ARTHROSCOPIC AND GROSS EVALUATION OF THE TRIANGULAR FIBROCARTILAGE COMPLEX OF THE WRIST: A CADAVER-BASED STUDY

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SUMMARY

The triangular fibrocartilage complex plays a key role on wrist biomechanics. An accurate injuries diagnosis is paramount for a successful treatment. There are controversies regarding specificity and sensitiveness of imaging methods employed today. Wrist arthroscopy is a method uncommonly used for diagnosing TFCC injuries in our environment, although it presents good advantages, such as the potential of direct viewing injuries, and treatment at the same surgical time. The objective of this study was to evaluate the role of wrist arthroscopy for inspecting TFCC, as well as for detecting potential injuries, comparing those data to gross dissection. Fifteen wrists of male cadavers (mean age: 56.1 years old) were assessed. Arthroscopy showed the presence of injuries in 33.3% of the assessed wrists. Those findings showed consistency after an anatomical study with broad dissection. We concluded that an absolute correlation existed between arthroscopic test and gross dissection in detecting TFCC injuries.

Keywords: Wrist; Cartilage; Cadaver

INTRODUCTION

The Triangular Fibrocartilage Complex (TFCC) is located between the radius, ulna, semilunare and pyramidalis[(1)], being formed by five components: central disc, dorsal and volar radioulnar ligaments, ulnar extensor sheath of the carpus and homologous meniscus[(2)].

Biomechanically, the TFCC has as major functions the stabilization of ulnocarpal and distal radioulnar joints, distribution of forces between ulna and carpus, and the ability to enable harmonic and smooth rotation movements of the wrist and forearm. Approximately 80% of the forces transferred to the wrist pass through the radius and 20% through the ulna[(3)].Rotation movements during pronation and supination of the forearm producing axial load yield a "drilling-like" effect of the ulna at carpus ulnar site, which can cause degenerative changes[(4)].

A successful treatment of TFCC injuries depends on a correct diagnosis. Much controversy exists regarding the best diagnostic imaging method, anatomical location, and extension of those injuries. Haims et al.[(5)] found limitations for diagnosing peripheral injuries through Magnetic Resonance, while Morley et al.[(6)], considering the "gold standard" arthroscopy, described low sensitiveness (44%) in detecting those injuries.

Macroscopically, the details of the interfaces between fibrocartilaginous tissue and ligaments, as well as their injuries, are nor easily detectable[(7)]. But the arthroscopic method provides a magnified view of the structures, different angles view, and the potential to provide treatment at the same time of diagnosis.

The objective of this study was to compare the arthroscopic and macroscopic findings of the TFCC in 15 random cadaver wrists.

MATERIALS AND METHODS

Fifteen male cadaver wrists, average age: 52.13 years old (ranging from 36 to 65 years old) provided by the São Paulo City Death Examination Service of the University of São Paulo, were assessed. Exclusion criteria were history of previous trauma, cause of death related to trauma, and consumptive disease.

Aiming to preserve cadaver's integrity, the study piece was removed without skin and subcutaneous cellular tissue, which were dissected from the distal region of the forearm

Study conducted at the Arthroscopy Laboratory, Orthopaedics and Traumatology Institute, Hospital das Clínicas, Medical College, University of São Paulo

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(about 8.0 cm proximal to radius styloid apophysis) to metacarpophalangeal joints. The region comprehending cadaver's forearm and wrist was then reconstructed with a stiff fixation material from the forearm to the hand, filled by sawdust.
Those pieces had extensor tendons, carpus cross-sectional ligament, flexor tendons, extrinsic and intrinsic ligament structures, and the other uninjured osteo-articular components.
The study was conducted within two phases: arthroscopy and macroscopy, comparing TFCC characteristics and the presence of injuries.
Those pieces were positioned in a distractor, with proximal fixation by cross-sectional Kirshnner thread at the radius, and distally at the neck of the second and third metacarpals. (Figure 1).

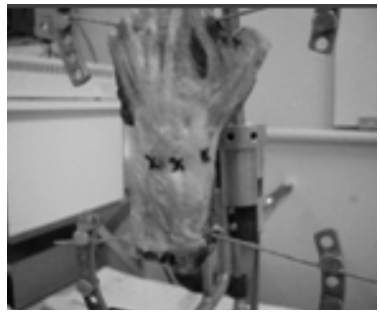

Figure 1 – *Piece at the distractor with marked portals.*

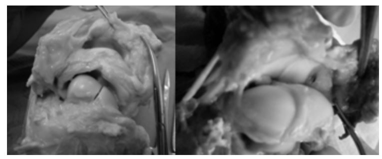

Figure 2 – *TFCC dissected and fully lifted. Right, injury.*

In all cases, the TFCC was verified and recorded at portals 1-2, 3-4 and 4-5, with portal 6-U being used for drainage. A 2.0 mm probe was used for palpation of structures.
The evaluation algorithm at each portal was started by palpating central region, performing the so-called “”spring board test” aiming to demonstrate complex's tension. In the presence of laxity, injury may be suspected.
Then, the radial insertion, ulnocarpal ligaments (ulnopyramidal and ulnosemilunar), ulnar insertion, the ulnar extensor sheath of the carpus, and the dorsal capsule were checked and palpated. When present, injuries were graded according to their anatomical locations, and measured using probe's tip as a parameter.
The following phase was initiated by wrist dissection. Through a cross-sectioned incision at the level of dorsal medial-carpal, a careful juxtaosseous dissection from distal to proximal, resulted in the whole TFCC being lifted, when the macroscopic study could be initiated, following the algorithm previously described (Figure 2).

RESULTS

Injuries were graded according to their topographic location. In two cases, injuries were seen at the radial edges of the TFCC, other two at the central region, and only one case presenting injury at the ulnar edge.
Injuries extension ranged from 2.0 to 9.0 mm, with an average of 5.2 mm.
The “spring board sign” was positive in 4 of the 5 wrists presenting injuries, and in 2 of the 10 normal wrists, resulting in a sensitiveness of 66%, and a specificity of 88%.
The presence of synovitis was seen in 4 of the 5 injured wrists (80%) and in 5 of the uninjured wrists (50%).
Macroscopic evaluation showed the presence of the same injuries seen via arthroscopy, except for the visualization of synovites (Table 1).

Case	Side	Age	Spring Board Sign	Length of injury	Arthro	Macro
1	D	50	+	9,0 mm	radial injury synovitis (++/4+)	-radial injury
2	E	50	-		synovitis (++)	-no changes
3	D	58	+	3,0mm	ulnar injury synovitis (+)	-ulnar injury
4	E	58	-		no changes	-no changes
5	E	47	-		synovitis (+)	-no changes
6	D	47	-		no changes	-no changes
7	D	55	+		synovitis (+)	-no changes
8	E	49	-		synovitis (+)	-no changes
9	E	54	+	7,0 mm	central injury synovitis	-central injury
10	E	36	-		no changes	-no changes
11	E	59	-		no changes	-no changes
12	D	59	+	5,0 mm	central injury synovitis (++)	-central injury
13	D	65	-		no changes	-no changes
14	D	52	+		synovitis (+)	-no changes
15	D	43	-	2,0 mm	radial injury	-radial injury

Source: Arthroscopy Laboratory, IOT-HCFMUSP

Table 1

DISCUSSION

The TFCC of the wrist is composed by several structures such as the central disc, dorsal and volar radioulnar ligaments, ulnar extensor sheath of the carpus, and homologous meniscus[2], which interact biomechanically, stabilizing distal radioulnar and unocarpal joints. Its plasticity provides anatomical remodeling during prono-supination of the forearm and flexo-extension of the wrist, resulting in maximum stability of carpus ulnar edge [4,5,8,9,10].
Mattar et al.[11] studied the histology of the mechanoreceptors and free nervous ends in 34 cadaver TFCCs, showing a higher concentration of sensitive fibers at ulnar edge. Those findings clearly suggest the cause of ulnar signs and symptoms of the wrist when clinically relevant injuries are in place.
The presence of such injuries may cause instability of the distal radioulnar joint, and, as a result, pain, restrained range of motion on the forearm and wrist, and reduced prehension force. Ruch et al.[12], conducted a biomechanical study in cadavers, demonstrating that theory. They concluded that the total rupture of the TFCC significantly increases instability of that joint, and its repair restores stability once lost.
While the central portion of the TFCC is cartilaginous and poorly vascularized, peripheral insertions are relatively strong and well vascularized. Central injuries are usually treated by débridements and ulnar end shortening[13]. On the other hand, peripheral injuries are addressed with reinsertions. Mattar et al.[15] achieved good outcomes in 17 of 21 patients with symptomatic injuries at wrist medial surface, while Cooney et al.[16] reported 26 good and excellent outcomes in 33 patients with peripheral injuries, not associated

to instability of the distal radioulnar joint. Hermansdorfer and Kleinman[17] recommend surgical repair in cases of TFCC avulsions, while Trumble et al.[18], described good outcomes using arthroscopic repair in isolated peripheral injuries. Obviously, a successful treatment of TFCC injuries depends on a correct diagnosis. Arthrography, NMR, and Arthroresonance are the methods mostly employed. Much controversy exists around sensitiveness, specificity and accuracy of imaging methods. Haims et al.[5] evaluated 86 NMRs, examined by three investigators, found sensitiveness of 17%, specificity of 79% and accuracy of 64%, while Morley et al.[6], analyzed 54 NMRs of patients with wrist ulnar pain and demonstrated a sensitivity of only 44% and specificity of 87%. Blazar et al.[19] concluded that NMR may have an accuracy of 83% when interpreted by largely experienced investigators. In all cases, arthroscopy was considered as the "gold standard".

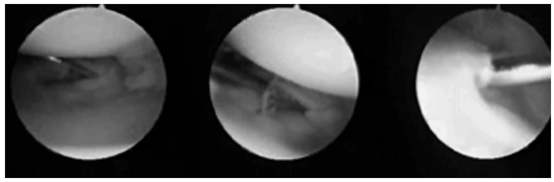

***Figure 3 –** Injury assessed through portals 1-2, 3-4 and 4-5.*

Pederzini et al.[20] evaluated, through NMR and preoperative arthrography, 11 patients with chronic wrist ulnar pain, obtaining a specificity of 100% and sensitivity of 82 and 80%, respectively. They concluded that although NMR does not require arthrography, it does not exactly determine degenerative and joint cartilage injuries site, whereas arthroscopy would precisely evidence the main injury, as well as causes related to chronic ulnar pain in the wrist, as chondromalacia and synovitis.

The importance of wrist arthroscopy for diagnosis and treatment of TFCC injuries is notorious. In this study, where 15 wrists were assessed, we found an injury rate of 33.3%. These findings are similar to those reported by Lee et al.[21].

The topographic classification was employed, because the purpose of the study was not elucidating the potential etiologies of the injuries, whether traumatic or degenerative, as recommended by Palmer[22], but comparing findings between arthroscopy and macroscopy.

Although TFCC injuries open repair may be performed[9], in this study, we demonstrate the importance of arthroscopic checking for the correct injury diagnosis, as well as their morphologic characteristics (location, format and dimensions), due to a magnified view of structures, appropriate lighting, in addition to the possibility of using many portals. It also allows for a more adequate evaluation of regions hardly accessible, even after wide arthrotomies, such as pyramidal volar region, pisiform-pyramidal joint, and ulnocarpal ligaments.

All injuries were seen at the three portals of the study (1-2, 3-4, 4-5). Different angles allow for the distinction of different visual fields of the same injury (Figure 3).

Portals most commonly used are 3-4, 4-5 and 6-R, of which dissection is easier and safer, besides providing an excellent view of the whole TFCC. It's worthy to highlight the importance of the portal 1-2, which provides a panoramic view of the ulnar edge, especially the dorsal surface(23). The need for a stronger traction, the presence of the radial sensitive branch and of the radial artery branch are the major obstacles to its use. Especially at laboratory training, this portal may provide an easier identification and understanding of the structures and injuries belonging to TFCC.

A potential criticism to the study is concerned to the absence of wrist X-ray images for analyzing ulnar variance and the correlation with arthroscopic and macroscopic findings.

CONCLUSION

This study demonstrated the presence of injuries in one third of the assessed wrists. There was a correlation, in all cases, between arthroscopic test findings and macroscopic dissection and visualization of TFCC injuries.

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