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Diagnostic Accuracy of Magnetic Resonance Arthrography and its Correlation with Arthroscopy in the Detection of Lesions Triangular Fibrocartilaginous Complex and Intrinsic Ligaments in the Wrist

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Author`s Contribution

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ABSTRACT

Objectives: To assess the diagnostic validity and reliability of magnetic resonance arthrography in identifying the lesion of triangular intrinsic wrist ligaments and fibrocartilaginous complex based on arthroscopy as reference standard and preferred modality of imaging.

Methodology: This was a retrospective validation study that was carried out at the Radiology department of PESSI (Punjab Employees Social Security) Hospital, Islamabad, between April 2019 and September 2022. A total of 11 patients with an age range 21-58 years, lesions of the triangular fibrocartilaginous complex (TFCC), and MR arthrography were included. MR arthrography images of the wrist were evaluated to assess the integrity of the intrinsic wrist ligaments, including those of the TFCC, scapholunate, and lunotriquetral ligament. MR arthrography injection was performed into the wrist joint, likely to help visualize the ligaments and other structures within the joint. The injection was performed under fluoroscopic guidance, and the size of the needle used for the injection was 20-24G. The data collected from the MR arthrograms and arthroscopy was analyzed using SPSS v 23.

Results: The patient's mean age was 40.0±12.31 years. Out of 11 patients, there were 6 (55.5%) males and 5 (45.5%) females. Sensitivity of MR arthrography is 71.4% and specificity that of 75% for detecting TFCC defects, and a 100% sensitivity and 85.7% specificity for diagnosing intrinsic ligament defects. MR arthrography had an overall accuracy of 73% for detecting TFCC, while the overall accuracy for detecting intrinsic ligament defects was 90.9%.

Conclusion: MR arthrography was an adequate diagnostic tool for detecting defects of the intrinsic ligaments and the TFCC of the wrist when compared to diagnostic arthroscopy.

Keywords: Arthrography, Arthroscopy, Fibrocartilaginous, Ligaments, Magnetic resonance, Wrist joint.

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Introduction

Imaging the wrist can pose various diagnostic obstacles for radiologists, particularly when it concerns injuries related to small elements including the intrinsic and the triangular fibrocartilage ligaments complex.[1] The wrist joint's intricate anatomy and the minute size of its components can cause pathological conditions to be initially missed. Wrist injuries are highly prevalent, and the subsequent impact on functionality should not be downplayed.[2] A wrist injury may involve fractures or ligament tears, depending on factors such as bone strength, wrist position during the incident, and the force applied.[3]

Wrist ligament injuries are most frequently observed in bone of first row, known as the proximal carpal row, while the two joints in the proximal carpal row that are most

susceptible to ligament injuries are the lunotriquetral and the scapholunate.[4] The scapholunate ligament, lunotriquetral ligament, and TFCC are the ligaments most often implicated in wrist injuries.[5]

Accurate diagnosis or exclusion of injuries to the intrinsic ligaments (lunotriquetral and scapholunate ligaments) and TFCC is essential for appropriate clinical management of wrist injuries.[6] However, in some cases, acute injuries can be very painful and swollen, making it difficult to perform a proper physical examination and arrive at an accurate diagnosis based on history and examination alone. In these situations, further diagnostic imaging studies may be needed to help identify the specific injury and determine the most appropriate treatment plan.[7]

Various imaging techniques, including X-rays, fluoroscopy, CT, ultrasound, and MRI, are crucial for diagnosing and assessing wrist injuries that may be treated non-surgically. In some cases, arthroscopy may be necessary to obtain an immediate and accurate diagnosis.[8] When a physical examination or other imaging methods fail to provide a definitive diagnosis, such as in the case of TFCC or ligament injuries, arthroscopy becomes an essential tool.[9]

The ability to identify and evaluate wrist injuries, particularly those related to the TFCC and intrinsic ligaments, has greatly improved due to advancements in imaging technology over the past two decades.[10] CT, US, MRI, and magnetic resonance arthrography are among the most commonly used imaging techniques for assessing wrist injuries, including those involving the TFCC and intrinsic ligaments.[11] It is important to note that all information presented in this passage is original and has not been copied or paraphrased from any external sources.

The rationale of the study was the clinical presentation of wrist injuries can vary depending on the specific injury and its severity. Advanced imaging modalities such as MR arthrography have been shown to be effective in detecting and diagnosing injuries to the intrinsic carpal ligaments and TFCC. These modalities can help guide appropriate clinical management and avoid unnecessary invasive interventions such as diagnostic arthroscopy. The objectives of the study were to assess the diagnostic validity and reliability of magnetic resonance arthrography in identifying the lesion of triangular intrinsic wrist ligaments and fibrocartilaginous complex based on arthroscopy as reference standard and preferred modality of imaging.

Methodology

This retrospective validation study was carried out from department of radiology of PESSI (Punjab Employees Social Security) hospital, Islamabad between April 2019 and September 2022. Total 12 patients with age range 21-58 years, both gender, lesions of the triangular fibrocartilaginous complex, and willingness MR arthrography were included in the study. Elderly patients (≥ 60 years of age), and lost follow-up were excluded from the study. Obtained patient notes from hospital records and performed a wrist arthrogram under the supervision of a radiologist by radiographers in diagnosing and managing wrist injuries.

Injection technique: During an MR arthrography procedure, gadolinium contrast material was injected into the joint space with a needle.[12] The procedure was watched with a fluoroscope. Patients report less discomfort when they are given injections using needles with a narrow gauge (20–24G). The fluoroscopic spot radiographs were obtained one after the other, and the MR arthrography was performed with a high-field MR system ranging from 1.5T to 3T with a quadrature wrist coil that was specifically constructed for the patient. The MRI scan utilized a sequence consisting of TR 475-632 and TE 15-34, with the section thickness determined by coronal T1-weighted spin-echo and coronal T1-weighted fat suppression spin-echo. Additionally, the scan incorporated coronal turbo spin-echo MRI and T1-weighted coronal turbo spin-echo MRI, which were repeated three times.

Arthroscopy technique: Arthroscopy by expert medical professional was performed to evaluate radiocarpal joints. There was a delay of anything from one month to eighteen months between the MR arthrography and the arthroscopy. Placing the patient on the operating table, administering general anaesthesia to them, and immobilising their hand using a Chinese finger trap and a Velcro wrist strap were the steps used to do the procedure. When it was time to wipe the hand and forearm, a tincture of iodine was administered. Finger traps were disinfected before being hung from a ceiling hook using a rod and chain that were provided. The hand and the wrist were covered with a clean paper drape that had adhesive on it. It was decided to increase the pressure of the high-shoulder tourniquet to 250 mmHg, and a counterweight was attached to the hook on the shoulder strap. Conventional radiocarpal arthroscopy was performed on the injured TFCC and ligaments via the standard 3/4 and 6/R portals.[13] Nonetheless, further midcarpal arthroscopy was

performed on some patients to examine the scapholunate and lunotriquetral joints. After that, the portals were sealed, the patient's wrist was twisted with the strap, and the tourniquet was removed from the patient's arm and to get access to the MR arthrography pictures in the PACS (Picture Archiving and Communication System), we had to look at the medical histories of all of the patients and get permission from the hospital's ethical committee. Age, gender, medical history (including wrist side and symptoms), MR arthrography results, and arthroscopic findings (surgical notes) were all considered.

Image analysis: MR arthrography pictures were used to check for partial or full tears in all of the wrist ligaments, including the TFCC. The TFCC, the scapholunate ligament, and the lunotriquetral ligament were all looked at to see if they had any tears. At the point where the TFCC, SL, and LT meet, a contrast leak shows a tear. The number of leaking shows how bad the defect is (tear). A partial-thickness tear only goes through part of the palmar, medial, or dorsal area, while a full-thickness tear goes all the way through the area, or the area is lacking.

Using SPSS v23, data from MR arthrograms and arthroscopy outcomes were combined. Quantitative data were analyzed by the mean and standard deviation, whereas qualitative data were analyzed by frequencies and percentages. MR arthrogram findings (for TFCC tears and internal ligament tears) were compared to arthroscopy findings (as documented in each patient's surgical record), taking arthroscopy as the gold standard. Estimates were produced on the specificity, sensitivity and accuracy of tears. Only when the diseased conditions appeared in both imaging and surgical results was there a true positive result. Every false-negative and false-positive data set was subjected to a false-positive analysis.

Results

MR arthrograms were performed on a total of 12 patients during the months of April 2019 and September 2022 to get comprehensive information on their medical and surgical conditions. Since there was no record kept for one patient, that was excluded from the study. The eleven most recent patients were investigated. There were five female patients, which accounts for 45.5% of the total, and there were six male patients, which accounts for 55.5%. Those that were admitted to the hospital had an average age of 40.0±12.31 years old. From the time of the MR arthrography to the operation, the process typically took 7.8 months. We investigated the efficacy of arthroscopic surgery as well as MR arthrography (Table 1).

Table I: Arthroscopy and MR arthrography for detecting intrinsic ligaments tears and TFCC (n=11)

	Gender	**N**	**%**
TFCC tear scanned on MR	Male	2	18.2
	Female	3	27.3
Ligaments tear on MR	Male	3	27.3
	Female	2	18.2
Total		**10**	**91.0**
TFCC tear on arthroscopy	Male	3	27.3
	Female	4	36.3
Ligaments tear on arthroscopy	Male	2	18.2
	Female	2	18.2
Total		**11**	**100.0**

Seven individuals who had arthroscopy were discovered to have TFCC tears. Four people had damage to lunotriquetral and scapholunate ligaments. MR arthrography revealed that five individuals had TFCC tears. Five people had damage to the s lunotriquetral and scapholunate ligaments. MR arthrography was superior to arthroscopy in locating TFCC tears in 5 of 11 instances (5 true positives and 1 false positive). In one instance, arthroscopy detected a TFCC tear that MR arthrography did not (false negative). arthroscopy did not detect a TFCC rupture in one patient, but MR arthrography detected (false positive). Table II

Table II: Assessing the diagnostic performance of arthroscopy and MR arthrography in detecting TFCC tears (n=11)

Test result	**Arthroscopy**		
	Tear	No tear	Total
MR arthrography	TP = 5	FN = 2	7
	FP = 1	TN = 3	4
	Total = 6	5	11

In five of the seven patients, MR arthrography proved to be a significantly more effective method for detecting TFCC tears compared to arthroscopy. MR arthrography can identify TFCC abnormalities with a sensitivity of 71.42 percent. Meanwhile, 75% of the time, MR arthrography does not reveal any issues. In two patients, MR arthrography could not detect a TFCC tear, with a false positive result, while arthroscopy successfully identified the tear leading to false-negative outcomes for MR arthrography). In one case, MR arthrography detected a tear that arthroscopy had failed to observe, resulting in a false-positive outcome. The research investigated sensitivity, specificity and positive predictive value (PPV), negative predictive value (NPV), and accuracy for detecting TFCC and intrinsic ligament tears. This rephrased version conveys the same meaning as the

original passage while improving the phrasing and structure (Table III & V).

PPV: TP/(TP+FP)x100
NPV: TN/(FN+TN)x100
Accuracy: (TP+TN)/(TP+TN+FP+FN)x100
Sensitivity: TP/(TP+FN)x100
Specificity: TN/(FP+TN)x100

Table III: MR arthrography in detecting TFCC tear (n=11)

Accuracy	72.7%
Negative predictive value	60.0%
Positive predictive value	83.3%
Sensitivity	71.4%
Specificity	75.0%

Table IV: Comparison of A comparison of the diagnostic performance of MR arthrography and arthroscopy in detecting tears of intrinsic ligaments (n=11)

Test result		**Arthroscopy**		
		Tear	No tear	Total
MR arthrography	Tear	TP: 4	FP: 1	5
	No Tear	FN: 0	TN: 6	6
	Total	4	7	11

Table V: MR arthrography in detecting intrinsic ligaments tear (n=11)

Accuracy	90.9%
NPV	100.0%
PPV	80.0%
Sensitivity	100.0%
Specificity	85.7%

The diagnostic accuracy of MR arthrography for TFCC tear detection is 73%. In all four patients, MR arthrography outperformed arthroscopy in identifying tears within the joint. MR arthrography provides a 100% positive predictive value in detecting intrinsic ligament abnormalities (sensitivity). For MR arthrography, 85.7% of negative results were validated. In one case, MR arthrography discovered a tear that arthroscopy had failed to detect (false positive). MR arthrography was successful in identifying a torn intrinsic ligament 91% of the time.

Discussion

It was seen in 11 MR arthrograms and 11 intrinsic tears matched the arthroscopic findings to confirm the TFCC in this study. MR arthrography detects TFCC abnormalities with a sensitivity of 71.4% and a specificity of 75%. It had a sensitivity of 100 percent and a specificity of eighty-five and a half percent for identifying intrinsic ligament anomalies. 73% of the time, the TFCC was right, whereas 90.9% of the time, ligaments were correct. The average sensitivity of MR arthrography for TFCC tears was 71.4%, which was good for intrinsic tears. 90.9% of the time, rips in the intrinsic ligaments are accurately diagnosed. The typical TFCC tear percentage is 72.7%. Prior to MR arthrography, arthroscopy was performed on each participant in this study. In terms of validating the diagnosis and evaluating the reliability and accuracy of this imaging technique, arthroscopy on MR has produced either negative or positive results. On the other hand, the diagnostic accuracy and sensitivity MRA suggest that it is an invasive and costly technique. In some circumstances, diagnostic arthroscopy may not be necessary, although large-scale studies are required to evaluate whether MRA is associated with greater diagnostic sensitivity for TFCC tears. Magnetic resonance imaging (MRI) is believed to have revolutionised the identification and treatment of wrist conditions. Despite this, early research failed to demonstrate that MR arthrography was considerably superior to conventional MRI of the wrist, with sensitivity and specificity of 50% and 50%, respectively.[14] It has been shown that MR arthrography may identify scapholunate ligament lesions 86% of the time. By injecting contrast material into the joint space, MRI images of internal structures may be rendered much sharper because the joint capsule expands, intraocular structures can be seen, and tears can be seen because they leak into the joint space above.[15] According to a study by Steinbach et al MR arthrography is the most effective method for evaluating wrist lesions because it combines the benefits of conventional arthrography with magnetic resonance (MR) imaging.[16] Nevertheless, Scheck et al identify and quantify ligamentous anomalies in all regions of the scapholunate ligament, revealing that they correlate well with wrist arthroscopy and have diagnostic and therapeutic planning applications.[17] Our results are comparable with those of other studies that used MR arthrography to investigate wrist injuries. Several authors compared MR arthrography to different diagnostic techniques to illustrate its sensitivity. According to Brydie et al and Zlatkin et al MRI is a valuable diagnostic technique for identifying injuries to bones, ligaments, and tendons. MRI measurements of the scapholunate and lunotriquetral ligaments were accurate to 90% and 80%, respectively.[18,19] Totterman et al also investigated the sensitivity of MRI for TFCC tear identification.[20] Hobby et al assessed the diagnostic effectiveness of magnetic resonance imaging (MRI). According to the study, MRI had limited reliability in the

absence of intrinsic ligament tears, despite displaying high specificity, with only moderate sensitivity. When compared to arthroscopy, MRI demonstrated an overall accuracy of 85%, a 70% an overall accuracy of 85%, a sensitivity of 70%, and a specificity of 90%, a specificity of 90%.[21] In contrast, Scheck et al showed that MR arthrography had a high level of specificity and sensitivity, ranging from 90% to 96% and 87% to 100%, respectively, for detecting lesions of the intrinsic ligament and TFCC, with moderate to high sensitivity and support for TFCC connection.[17]

Conclusion

The results of the study show that magnetic resonance arthrography (MR arthrography) is a better way to find problems in the wrist's internal ligaments and TFCC than diagnostic arthroscopy. When injuries to the scaphoid-lunate, lunotriquetral, or TFCC ligaments are suspected, this may be recommended as a risk-free diagnostic method. Even though it will be more expensive, intrusive, painful, and expose them to radiation. Although it cannot yet replace diagnostic arthroscopy, it may be able to reduce the frequency with which it is required. As MR arthrography enhances picture contrast and diagnostic precision, it should be considered the primary test for those who suspect they have a TFCC or intrinsic ligament injury.

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