and the fixed axis of the ulna. Traumatic injuries are usually treated with immobilization or surgical repair of the avulsed TFCC to prevent instability. Both open and arthroscopic repairs have been performed.

Atraumatic injuries result from ulnar impaction against the carpus. This impaction causes wear and perforation of the TFCC, with subsequent impaction against the lunate and the lunotriquetral ligament [6].

Chronic radial or ulnar-sided detachment of the TFCC can result in symptomatic instability, pain on palpation of the DRUJ, and pain with forearm rotation. If conservative therapy such as immobilization and antiinflammatories fails, surgical treatment should address both the DRUJ arthritis and the wrist instability [6].

Traumatic and atraumatic injuries have been subdivided further into subtypes (Table 1). Traumatic lesions are classified into subtypes A through D based on the precise location of the lesion. Palmer 1A tears involve the central disk. Palmer 1B lesions involve an ulnar-sided avulsion with or without concomitant injury of the ulnar styloid. Palmer 1C lesions are distal avulsions, and Palmer 1D lesions are radial-sided lesions with or without injury to the radius [6, 12].

In contradistinction, the subtypes of the atraumatic lesions represent a continuum of injury and arthritic degeneration. Palmer 2A lesions are superficial degenerative lesions. Palmer 2B lesions have a TFCC tear with associated lunate or ulnar chondromalacia, whereas Palmer 2C lesions have disk perforation and associated lunate or ulnar chondromalacia. Palmer 2D and Palmer 2E lesions progress to lunotriquetral instability and ulnocarpal arthrosis, respectively [6, 12].

Table 1: Palmer Classification of Acute and Degenerative Triangular Fibrocartilage Complex Injuries [12].

Palmer type 1 (traumatic)
A. Tear of the central disk
B. Ulnar-sided tear ± ulnar styloid injury
C. Distal avulsion
D. Radial-sided tear ± bony injury to the radius
Palmer type 2 (degenerative)
A. Superficial degeneration
B. 2A + lunate or ulnar chondromalacia
C. Perforation of the TFCC disk + lunate or ulnar chondromalacia
D. 2C + lunotriquetral instability
E. 2D + ulnocarpal arthrosis

A clinical suspicion of TFCC foveal tear is based on the traumatic history of the involved wrist, positive ulnar fovea sign, and DRUJ laxity found in the DRUJ ballottement test. Routine radiograph examination is used to evaluate the ulnar variance, arthritis status of the ulnocarpal joint and DRUJ, and the possibly associated ulnar styloid fracture or nonunion. This clinical suspicion of TFCC foveal tear could also be illustrated by magnetic resonance imaging [14].

Wrist arthroscopy is the gold standard in the diagnosis and treatment of TFCC injuries. Arthroscopic suturing is the preferred method of treatment for ulnar-sided tears, whereas debridement is recommended for central and radial tears [15].

Patients and Methods

This study to assess functional outcome of arthroscopic repair of TFCC tears.The study includes ten patients diagnosed with torn TFCC who underwent arthroscopic repairt in Ahmed Maher Teaching Hospital during the period between May 2015 and February 2017.

Our study include ten patients with ulnar-sided wrist pain. In all patients, the wrist pain limited their capacity for work and activities of daily living. Local wrist tenderness was located on the ulnar aspect of the wrist and was exacerbated by the ulnar grinding test or pronation and supination of the forearm. All patients had failure of nonoperative treatment, which included rest and immobilization, nonsteroidal anti-inflammatory drugs (NSAIDs) and physical therapy. All patients underwent preoperative magnetic resonance imaging (MRI) evaluation. Complete medical history and clinical examination has been done.

The inclusion criteria for the study included (1) Age: 18-60 years. (2) Athletes and non-athletes. (3)Failure of conservative treatment in alleviation of patient's Symptoms after 3 months. The exclusion criteria for the study included (1) Skeletally immature patients. (2) Elderly patients (> 60 years old). (3)

Wrist deformities. (4) DRUJ arthritis.
Functional evaluation based on the visual analogue score and The Patient-rated Wrist Evaluation (PRWE) pre and post surgery has been done.
The visual analogue scale (VAS) is a simple and frequently used method for the assessment of variations in intensity of pain. In clinical practice the percentage of pain relief, assessed by VAS, is often considered as a measure of the efficacy of treatment.
The pain VAS is a continuous scale comprised of a horizontal (HVAS) or vertical (VVAS) line, usually 10 centimeters (100 mm) in length, anchored by 2 verbal descriptors, one for each symptom extreme. Instructions, time period for reporting, and verbal descriptor anchors have varied widely in the literature depending on intended use of the scale. For pain intensity, the scale is most commonly anchored by "no pain" (score of 0) and "pain as bad as it could be" or "worst imaginable pain" (score of 100 [100-mm scale]).
Based on the distribution of pain VAS scores in postsurgical patients who described their postoperative pain intensity as none, mild, moderate, or severe, the following cut points on the pain VAS have been recommended: no pain (0–4 mm), mild pain (5–44 mm), moderate pain (45–74 mm), and severe pain (75– 100 mm).
The Patient-rated wrist/hand Evaluation (PRWHE) was developed to assess pain in the wrist joint and functional difficulties in activities of daily living resulting from injuries affecting wrist joint area.
The PRWHE is a self-report measure sensitive to change in varying patient's groups. The questionnaire has been shown to have good validity and reliability. The tool enables participants to rate pain and disability individually on a score out of 50. The two scores for pain and disability are combined giving a total possible score of 100, where 100 represents maximal pain and disability. A score of 0 of 100 indicates no pain or disability. For the purpose of this study, scores of 1to 29 of 100 represented ''low'' levels of pain and disability. Scores of 71to100 represented ''severe'' pain and disability.

Surgical Technique
A standard approach for wrist arthroscopy had been used in each patient. The surgical routine include genreral or regional anaesthesia, using tourniquet, 4.5 to 5.5 kg of wrist distraction, Joint expansion by saline injection before trocar placement.
Portals: For the procedure of arthroscopic repair of TFCC injury, the operative approach is to place the scope in the dorsal 3-4(dorsal compartment) portal. The 4-5(dorsal compartment) portal is used primarily for instrumentation such as probes, basket punches, grabbers and shavers. It is also very useful for enhanced visualization of the TFCC complex and to provide an alternative view of the radiocarpal joint. With the triangulation probe, the location and extent of the TFCC tear can be determined. Arthroscopic outside-in repair was done for TFCC injury

Postoperative care
Postoperatively, The operated wrist was placed in a long-arm splint with the forearm in neutral rotation and the wrist in neutral flexion and mild ulnar deviation Until suture removal. Then splint intermittently and begin a therapy program stressing ROM initially, followed by a graduated strengthening program.

Results
Ten patients were enrolled in the study (6males and 4females) and followed up mainly to control these results. The shortest follow-up period was 3 months and the longest was 18 months with a mean of 10.93 months.

Visual Analogue Scale (VAS)
In patients to whom TFCC repair was done, VAS improved from a mean of ***6,58***to a mean of***1,8***.

Table 2: VAS analysis

Procedure	Pre-operative VAS	Post-operative VAS	P-value
Repair			
Number	10	10	*0.001
Mean	6,85	1,8	
Std. Deviation	0.83	1.13	
Median	7	2	
Minimum	6	0	
Maximum	8	4	

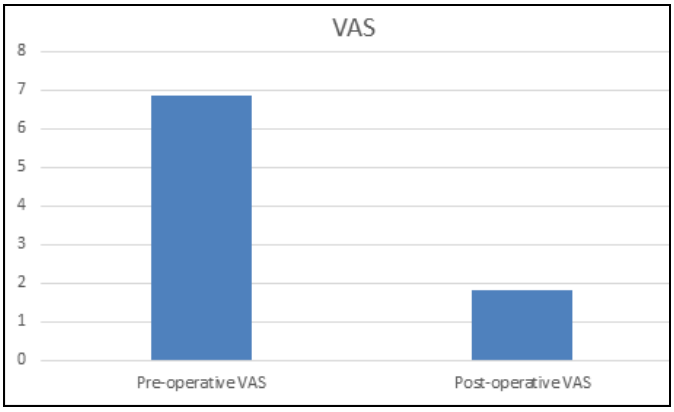

Fig 2

Table 3

Procedure	Pre-operative VAS	Post-operative VAS
VAS	6.85	1.8

The Patient-rated wrist/hand Evaluation (PRWHE)
In patients to whom TFCC repair was done, PRWHE improved from a mean of 49.18 to a mean of 25.0

Table 4: PRWHE analysis

Procedure	Pre-operative PRWHE	Post-operative PRWHE	P-value
Repair			
Number	10	10	*0.001
Mean	49.18	25.0	
Std. Deviation	18.8	20.5	
Median	49	25	
Minimum	27	45	
Maximum	78	10	

Table 5

Procedure	Pre-operative PRWHE	Post-operative PRWHE
PRWHE	49.18	25

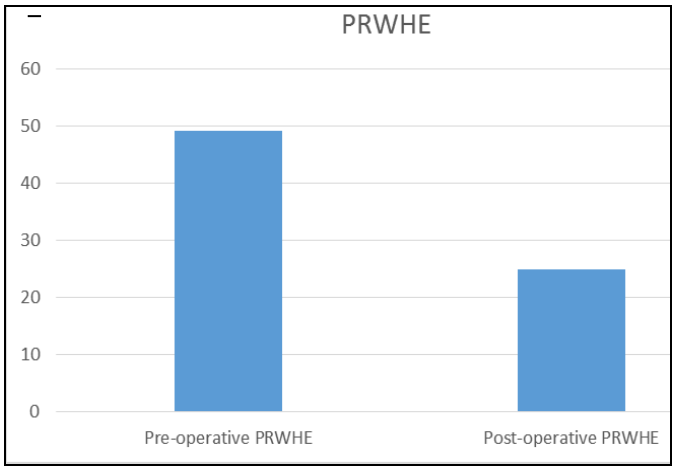

Fig 3

Complications

One patient developed paraesthesia in the distribution of the dorsal sensory ulnar nerve that resolved by 3 months after surgery. One patients developed stitch irritation and stitches were removed in another setting.

Discussion

Despite the importance of the preoperative workup, wrist arthroscopy remains the gold standard for diagnosis, with its ability to differentiate between chronic tears that may benefit most from debridement or joint leveling versus acute tears amenable to repair. When combined with the differing strategies for peripheral tears depending on whether or not there is DRUJ instability, patients must be made aware of the different treatments that may be rendered based on the intraoperatively findings at arthroscopy [16].

Repair of peripheral tears, whether open or arthroscopic, has demonstrated excellent outcomes, with improvement in pain, grip strength and function [7, 17, 18, 19].

Arthroscopic treatment has been gaining favor, owing to the ability to easily address other intra-articular pathology, improved visualization of the tear and results suggesting improved range of motion and grip strength over open techniques [20, 6].

Iwasaki and Minami reported an arthroscopic technique of reattachment of the avulsed TFCC to the ulnar fovea by creating a 2.9-mm osseous tunnel from the ulnar neck to the fovea to pass the sutures. They showed that the creation of an osseous tunnel can enhance bleeding from cancellous bone and provide progressive adhesion of the avulsed TFCC to the ulnar insertion [21, 22]. However, their technique requires a relatively large osseous tunnel in the small ulnar head. Nakamura *et al*. [23] and Shinohara *et al*. [24] reported their arthroscopically assisted transosseous outside-in techniques to reattach the TFCC using 2 separate 1.2-mm osseous tunnels from the ulnar neck to the ulnar fovea region. However, creating these 2 separate tunnels in such a small ulnar fovea region is technically demanding with little room for error.

In recent years, less invasive arthroscopic repair techniques for TFCC foveal tears have been introduced. Atzei [25] reported arthroscopically assisted foveal repair using a suture anchor.

Peripheral ulnar-sided tears have been more amenable to repair than radial-sided tears because of the increased vasculature at the ulnar TFC attachment site to the capsule. If the tear is central or stable, it is best treated with debridement alone, with good to excellent results in 90% of cases [25].

McAdams et al. shows that arthroscopic debridement or repair of the TFC is successful in competitive athletes who require a high level of wrist function for performance. All of the patients were able to return to full competition for their sport. The decision to perform arthroscopic debridement versus repair was based solely on the location and stability of the tear [2].

Rettig [1] stated that golf or tennis athletes typically return to restricted sports in 4 to 6 weeks if a central TFC tear is debrided, and return is 3 to 4 months after repair. Whipple reported that athletes may return to competition as soon as comfort allows after debridement of a central TFC lesion

EP Estrella, *et al*. show that arthroscopic repair of peripheral TFCC tears can be performed with good results. Improvement in pain and an increase in grip strength after arthroscopic peripheral TFCC repair, with 74% of our patients having good to excellent functional outcome [17].

The largest series to date of arthroscopic TFCC repair was reported by Corso *et al*. [26] there were 41 of 45 (91%) good to excellent results using the Modified Mayo Wrist Score. Trumble *et al*. [27] noted a direct correlation between delay from injury to surgery to final range of motion and grip strength

Soreide and colleagues, in 11 peripheral tears repaired arthroscopically, Median Mayo Wrist score was 85 (30–100) and, according to the Modified Mayo Wrist Score, seven patients presented good or excellent results. The patients reported median low 25 (0–66) on pain and median high 90 (1–100) on satisfaction. The study support the trend of persisting good results for the majority of patients having undergone arthroscopically assisted repair with an outside-in suture technique for peripheral tears of the TFCC [28].

Tunnerhoff and Haussmann reported on 23 arthroscopic repairs of type IB tears, with improvement in Mayo wrist score noted. However, 38% of their cohort had preoperative DRUJ instability, and instability was a predictor of poorer outcome [29].

In a study by Wysocki and colleagues, twenty-nine wrists were treated arthroscopically for peripheral TFCC tears with outside-in suture repair of the TFCC to the ulnar capsule. Twenty-five patients (90%) were available for follow-up at a mean of 31 months. The mean VAS score improved from a pre-operative score of 5.4 to a score of 0.9 at the final follow-up. Of 11 high-level athletes in the total cohort, 7 patients (64%) were able to return to sports, however, athletes who bore weight through their hands were unable to return to their sporting activity [30].

Conclusion

The general populations, especially athletes, are subject to ulnar-sided wrist injuries given the increasing demands placed on the wrist and hand. Evaluation of such problems begins with a thorough history and physical to localize the symptoms and assess the mechanism of injury.

Imaging studies begin with plain radiographs, which are paramount to determining ulnar variance and elucidating any osseous injuries. MRI is gaining in popularity in the imaging of the athlete's wrist. Arthroscopy remains the gold standard for diagnosis and allows for proper and effective treatment of both TFCC injuries and associated intra-articular pathology, with return to sport in greater than 85% of effected athletes.

Arthroscopic management of TFCC tears has shown good results with improvement in pain and function. However, our study is limited by the relatively short follow-up period and a longer follow-up period is necessary for better evaluation of the functional outcome.

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