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Assessment of Triangular Fibro-cartilaginous Complex Injuries of The Wrist Using High Resolution Ultrasound versus Magnetic Resonance Imaging

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ABSTRACT

Background: Triangular fibrocartilage complex (TFCC) may be assessed using ultrasound (US) because of its wide availability, mobility, low cost, and lack of radiation. When it comes to TFCC imaging, MRI is the gold standard, although US can provide a more detailed picture of the disease.

Objective: Comparing and contrasting the use of ultrasound (US) and magnetic resonance imaging (MRI) in the detection of triangular fibrocartilaginous complex injuries of the wrist.

Patients and Methods: The study was conducted at the Radiodiagnosis Department, Zagazig University Hospital, Egypt. Wrist discomfort or reduced wrist mobility was reported by 35 individuals with a mean age of 39 ± 13.18 years old. Both radiologists who performed the ultrasound and the MRI were blinded to each other's results in order to minimize bias.

Results: 82.9 % of patients showed normal ulnar variance while 11.4 % of patients showed positive variance and 5.7% with negative variance. The ultrasound detected 18 positive cases with TFCC injury with a percentage of 51.4%. The MRI detected 24 positive cases with TFCC injury with a percentage of 68.6%. The ultrasound detected TFCC cases with a sensitivity of 75%, specificity 100%, PPV 100 and NPV 64.7.

Conclusion: It is very suggested that tendons and inflammation of the wrist could be examined by ultrasonography. In recent investigations, it was shown that US had the ability to identify injuries in the TFCC and intrinsic ligaments.

Keywords: Triangular fibro-cartilaginous complex injuries, High resolution ultrasound, Magnetic resonance imaging.

INTRODUCTION

Diagnosing wrist pain on the ulnar side might be difficult. To a large extent, this is owing to the region's tiny size and complexity. To make things easier, the anatomical structures implicated in ulnar-sided wrist discomfort can be categorized. Joint, cartilage, tendon, nerve, and, bone ligament are all examples of these structures [1].

An ultrasound test may be performed at a fraction of the cost, is easy to transport, and does not emit radiation. Aside from the soft tissues, ultrasound may also reveal cortical information about the bone. Ultrasound was made possible by its imaging, practicality, capabilities and dynamic component. Therefore, it is increasingly used as a first-line investigation for wrist soft-tissue abnormalities [2]. The distal radioulnar joint (DRUJ) is stabilized by the triangular fibrocartilage complex (TFCC), which acts as a cushion for the ulnar head and lunate during wrist axial stress and ulnar deviation, and also restricts carpus ulnar deviation [3].

As the principal stabilizers of the distal radioulnar joint, the articular disc is encircled by the dorsal and palmar radioulnar ligaments. Meniscus homologue, ulnar collateral ligament and ECU subsheath are all part of the complex, which all contribute to the stability of TFCC stability. In addition, the ulnotriquetral ligaments, and ulnolunate, which both come from the palmar radioulnar ligament, support the TFCC on the palmar side of the wrist [3, 4].

When diagnosing musculoskeletal tissues, the best equipment and transducers must be used, as well as comprehensive software choices to enhance the picture quality. In other words, the finest feasible artefact removal, as well as the best possible resolution. Ultrasound equipment should provide the most sensitive color Doppler choices as well as high-quality grayscale pictures [5]. In order to get a clear picture of the TFCC, a systematic approach is necessary. US can display the various components of the TFCC as well as detail the lesions of the articular disc and meniscus homologue [6].

Regarding MRI of the wrist, proton density, gradient-echoes, or T2-weighted sequences can detect a TFCC rupture in the disc or ligament with fluid signal intensity extending through it. If the tear is horizontal or parallel to the distal radius rim, it is called a radial tear and is sometimes called a "slit-like" radial or "vertical look." It's fairly unusual for a tear to include two components, such as a complicated tear [3].

We aimed at this study to highlight the role of US in detecting different triangular fibrocartilage complex injuries of the wrist in comparison with MRI as a gold standard.

SUBJECTS AND METHODS

At Radiodiagnosis Department, Zagazig University Hospital, Egypt, this study was conducted. This research included 35 patients, ranging in age from 17 to 70, who reported either wrist discomfort or restricted wrist movement. There were 21 male patients (60%) and 14 female patients (40%) in the study. Trauma history was present in 86.6 percent of the patients. In 18 (51.4%) of the patients, the right wrist was examined, whereas the left wrist was also examined in 17 (48.6 percent).

Ethical approval:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee (ZU-IRB#6210).

Every patient signed an informed written consent for acceptance of the operation. This work has been carried out in accordance with The Code of Ethics of

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the World Medical Association (Declaration of Helsinki) for studies involving humans.

Exclusion criteria:

Patients with previous history of operation and those with claustrophobic tendencies or those with pacemakers, metallic foreign bodies in crucial positions, or vascular implants that aren't compatible with MRI scans were excluded from this research.

Full clinical evaluations were performed on all patients, including thorough history-taking and subsequent examinations:

- Wrist ultrasound examination.
- When necessary, dynamic ultrasound was done.
- Power and color Doppler studies can be used as necessary.
- A wrist MRI was performed.

Technique:

Evaluation using ultrasound:

GE's 7.5–10 MHz superficial linear array transducer was used for USG tests. Wrist joints were checked when the patient was sitting upright and with the hand on a cushion and fully pronated before being totally supinated. This examination is followed by an assessment of the palmar aspect. This is how the wrist is typically examined by a USG. In order to distinguish the second compartment (lateral) from the third compartment (medial), we used the Lister tubercle on the dorsal radius as a bony reference (medial). It is possible to locate and evaluate the extensor pollicis longus tendon on the Lister tubercle's medial side. This compartment was examined by placing the transducer in the transverse plane above the mid-dorsal wrist to examine the fourth compartment (extensor digitorum communis and extensor indicis proprius) as well as the fifth compartment (extensor digiti minimi tendon).

The extensor carpi ulnaris tendon is examined by placing the wrist slightly radially deviated. This tendon necessitates axial and longitudinal imaging.

The TFCC is situated between the distal ulna and the first row of the proximal carpals. Forearm pronation, volar pad placement, and internal rotation of humerus at shoulder are the best positions to see it.

The use of MRI technology:

Traditional MRI was used to evaluate patients in this study. Philips MRI system was the MRI machine in use (1.5 T). Patients were scanned in a prone posture with their arm raised above their head using a specialized wrist coil. The axial, sagittal, and coronal planes were all examined throughout the procedure. In order to reduce the risk of bias, the radiologists doing the ultrasound and the MRI had to be blinded to the results of the other modality. The results of both imaging modalities were then linked statistically.

Statistical analysis

Statistical analysis for various wrist injuries was carried out using the chi-square test in terms of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), accuracy, and P value. For all statistical computations, the SPSS (Statistical Package for the Social Science) version 26 computer application was used. Categorical data were presented as number and percentage and the chi- squared test was used for studying the differences between groups with regard to categorical variables and the relationships between variables. The level of significance was adopted at P-value ≤ 0.05.

RESULTS

The mean age of studied patients was 39, about 60% of them were males and 31.4% were housewives (Table 1).

History of trauma was 68.6% and 51.4% of them on right side, the other 48.6% on the left side. 82.9 % of patients showed normal ulnar variance while 11.4 % of patients showed positive variance and 5.7% with negative variance. The ultrasound detected 18 positive cases with TFCC injury with a percentage of 51.4% (Table 2).

The MRI detected 24 positive cases with TFCC injury with a percentage of 68.6% (Table 3).

13 cases showed central tear while 9 cases showed tear of peripheral site and only two cases with both central and peripheral tears. They showed partial tear with a percentage of 83.3% while 16.7% of the cases with complete tear (Table 4).

The ultrasound detected TFCC cases with a sensitivity of 75%, specificity 100%, PPV 100 and NPV 64.7% (Table 5).

Table (1): Socio-demographic data of studied patients

	No. (35)
Age (years):	
Range	17-70y
$\dot{X}$ ± SD	39 ± 13.18
Sex:	
Male No. (%)	21 (60%)
Female No. (%)	14 (40%)
Occupation:	
Workers No. (%)	10 (28.6%)
Housewives No. (%)	11 (31.4%)
Medical Staffs No. (%)	3 (8.6%)
Employees No. (%)	7 (20%)
Students No. (%)	4 (11.4%)

Table (2): Detection of triangular fibro-cartilage complex injuries of studied patients by ultrasound

	No.	**%**
Negative	17	48.6%
Positive	18	51.4%
Total	35	100%

Table (3): Detection of triangular fibro cartilage complex injuries of studied patients by magnetic resonance imaging

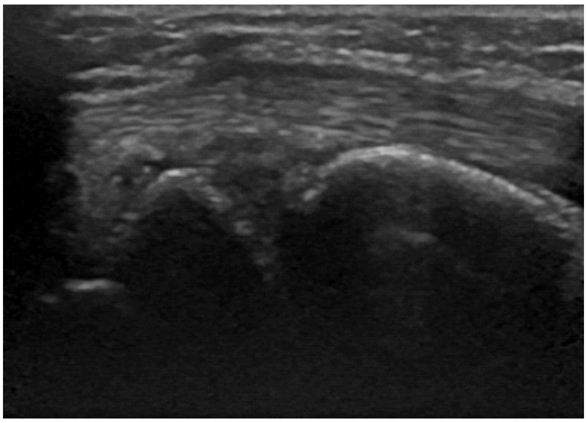
	No.	%
Negative	11	31.4%
Positive	24	68.6%
Total	35	100%

Table (4): Site and Type of TFCC tear

	No.(24)	%
Site of TFCC tear :		
Peripheral	9	37.5%
Central	13	54.2%
Both	2	8.3%
Type of TFCC tear :		
Partial	20	83.3%
Complete	4	16.7%

Table (5): Validity of ultrasound in detection of triangular fibro cartilage complex injuries versus Magnetic resonance imaging

		TFCC injuries by MRI		Total
		+ve	-ve	
TFCC injuries by US	+ve	18	0	18
	-ve	6	11	17
Total		24	11	35



(A)

(B)

Figure (1): A forty four years old female doctor patient is suffering from right wrist pain after overusing it presented with tenderness over right sided ulnar wrist. **(A): Gray scale US:** Small hypoechoic area is seen in the TFCC region. **PDS:** normal vascularity on color Doppler, **(B): MRI examination:** Mild joint effusion and partial intra substance tear of the triangular fibro-cartilage.

DISCUSSION

Diagnosing wrist pain on the ulnar side might be difficult. In part, this is due to the region's modest size and complexity in terms of anatomical features. Imaging abnormalities that are clinically asymptomatic might exacerbate the problem [1].

MR imaging is more sensitive to soft tissue contrast and subtle changes in the bone marrow, such as bone edema, than CT imaging for diagnosing occult fractures and stress fractures, despite CT's better osseous resolution [7].

With the advancement of ultrasound technology, it is now more frequently used to assess superficial soft tissue structures in the musculoskeletal system, such as the hand and wrists. Using higher frequency transducers, doctors can get a better view of tendon and ligament internal architecture and hence have more information on the structural integrity of these important supporting structures [8]. Ultrasonography of the intrinsic wrist ligaments and the triangular fibrocartilage complex and the majority of extrinsic wrist ligaments have shown promising findings. High-frequency linear transducers can be used to see these formations [4]. With the advantages of US imaging: cheaper cost, no known contraindications, and the ability to do dynamic evaluations in real time, US is a viable option for patients. However, consistent imaging techniques can compensate for the fact that US is operator-dependent [4].

Regarding evaluating triangular fibrous cartilage by ultrasound, we found that it was 75% accurate in cases of damage. Our results concerning the TFCC injury are consistent with results stated by **Finlay *et al.*** [9] who used conventional arthrography as a gold standard, which showed a sensitivity approaching 64% in the detection of TFCC tear. Our study had a number of flaws, one of which was the exclusion of asymptomatic patients with normal triangular fibrocartilage in the study group. **Keogh *et al.*** [10] who studied triangular fibrocartilage Us examination and compared his results to the MRI showed a sensitivity of 87.5%, which is consistent with our results as this study also did not include asymptomatic patients with normal triangular fibrocartilage. **Chiou *et al.*** [11] conducted a research in which high resolution ultrasonography was used to evaluate triangular fibrocartilage and the findings were compared to those obtained using standard arthrography. Ultrasound of the triangular fibrocartilage exhibited good specificity, PPV, and NPV and might be utilized as an initial imaging modality to avoid arthrography in some situations, according to the results of this investigation. While HRUS has a sensitivity of 68%, additional research is needed to determine its efficacy in screening for triangular fibrocartilage injuries, which is consistent with our findings.

There are many changes to be encountered during painful wrist examination including subcutaneous edema, synovial thickening, effusion, and inflammation. Ultrasound detection of these changes in our study showed a sensitivity and specificity of approximately 100% for both. These results are matched with all the studies that we found discussing the role of ultrasound in evaluation of the rheumatological changes of the wrist joint.

Since ultrasound is an extremely sensitive imaging modality for the identification of synovial enlargement, **Harish *et al.*** [12] also came to this conclusion. US can also identify early inflammation, such as synovitis, bone erosions, and to a lesser extent, cartilage loss, by directly seeing the articular and periarticular pathologies, according to **Wong *et al.*** [13]. Synovitis has been detected by US as well as MRI, arthroscopy, scintigraphy and histology, according to the findings of **Karim and colleagues** [14]**.**

Concerning the detection of ulnar negative variance by ultrasound compared to MRI, we did not find any studies discussing the role of ultrasound in the evaluation of ulnar negative variance as ulnar as a simple radiography is sufficient for the diagnosis of ulnar variance as stated. Forearm neutral rotation and shoulder and elbow in 90° flexion were recommended by **Epner *et al.*** [15] for measuring ulnar variance on PA radiographs.

Occult scaphoid fractures (20 to 25 percent of occurrences) may go missed during the first radiographic scan, according to **Fussetti *et al.*** [16]**.** Radiocarpal and triscaphe (shared joint between scaphoid, trapezium and trapezoid bones of the wrist) joint symptoms are also seen in the US. However, studies mentioned that further imaging studies are always needed to confirm the US diagnosis.

CONCLUSION

It is very suggested that tendons and inflammation of the wrist to be examined by ultrasonography. In recent research, it was shown that its ability to identify rips in the TFCC and intrinsic ligaments may be underrated. Anatomical features of the TFCC, including the articular disc, meniscus homologue, and juxta-articular ligaments may be accurately shown by US as can the pathology of the ligaments.

When it comes to diagnosing wrist discomfort, magnetic resonance imaging and musculoskeletal ultrasonography play complementary roles.

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