Role of MRI in evaluation of wrist ligament injury

Fatma R.A. Sedeek, Moustafa H.M. Othman, Abolhasan H. Mohammad

Department of Radiodiagnosis, Faculty of Medicine, Assiut University, Assiut, Egypt

Correspondence to Fatma R.A. Sedeek, Bsc, Department of Radiodiagnosis, Faculty of Medicine, Assiut University, Assiut, Egypt. Postal Code: 71526;
Tel: 01066952726
e-mail: fatma.sedeek@yahoo.com

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Aims

The aim of the study was to evaluate the role of MRI in detection of wrist ligament injury.

Patients and methods

We performed coronal PDW, coronal PDWSPIR, coronal T2-weighted, coronal gradient, and coronal STIR in 20 patients complaining of wrist pain. The authors assessed images for the integrity of lunotriquetral ligament (LTL), scapholunate ligament (SLL), and TFCC tears. Then the authors compared imaging findings with arthroscopic data in 16 patients who underwent arthroscopy (gold standard).

Results

A total of 12 TFCC tears were detected arthroscopically, whereas nine were found on MRI. MRI sensitivity in the diagnosis of TFCC tears was 92.31%. Eight SLL tears were found arthroscopically, whereas three tears were detected on MRI. MRI sensitivity in detecting SLL tears was 42.86%. Three LTL tears were diagnosed arthroscopically, whereas we found two LTL tears on MRI. MRI sensitivity in detecting LTL tears was 33.33%.

Conclusion

MRI has an excellent role in the diagnosis of the TFCC tear with high sensitivity and specificity but less accurate in the evaluation of SLL and LTL injuries.

Keywords:
arthroscopy lunotriquetral ligament, scapholunate ligament, TFCC, wrist ligament injury

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Introduction

The wrist joint is very complicated. It is built on many small carpal joints. It has a wide range of movement in all planes; the radioulnar joints and the wrist joint allow 3D rotatory movements along the axis of the forearm [1].

Scapholunate ligament (SLL) tears and TFCC tears are widespread and are often associated with dislocated distal radial fractures. These ligament tears are frequently missed as there is deficient knowledge or experience; moreover, making a diagnosis is very difficult. It is known that missed ligament tears cause low grip strength and range of motion, instability, and constant pain, as well as degenerative arthritis [2].

MRI was used to detect the volar and dorsal parts of the lunotriquetral and SLLs [3].

Wrist ligaments preserve close communication between wrist bones, permit for a wide range of movement, and preserve the stable joint. The wrist ligaments were classified as intrinsic and extrinsic. The intrinsic ligaments have an origin and insertion within the wrist, whereas the extrinsic ligaments connect the carpal bones with forearm bones or metacarpals. Radio carpal, dorsal ligaments, and triangular fibrocartilage complex are extrinsic ligaments. The triangular fibrocartilage complex includes triangular fibrocartilage disk proper, dorsal and volar radioulnar ligaments, ulnar collateral ligament ulnolunate ligament, ulnotriquetral ligament, meniscus homologue, and subsheath of extensor carpi ulnaris tendon. The intrinsic ligaments are lunotriquetral ligament (LTL), SLL, trapezium–trapezoid ligament, deltoid/arcuate ligament, capitate–hamate ligament, and trapezoid–capitate ligament. LTL and SLL are the most essential intrinsic ligaments; TFCC is the main stabilizer of the distal radioulnar joint [4].

Therefore, the aim of the current study was to assess the role of MRI in the diagnosis of wrist ligament injury.

Patients and methods

A cross-sectional study was approved by the Institutional Ethical Review Board. The nature of the study was adequately explained to the patients, and an informed consent was obtained from all the participants before participating in the study.

Twenty patients were included, with an age range from 19 to 53 years. Their mean age (±SD) was

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30.3 ± 9.78 years. All patients were complaining of wrist pain and/or limitation of movement. We included patients who were clinically suspected to have ligament injury over 1 year from June 2017 to June 2018. There were 16 (80%) males and four (20%) females in the study. A total of 16 patients had history of trauma in the current study. Painful wrist was present in 20 patients, whereas stiffness occurred in 12 patients. Fractures were present in 11 patients. We excluded cases with contraindication for MRI such as presence of cardiac pacemakers, intracranial metallic surgical clips, or retained metallic foreign bodies. Sixteen (80%) patients underwent arthroscopy.

MRI

All patients underwent examination with MRI machine with 1.5 T scanner. The examination protocol included coronal, sagittal, and axial planes. Coronal PDWI (TR/TE, 1000/30), coronal T2-WI FEE (TR/TE, 1200/25), coronal STIR (TR/TE, 20000/48), coronal PDW SPIR (TR/TE, 3500/30), coronal and axial fast T1-weighted (TR/TE, 400/15), coronal axial, and sagittal T2-weighted sequences (TR/TE, 2000/70) were performed. A field of view of 12 cm was used. Slice thickness was 2.5 mm with 2-mm interslice gap.

Image analysis

Experienced musculoskeletal radiologists analyzed the images. They were blinded to arthroscopic data. They made decisions by means of consensus. We evaluate PDW, PDW SPIR, and T2-weighted MR images for the integrity of SLL/LTL/TFCC injuries and for the accurate location of the injuries. We recorded a TFCC tear if we found a linear band of increased signal intensity on PDW, PDW SPIR, and T2-weighted. We diagnosed a SLL and LTL tear if we found distinct areas of ligament discontinuity with increased signal intensity on coronal sequences, or complete absence of the ligament.

Arthroscopy

We excluded patients with normal MRI findings from arthroscopy. Patients who were diagnosed to have one of the following were included for arthroscopy in our study: patients presenting within 6 weeks of trauma with associated fractures, young patients who are actively involved in sports and wish to repair the ligament injury, chronic and debilitating symptoms despite conservative management. Trained orthopedic surgeons performed arthroscopy in 16 patients. They recorded the following findings: presence of full/partial/thickness ligament injury and accurate localization of these injuries.

Statistical analysis

Data were collected and analyzed using SPSS (statistical package for the social science, version 20; IBM, Armonk, New York, USA). Continuous data were expressed in the form of mean ± SD whereas nominal data were expressed in form of frequency (percentage). Diagnostic accuracy, sensitivity, specificity, and positive predictive value of MRI were calculated.

Results

Diagnosis of TFCC tears

We diagnosed TFCC tears in 13 (85%) cases. We found 12 full-thickness TFC tears in 16 cases that underwent arthroscopy. We performed statistical analysis for these 16 cases (Figs. 1–4). The specificity, sensitivity, accuracy, and positive predictive value were 83.33, 92.31, 92.31, and 80%, respectively, for the diagnosis of TFC tears.

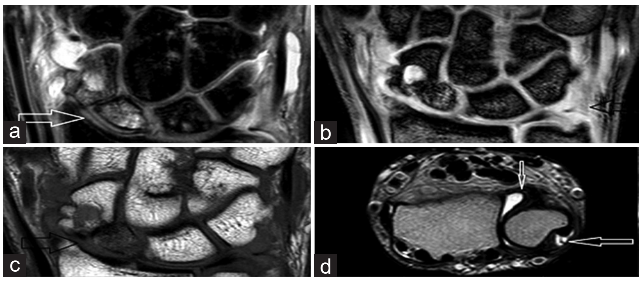
Diagnosis of scapholunate ligament tears

We diagnosed SLL tears in three (15%) cases. We found six SLL tears in 16 cases that underwent arthroscopy. We performed statistical analysis for these cases (Fig. 5). The specificity, sensitivity, accuracy, and positive predictive value were 62.5, 42.86, 42.86, and 100%, respectively, for detecting SLL tears.

Diagnosis of lunotriquetral ligament tears

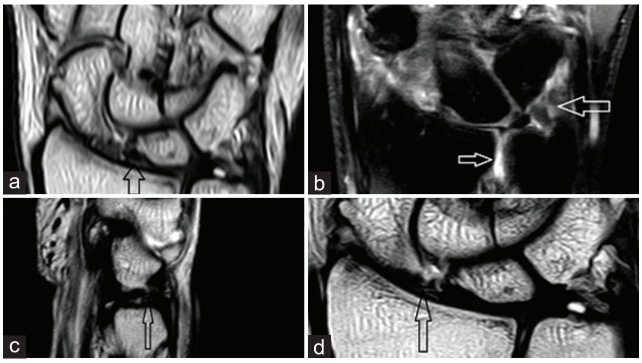
We diagnosed LTL tears in two (10%) cases. We found three LTL tears in 16 cases who underwent arthroscopy. We performed statistical analysis for these cases. The specificity, sensitivity, accuracy, and positive predictive value were 37.5, 33.33, 33.33, and 50%, respectively, for detecting LTL tears.

Figure 1



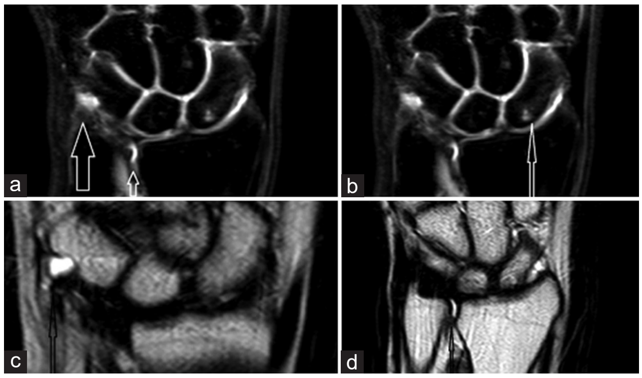
(a) Coronal PDW shows fissure fracture scaphoid waist with avascular necrosis (arrow); (b) coronal T2-W FEE shows TFCC central tear (arrow); (c) coronal T1WI shows fissure fracture scaphoid waist (arrow); and (d) axial T2WI shows synovitis ECU tendon (large arrow) and mild joint effusion (small arrow).

Figure 2



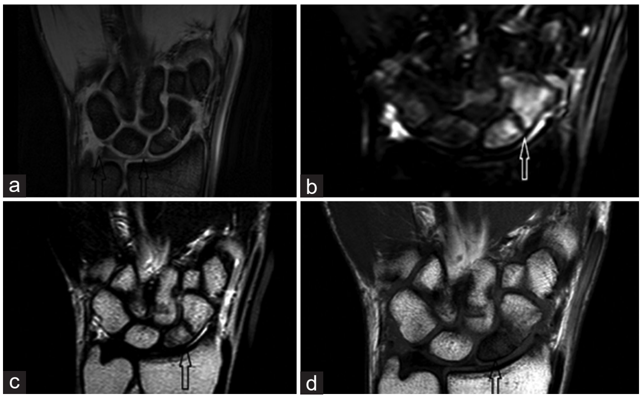
(a) Coronal PDW shows tear of SL ligament with reduced height of nearby edges of both scaphoid and lunate bones (arrow); (b) coronal PDW SPIR shows tear of central portion of TFCC (large arrow) with distal radioulnar joint effusion (small arrow); (c) sagittal T2WI shows tear of central portion of TFCC (arrow); and (d) coronal T2WI shows tear involving SL ligament (arrow).

Figure 3



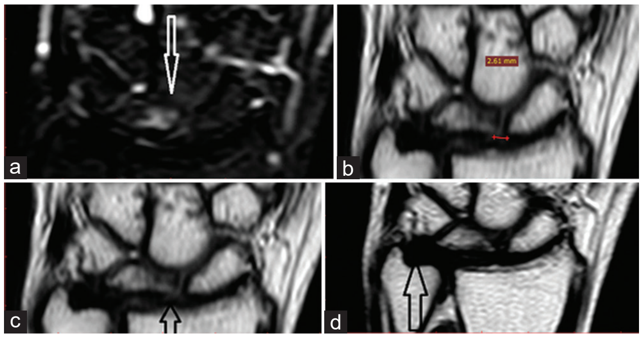
(a) Coronal PDW SPIR shows tear in peripheral ulnar with haziness and disfigurement and fluid collection of TFCC (large arrow) with distal radioulnar joint effusion (small arrow); (b) coronal PDW SPIR shows contusion proximal pole of scaphoid bone (arrow); (c) coronal T2WI shows haziness and disfigurement and fluid collection of TFCC (arrow); and (d) coronal T2WI shows distal radioulnar joint effusion (arrow).

Figure 4



(a) Coronal T2WI-FFE shows tear in peripheral ulnar TFCC (large arrow) – intact SLL (small arrow); (b) coronal STIR shows linear nondisplaced fracture of scaphoid bone (arrow); (c) coronal T2WI avascular necrosis of proximal pole of scaphoid bone (arrow); (d) coronal T1WI shows avascular necrosis of proximal pole of the scaphoid bone (arrow).

Figure 5



(a) Coronal STIR of right wrist shows fracture in lunate with bone marrow (BM) edema (arrow); (b) coronal PDW shows widening of SL joint space (red arrow); (c) coronal PDW shows SL ligament tear (arrow); (d) coronal T2WI shows intact TFCC (arrow).

Discussion

Good correlations between ligament injury at MRI and surgery have been shown in several studies with high accuracy. Radiologists were able to better evaluate complete tears than partial tears. Therefore, we must localize the TFC lesions accurately: the radial or central TFC lesions have good results, but ulnar insertion peripheral TFC lesions have poor results in the literature [5].

The diagnosis of peripheral TFCC tears is clinically essential as they may be associated with instability of the distal radioulnar joint. The peripheral and central tears of the TFCC should be identified and differentiated as the treatment plan is different in each condition. Peripheral tears can be repaired as they have a good vascular supply; however, central tears cannot be repaired as they are avascular [6].

Several studies reported wide variation for specificity and sensitivity of MRI for detecting triangular fibrocartilage complex tear between 100 and 44%. This variation can be because of differences in practice, such as the radiologists experience the resolution of the scanner used, the use of dedicated surface coil, and the thickness of the sections used [7].

MRI is able to do good work in diagnosis tear of the TFCC. Johnstone *et al.*[8] revealed that the specificity and sensitivity were 70 and 90%, respectively. Zlatkin *et al.*[9] revealed that the specificity, sensitivity, and accuracy were 89, 92, and 91%, respectively. Haims *et al.*[10] found that synovitis can be used as a marker for peripheral tear, although the specificity and sensitivity are low, which was 63 and 42%, respectively. Oneson *et al.*[11] found that specificity and sensitivity of central tear were 86 and 100%, respectively, although detection of peripheral tear was low [12].

In our study, 16 patients underwent arthroscopy: 12 TFCC tears were detected arthroscopically and 13 TFCC were detected on MRI. We found that sensitivity of MRI in the detection of TFCC was 92.31%, which was similar to the study by Zlatkin *et al.* [9].

Patients with SLL tears may be asymptomatic or may additionally have nonspecific clinical symptoms and signs. In the latter situation, they frequently present with instability and/or painful wrist and may have signs of subluxation of scaphoid or even normal findings on plain radiographs, motion, and stress views [13].

The lunotriquetral ligament (LTL) and SLL help preserve carpal stability, with LTL tears result in volar intercalated segmental instability, whereas SLL tears result in dorsal intercalated segmental instability. Persistent SLL tears may cause proximal migration of the distal carpal row and radiocarpal joint degeneration. Tears may be because of aging or with age-related tears, usually be free of symptoms. The evaluation of SLL and LTL integrity is difficult owing to their variable shape and small size. It is widely recognized that LTL tear is harder to diagnose than SLL tear [3].

Hobby *et al.*[14] evaluated the detection ability statistics of 1.5-T MRI for intrinsic wrist ligaments and revealed a specificity of 90%, sensitivity of 70%, and an accuracy of 85% for SLL lesions. Within the analysis of the abnormal SLL, published studies vary in their results. Zlatkin *et al.*[9] found sensitivities and specificities of 86 and 100%, respectively, in 20 cases (seven tears). Potter *et al.*[15] had comparative outcomes in the analysis of 53 cases with 17 ligament tears (sensitivity of 88% and specificity of 100%). Scheck *et al.*[16] had much lesser sensitivities and specificities (52 and 34%, respectively) in 41 patients with 17 ligament tears. Schweitzer *et al.*[17] had comparative outcomes in 15 patients (five tears) using shape abnormality or nonvisualization of the ligament as an indication of tear, with specificities of 78 and 86%, respectively, and sensitivities of 20 and 25%, respectively [10].

In our study, we diagnosed SLL tears in three (15%) patients. We found six SLL tears in 16 cases that underwent arthroscopy. We did statistical analysis for these cases and found that sensitivity of MRI in detection of SLL tear was 42.86%.

The LTL is difficult to diagnose at imaging. Smith and Snearly[18] revealed that the LTL may be surely found in 75 normal individuals. They described the normal shape and signal intensity of the ligament.However, evaluation of the abnormal lunotriquetral ligament has been more difficult. Zlatkin *et al.*[9] found a specificity of 100% and a sensitivity of 50% in 20 cases (eight ligament injuries). Potter *et al.*[15] found a specificity of 97% and a sensitivity of 40% in 53 patients (five ligament tears). Totterman *et al.*[19] diagnosed five true-positive, two false-positive findings, and one false-negative in 15 cadavers. In their clinical study of eight cases, they found six true-negative findings and two true-positive. Schweitzer *et al.*[17] analyzed 15 patients with four ligament injuries. They found a specificity of 56% and a sensitivity of 69% using nonvisualization as an indication of ligament tear. By using change in the ligament shape as an indication of tear, the specificity and sensitivity were 90 and 31%, respectively [10].

MRI has revealed different diagnostic work in diagnosing SLL, LTL, and triangular fibrocartilage complex tears. The low sensitivity for LTL (50–75%) and SLL (40–75%) injuries is largely because of their small size. The accuracy of MRI for triangular fibrocartilage complex tears is higher, at approximately 71–100%. Most of these diagnostic studies were done on 1.5-T MR systems [3].

In our study, we diagnosed LTL tears in two (10%) patients. We found LTL tears in three cases that underwent arthroscopy. We did statistical analysis for these cases and found that sensitivity of MRI in the detection of LTL was 33.33%.

Limitations

We include a small sample size. We did not include a control group of asymptomatic participants. We could obtain arthroscopic data for only a small number of cases in our study.

Conclusion

Detection and localization of wrist ligament tears are essential to keep the stability and mobility of the wrist and hand, especially because of more advanced arthroscopic and surgical techniques for wrist ligament repair.

We found that MRI has an excellent role in the diagnosis of the TFCC tear with high sensitivity and specificity but less accuracy in the evaluation of SLL and LTL injuries.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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