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CLINICAL & BASIC RESEARCH

The Role of Wrist Magnetic Resonance Arthrography in Diagnosing Triangular Fibrocartilage Complex Tears

Experience at King Hussein Medical Center, Jordan

Asem A. Al-Hiari

دور الرنين المغناطيسي الملون لمفصل المعصم في تشخيص تمزق المجمع الغضروفي المثلث

تجربة مدينة الحسين الطبية – الأردن

عاصم احمد الحياري

الملخص: **الهدف:** تهدف هذه الدراسة هي تقييم دور التصوير بالرنين المغناطيسي الملون لمفصل المعصم في الكشف عن تمزق كامل السمك للمجمع الغضروفي المثلث ومقارنة نتائج الفحص بالرنين المغناطيسي مع النتائج بالمنظار. **الطريقة**: تم إجراء الدراسة في مدينة الحسين الطبية، عمان، الأردن، خلال الفترة من يناير2008 إلى ديسمبر2011. اثنين وأربعين مريضا (35 من الذكور و7 من الإناث) أدرجوا في الدراسة ممن كانوا يعانوا من ا لم في الجانب الزندي من المعصم مع احتمال سريري بإصابتهم بتمزق في المجمع الغضروفي المثلث. خضع جميع المرضى لفحص الرنين المغناطيسي الملون لمفصل المعصم وبعد ذلك تنظير المعصم. تمت مقارنة نتائج الرنين المغناطيسي الملون لمفصل المعصم مع نتائج المنظار. **النتائج**: بعد المقارنة مع النتائج بالمنظار كان لفحص الرنين المغناطيسي الملون ثلاث نتائج سلبية كاذبة (الحساسية = 93%) وليس هناك أي نتائج إيجابية كاذبة. تسعة وثلاثون مريضا استطاعوا العودة لعملهم. نسبة الرضا كانت عالية في 38 من أصل 42 مريضا و 33 كان لديهم تحسن مقبول في مستوى الألم. كانت حساسية الرنين المغناطيسي الملون لمفصل المعصم في الكشف عن التمزق كامل السمك للمجمع الغضروف المثلث هي 93% (42/39)، وكانت الخصوصية 80% (20/16). كانت الدقة العامة لتنظير المعصم في الكشف عن التمزق كامل السمك للمجمع الغضروفي المثلث في دراستنا هي 85% (34/29). **الخلاصة**: هذه النتائج توضح دور الرنين المغناطيسي الملون لمفصل المعصم في تقييم تمزق المجمع الغضروفي المثلث مع الاقتراح باستخدامها كتقنية التصوير الأولى، بعد صورة الأشعة السينية في تقييم المرضى الذين يعانون من ا لم مزمن في الجانب الزندي من الرسغ مع احتمال سريري بإصابتهم بتمزق في المجمع الغضروفي المثلث.

مفتاح الكلمات: المجمع الغضروف المثلث؛ مفصل المعصم؛ تصوير الرنين المغناطيسي الملون.

abstract: ***Objectives:*** The aims of the study were to evaluate the role of magnetic resonance arthrography (MRA) of the wrist in detecting full-thickness tears of the triangular fibrocartilage complex (TFCC) and to compare the results of the magnetic resonance arthrography (MRA) with the gold standard arthroscopic findings. ***Methods***:The study was performed at King Hussein Medical Center, Amman, Jordan, between January 2008 and December 2011. A total of 42 patients (35 males and 7 females) who had ulnar-sided wrist pain and clinical suspicions of TFCC tears were included in the study. All patients underwent wrist magnetic resonance arthrography (MRA) and then a wrist arthroscopy. The results of MRA were compared with the arthroscopic findings. ***Results***: After comparison with the arthroscopic findings, the MRA had three false-negative results (sensitivity = 93%) and no false-positive results. A total of 39 patients were able to return to work. Satisfaction was high in 38 of the patients and 33 had satisfactory pain relief. The sensitivity of the wrist MRA in detecting TFCC full-thickness tears was 93% (39), and specificity was 80% (16/20). The overall accuracy of wrist arthroscopy in detecting a full-thickness tear of the TFCC in our study was 85% (29/34). ***Conclusion***: These results illustrate the role of wrist MRA in assessing the TFCC pathology and suggest its use as the first imaging technique, following a plain X-ray, in evaluating patients with chronic ulnar side wrist pain with suspected TFCC injuries.

Keywords: Triangular fibrocartilage complex; Wrist; Magnetic resonance imaging; Arthrography.

Advances in Knowledge

- *This was the first study in Jordan to use intra-articular injection magnetic resonance arthrography (MRA) for evaluating injuries of the triangular fibrocartilage complex (TFCC) in the wrist.*
- *Although the procedure is invasive, in a normal setting it carries no major complications.*

Department of Radiology, King Hussein Medical Center, Amman, Jordan
E-mail: ahiari@hotmail.com

Applications to Patient Care

- *MRA of the wrist is a valuable tool in the diagnostic evaluation and detection of full-thickness tears of the TFCC.*
- *It is a safe procedure when performed by an expert radiologist and in the presence of a new magnetic resonance imaging machine with retracted small joint coils.*

Wrist pain is always a challenging presenting complaint, particularly when it occurs on the ulnar side. Determining the exact cause of ulnar-sided wrist pain is difficult due to the complexity of the anatomic and biomechanical properties of the ulnar side of the wrist.[1]

Lesions of the triangular fibrocartilage complex (TFCC) are a common source of ulnar-sided wrist pain.[2,3] The TFCC consists of the articular disk, dorsal and palmar radioulnar ligaments, the meniscal homologue, the dorsal and palmar ulnocarpal ligaments, the ulnar collateral ligament, the sheath of the *extensor carpi ulnaris* tendon, and the capsule of the distal radioulnar joint (DRUJ).[5]

There are two attachments for the TFCC—the radial and ulnar sides. The radial side is attached to the medial surface of the distal radius at the distal margin of the sigmoid notch, while the ulnar side is either a single broad band that is attached to the ulnar styloid or two separate bands that insert into the styloid process and fovea.[2,6]

The ulnar portion of the TFCC is vascularised by the ulnar and posterior interosseous artery braches; on the other hand, the central and radial aspects of the complex are avascular.[6]

Ulnar-sided wrist pain may be due to a tear or perforation in the TFCC. The tear can be detected radiologically in many ways, including through arthrography, magnetic resonance imaging (MRI), or magnetic resonance arthrography (MRA).[4] Arthroscopy is considered the gold standard to which all other modalities are compared. Radial side tears or perforations tend to be traumatic and occur more in younger age groups. On the other hand, central and ulnar side lesions are more often degenerative and are more commonly seen in older patients.[2]

A carefully investigated medical history and a physical examination often lead to a correct diagnosis. However, a search for whether the wrist pain was caused by an acute injury, or brought on by repetitive minor trauma of the wrist, is essential in reaching a diagnosis of the patient's complaint.

The aim of this study was to compare the findings of MRA of the TFCC with the findings of the gold standard, arthroscopy.

Methods

This study was performed at King Hussein Medical Center, Amman, Jordan, between January 2008 and December 2011. Approval of the ethical committee was obtained before starting the study. Patient consent was obtained before examination. The study included 42 consecutive patients who had ulnar-sided wrist pain and clinical suspicions of TFCC tear. The sample consisted of 35 males and 7 females, with an average age of 27.5 years.

All 42 patients underwent a wrist arthrogram before they were sent for a wrist MRI study. The arthrogram was done with the wrist in a prone semi-flexed position to allow the distal articular surface of the radius to be nearly perpendicular to the tabletop. Using a complete aseptic technique to avoid infection, local anaesthetic was given. A 23–24 gauge needle was then introduced and guided fluoroscopically into the radioscaphoid joint. The needle tip position was confirmed with an injection of a few drops of water-soluble contrast material. Then 4–6 ml of a prepared solution of 50% normal saline and 50% water soluble contrast with gadolinium in a concentration of 2.5 mmol/L was injected [Figure 1]. The MRI was initiated within 10–15 minutes of the contrast injection, using the same MRI machine for all patients (1.5T Syngo MRI Scanner, SymphonyTM, Siemens Medical Solutions, Erlangen Germany). A small joint coil was used with the wrist in a neutral position. The following sequences were performed: coronal T1-weighted (T1-W); coronal T1-W fat-saturated; coronal T2-W fat-saturated; axial proton density-weighted, and sagittal T1-W fat-saturated sequences [Figure 2]. An additional 3-D coronal gradient-recalled acquisition was taken in a few cases when the aim was to visualise the small ligaments or structures [Figure 3]. All scans were interpreted by the same radiologist; the site and type of tear were

Figure 1: Normal wrist arthrogram after injecting a water soluble contrast in the radioscaphoid joint.

specified.

All patients underwent a wrist MRA and then were referred to the orthopaedic hand surgeon for a wrist arthroscopy. The arthroscopy was done within 18 weeks of the MRA (mean time = 46 days) and the results of wrist MRA were compared with the arthroscopic findings.

Results

A wrist arthroscopy was carried out regardless of MRA findings, and the decision for an arthroscopy was based purely on clinical findings. TFCC tears were classified according to their locations, and were classified as site 1 if they were at the cartilage attachment to the radius; site 2 if they were pararadial (2–3 mm from the radius); site 3 if they were at the mid-portion; site 4 if they were paraulnar (2–3 mm from the ulnar insertion point of the TFCC); or site 5 if they were at the ulnar insertion point [Figure 4].[4] Of the 42 patients who underwent an MRA, 25 had a radiological criterium of TFCC tears. The tears were classified as: 15 central (site 3), 6 radial (site 1), 3 ulnar (site 5), and 1 paraulnar (site 4) [Figures 5–7].

Figure 2: Coronal fat-saturated T1-weighted image from a magnetic resonance arthrography demonstrates a normal triangular fibrocartilage complex (arrow).

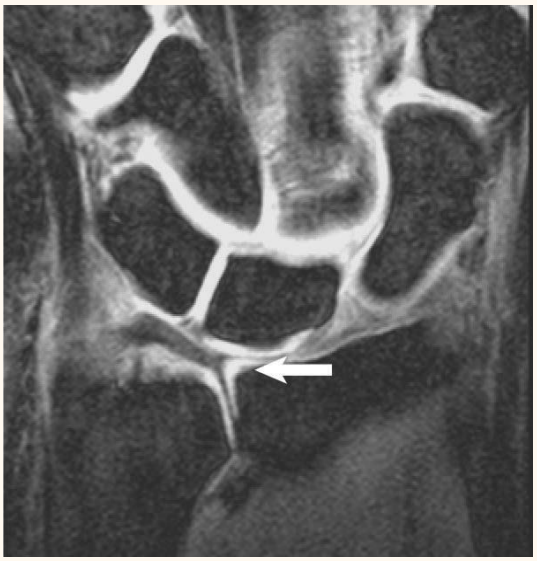

Figure 3: Coronal fat-saturated three-dimensional gradient echo (3-D GRE) image from a magnetic resonance arthrography shows the triangular fibrocartilage complex very clearly, particularly the radial side attachment (arrow). 3-D GRE is excellent for the imaging of small structures of the wrist and evaluation of the cartilage.

After a comparison with the arthroscopic findings, the wrist MRA had 3 false-negative results (sensitivity = 93%) and no false-positive results. The 3 false-negative cases included a 28-year-old male patient with a complete vertical tear at the ulnar attachment of the TFCC which was seen clearly in arthroscopy, but not shown on the MRA. It was reported as an increase in signal intensity in the T1-W sequence at the ulnar attachment side and the finding was considered non-specific. In two male patients, a 35-year-old and a 19-year-old, ulnar detachment tears in the most dorsal aspects of the TFCC were recognised retrospectively. The sensitivity of a wrist MRA in detecting TFCC full-thickness tears was 93% (39/42), and specificity was 80% (16/20). The overall accuracy of a wrist arthroscopy in detecting a full-thickness tear of the

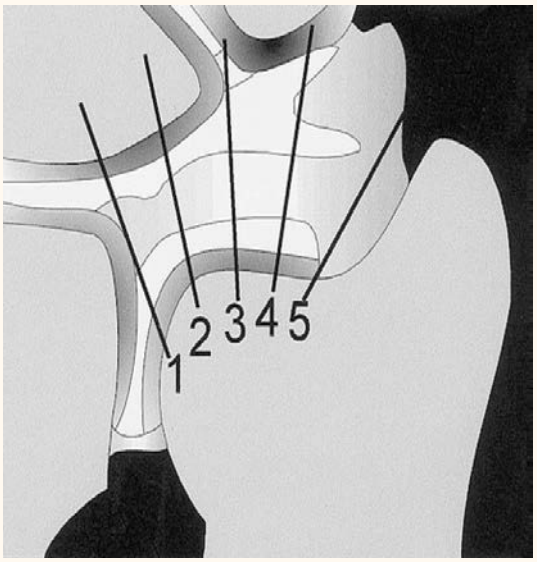

Figure 4: Coronal drawing of the wrist showing the location of triangular fibrocartilage complex tears.

Figure 5: Coronal T1W fat-saturated sequence showing a relatively big communicating tear (arrow head) close to the radial attachment of the triangular fibrocartilage complex.

TFCC in this study was 85% (29/34).

On a long term follow-up, 39 of the 42 patients were able to return to work, and 31 of the patients were able to return to their previous level of activity. Patient satisfaction was high in 38 of 42 patients, and 33 had satisfactory pain relief.

Discussion

This study revealed an overall accuracy of a wrist arthroscopy in detecting a full-thickness tear of the TFCC of 85%.

Many studies have shown evidence of central degenerative disc changes after age 40, which is often asymptomatic. This degeneration results in abnormal increased signal intensity within the material of the TFCC upon MRI. This disc degeneration may also cause non-traumatic communication between the distal radioulnar and radiocarpal joints which is reported in up to 7% of patients who are over 40 years of age.[5,7]

Detecting peripheral tears of the ulnar attachment of the TFCC is an imaging challenge. They are clinically important because they may be associated with instability of the DRUJ.[4,6,8] Although tears of the TFCC in the radial or central aspect are easily seen, tears at the ulnar attachment are frequently difficult to evaluate and may be missed. This difficulty in detection is clearly evident by the three false-negative ulnar side tears in this study. Standard MRI plays a limited role in the evaluation

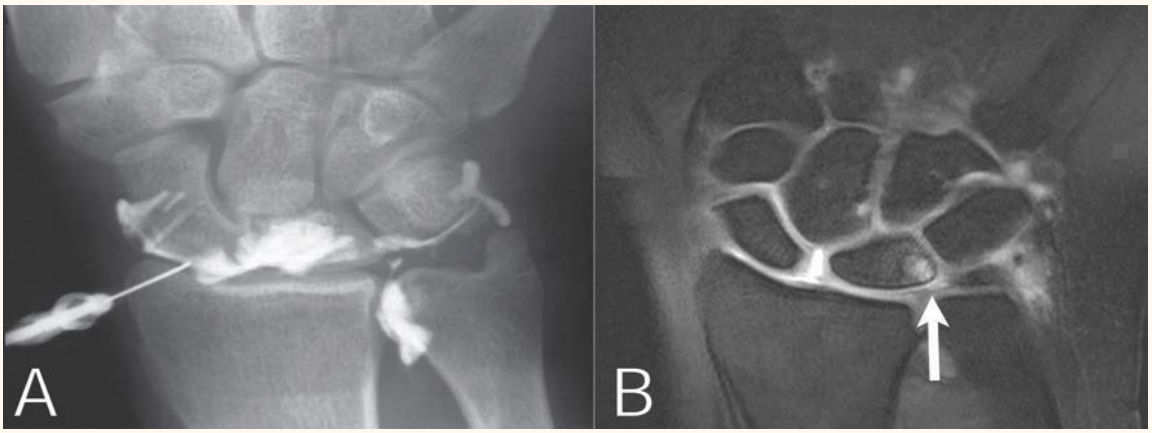

Figure 6: (A) Radiocarpal wrist arthrography showing a tear at the pararadial part of the triangular fibrocartilage complex (site 2); **(B)** Coronal T1-weighted fat-saturated sequence confirming the arthrogram finding and clearly showing the tear (arrow).

Figure 7: (**A**) Coronal T2-weighted fat-saturated sequence; (**B**) Coronal T1-weighted image; (**C**) Coronal T1W fat-saturated sequences showing clearly a small, full thickness tear of the triangular fibrocartilage complex at the radial end (arrow).

Table 1: Magnetic resonance imaging appearance of triangular fibrocartilage complex tears (Palmer classification)

Category	MRI features	Comments
1. Traumatic		
A. Central perforation	Linear increase signal intensity (T2W)	Avascular portion, may not heal
B. Ulnar avulsion	Increase signal at ulnar attachment (T2W)	May have ulnar base fracture
C. Distal avulsion	Increase signal at ulnar attachment and ulnolunate and ulnotriquetral ligament attachment (T2W)	May lead to ulnar translation
D. Radial avulsion	Increase signal at radial attachment (T2W)	May be associated with radial fractures
2. Degenerative		
A. TFCC central degeneration	Intermediate signal in PD and T2W sequence	
B. TFCC perforation with lunate chondromalacia	Same as A with thinning or increase signal in lunate articular cartilage.	
C. TFCC perforation and chondromalacia	Signal increase on T2W and lunate cartilage changes	
D. TFCC perforation, chondromalacia and lunotriquetral tear	Same as 2C plus increased signal in lunotriquetral ligament	
E. features of 2D plus ulnocarpal and radioulnar arthritis.	Same as 2D plus osteophytes in ulnocarpal and radioulnar joints	

MRI = magnetic resonance imaging; T2W = T2-weighted image; TFCC = triangular fibrocartilage complex

of peripheral ulnar side tears, so an MRI arthrogram is the examination of choice in such cases.[8]

The peripheral and central tears of the TFCC must be differentiated as the mode of treatment is different in each condition. Peripheral tears have a good vascular supply and are repaired; however, central tears are avascular and are commonly managed with debridement.[6]

The most widely-adapted classification of the appearance of TFCC tears upon MRI is the Palmer classification [Table 1]. However, in this study, tears are described as radial, central, or ulnar because this classification plays a major role in the clinical evaluation and management of patients. At King Hussein Medical Center, the ulnar side tears are repaired and sutured. On the other hand, radial and central tears are debrided. This information allows improved preoperative patient consent and planning.

In this study, the radiological evaluation of the TFCC included a plain X-ray, a computed tomography (CT) and MRI scans, and an arthrogram or MRA.

A simple, plain X-ray should include posterior-anterior (PA) and lateral views of the wrist, and is essential as it could illustrate joint arthrosis, ulnar styloid process fractures, and ulna variance (positive or negative). About 60–70% of the TFCC tears are associated with ulnar styloid fracture.[5,9]

A CT scan is a more detailed mode of investigation, particularly if 3-D reconstruction images are needed. The overall alignment of the carpal bones can be clearly evaluated. If CT arthrography is used, it can be helpful in detecting TFCC or an interosseous ligament defect. No research has mentioned the superiority of a CT scan over MRA in diagnosing TFCC tears.[9–12]

An MRI evaluation is usually done by using spin-echo T1-W and T2-W sequences along with a PD-weighted gradient-echo and a T1-weighted fat saturation technique. Recently, high-resolution 3-D gradient-echo, with thin cut sequence, has been used and could increase the detection rate of TFCC tears.[3,13] The TFCC appears very similar to the knee meniscus upon MRI.[14]

MRI has been proposed as a non-invasive alternative diagnostic test but it did not approach the accuracy of MRA in this sort of pathology.[3] Besides information about the TFCC and interosseous ligaments, MRI will give additional information regarding bone oedema, cartilage lesions, neuropathy, and bone and muscle injuries. Using arthroscopy as the gold standard, MRI has been shown to have an accuracy of 64–75% for perforations or tears.[2] The inhomogeneous signal intensity and the striated appearance of the TFCC, especially of the ulnar side, may make these disruptions more difficult to detect.[2,8]

An arthrogram may be used to confirm the diagnosis when a clinical history and physical examination suggest a TFCC defect or interosseous ligament instability. Water-soluble contrast material is injected into one of the 3 non-communicating spaces of the carpus: the distal radioulnar joint, the radiocarpal joint, and the midcarpal joint. The decision to obtain a single-injection *versus* a triple-injection arthrogram must be based on specific clinical findings.[1] This method will show abnormal connections between the radiocarpal, distal radioulnar, and midcarpal joints. With the addition of video recording during the injection of contrast material, the arthrogram can determine the specific site of abnormal communication.[7]

MRA is involved in the controversial question of the appropriate technique to use in the diagnosis of TFCC tears. Shionova *et al*. reported arthrograms to be superior to MRI scanning.[10] However, it is important to keep in mind that the MRI technique described in that study used relatively thick sections and a wide interslice gap, which may be considered suboptimal. Some authors would agree that the two techniques may be equivalent.[4] However, it is generally accepted that a combination of MRI and MRA is currently the method of choice in TFCC tear diagnosis, and at our institute the protocol was to perform this investigation in all patients who were sent to evaluate the TFCC for possible injuries or rupture. The MRA procedure is the same as arthrography; however, the contrast injected is a prepared solution of 50% normal saline and 50% water soluble contrast with gadolinium in a concentration of 2.5 mmol/L [Figure 5–7]. The MRI sequences also remain the same but with more fat-saturated sequences, as required.

There were some limitations to this study. The study group did not include asymptomatic patients with expected normal TFCCs. A second limitation was the delay of up to 18 weeks between the MRA and the arthroscopy. During such a delay, an incomplete tear can turn into a complete one, or a tear seen through MRA can fill in with healing reaction tissue, making such a tear undetectable upon arthroscopy. The small number of patients included in the study precluded statistical inference, but the results, if taken as those of a prospective pilot study, are promising.

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Conclusion

These results illustrate the useful role of wrist MRA in assessing TFCC pathology and suggest its use as the first imaging technique, after a plain X-ray, in evaluating patients with chronic ulnar side wrist pain with suspected TFCC injuries. MRA of the wrist is a valuable tool in a diagnostic evaluation to detect full-thickness tears of the TFCC.

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