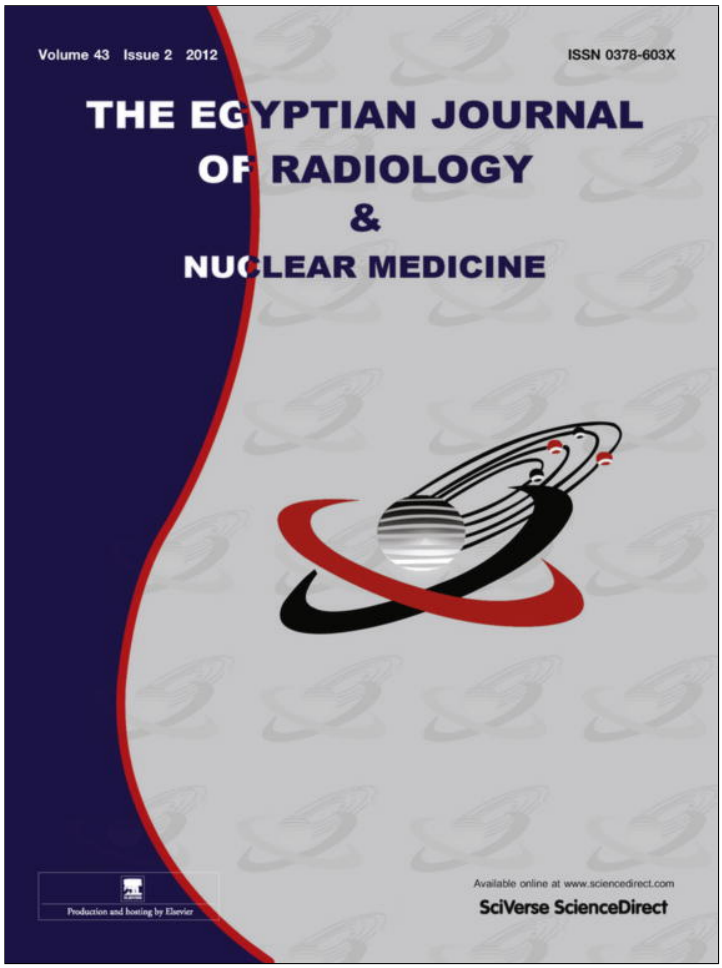
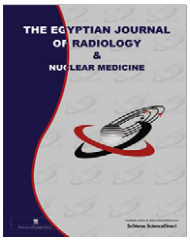


The Egyptian Journal of Radiology and Nuclear Medicine (2012) **43**, 235–244

Egyptian Society of Radiology and Nuclear Medicine

The Egyptian Journal of Radiology and Nuclear Medicine

www.elsevier.com/locate/ejrnm
www.sciencedirect.com



ORIGINAL ARTICLE

Conventional magnetic resonance imaging versus MR arthrography (MRA) of the wrist in the evaluation of triangular fibrocartilage lesions

Manar Hussein Abdelsattar [1], Mohamed Abdelfattah Hassaan [*], Heba Ahmed Kamal [2]

Kasr Elainy Hospitals, Cairo University, Egypt

Received 24 November 2011; accepted 28 January 2012
Available online 20 March 2012

KEYWORDS

Conventional MRI;
MR arthrography;
Triangular fibrocartilage

Abstract *Objective:* The aim of this study is to assess the diagnostic value of direct MR arthrography compared to conventional MR imaging in the diagnosis of different pathologic entities affecting the triangular fibrocartilage.
Subjects and methods: This study included 51 patients complaining of chronic wrist pain. Conventional MRI and MR arthrography (MRA) was done for all cases.
Results: A comparison of the sensitivity of conventional MRI versus MRA was done by correlating the final diagnosis of each modality with the results of arthroscopy. MRI revealed a sensitivity

Abbreviations: TFCC, triangular fibrocartilage complex; CMRI, conventional MRI; MRA, MR arthrography; DRUJ, distal radioulnar joint; ECU, extensor carpi ulnaris tendon; UCL, ulnar collateral ligament.

* Corresponding author. Mobile: +20 01005600614.
E-mail addresses: manarhussein@yahoo.com (M.H. Abdelsattar), moh_a_hassan@yahoo.com (M.A. Hassaan), hebaka mala@yahoo.com (H.A. Kamal).
[1] Mobile: +20 01001620233.
[2] Mobile: +20 01223600583.

Peer review under responsibility of Egyptian Society of Radiology and Nuclear Medicine.
doi:10.1016/j.ejrnm.2012.01.009

ELSEVIER **Production and hosting by Elsevier**

(SEN) of 88.5%, specificity (SPE) of 100%, positive predictive value (PPV) of 100%, and a negative predictive value (NPV) of 69.2%, with an overall accuracy (ACC) of 90.9%, while MRA revealed a SEN of 94.2%, SPE of 100%, PPV of 100%, NPV of 81.8%, and ACC of 95.5%.

Conclusion: MR arthrography is a potent additional tool facilitating the diagnosis of different pathologic entities affecting the triangular fibrocartilage requiring surgical intervention and help to reduce arthroscopic interventions.

1. Introduction

The anatomy of the wrist is complex and its structures are small, with ligaments and cartilage measuring in the order of millimeters, necessitating high-contrast and high-resolution imaging. In recent years, magnetic resonance imaging (MRI), and magnetic resonance arthrography (MRA) have greatly matured and proven efficacious for the diagnosis of internal derangements of the wrist (1,2).

Arthrography of the wrist has been shown to be effective in diagnosing TFCC tears. Magnetic resonance imaging (MRI) is a useful tool in the imaging of the wrist, because of its superior soft-tissue contrast and multiplanar capability. Combining MRI with arthrography could potentially increase the accuracy (2).

Combination of the advantages of conventional arthrography with the direct visualization of structures on magnetic resonance (MR) imaging made magnetic resonance arthrography (MRA) the preferred modality for imaging patients with internal derangement of the wrist (3).

Triangular fibrocartilage complex (TFCC) tear is a common cause for pain and instability in the wrist. Tears of the TFCC may not be apparent on clinical examination alone, and a variety of radiographic tools have been used to enhance the accuracy of diagnosis (4).

The aim of this study: to assess the diagnostic value of direct MR arthrography compared to conventional MR imaging in the diagnosis of different pathologic entities affecting the triangular fibrocartilage.

2. Materials and methods

This study included fifty-one patients; (33 males, 18 females) with ages ranging from 17 to 59 years (mean age 38 years). Consent was obtained from all patients before doing this study. All patients were referred to the Radiology Department from the out patient clinic and emergency unit of the Orthopedic Department, Faculty of Medicine Kasr El-Eini Hospital, Cairo University between October 2006 to October 2009.

All patients complained of chronic refractory unexplained wrist pain, whether post traumatic (30) 58.85%, or non-traumatic (21) 41.2%.

All patients were subjected to the following:

- History taking, and clinical provisional diagnosis,
- Radiological investigations:
  - o Conventional unenhanced MRI.
  - o X-ray and conventional arthrography films.
  - o MR arthrography.
- Surgical arthroscopy as gold standard was performed for 44 patients. Three patients refused to undergo the procedure, and four patients improved on medical treatment and physiotherapy.
- Three musculoskeletal radiologists assessed the MR images for TFCC tears before and after contrast injection, but were unaware of the arthroscopic results.

2.1. Magnetic resonance imaging

MRI was performed using GYROSCAN INTERNA 1.5T MAGNET (PHILIPS) at the Radiology Department of Kasr El-Eini Hospital, Cairo University.

The patients were scanned in the supine position, with the arms alongside the body and the dorsum of the hand parallel to the coronal plane of the magnet. However, 22 patients were scanned in the prone position with the arm above their head in the so-called "Superman" position.

A circular coil was (C 200) placed over the wrist joint, and was secured by rubber bands.

2.1.1. Protocol of MR imaging (Table 1)

Preliminary scout localizers in axial, coronal and sagittal planes were done.

N.B: Additional coronal STIR images were done only in 35 patients.

2.1.2. Direct magnetic resonance arthrography

MRA was performed guided by fluoroscopy, using Omni Diagnost Multipurpose X-ray system (PHILIPS) at the Radiology Department of Kasr El-Eini Hospital, Cairo University.

All patients were placed supine, with the forearm at the side and pronated, using the dorsal approach to inject the contrast mixture.

The area of interest was prepared and draped in a sterile fashion using Betadine solution.

The subcutaneous tissue was locally anaesthetized, using 4–5 ml of xylocaine 0.5% solution for injection.

Gadopentetate dimeglumine 0.1 ml was added to 3 ml non-ionic contrast medium, 5 ml xylocaine, and sterile saline solution was added to form a mixture of 20 ml.

Mid carpal injection: The needle tip (22 gauge) of 5 cm syringe was advanced through a dorsal approach into the mid carpal joint compartment at the scaphocapitate space, and injection was continued until contrast was visualized within the capitolunate joint space. Single mid carpal injection was done only in 10 patients, where leakage into the radio carpal joint was encountered.

Table 1 Protocol of MR imaging.

	TR	TE	FOV	SL	Gap	Matrix	NSA
Coronal T1 (TSE)	500	16	10	2.5	0.3	256×516	4
Coronal T2 (TSE)	3046	100	10	2.5	0.3	256×516	6
Coronal T2* (3D/FFE)	30	13	10	1.5	0	240×512	3
Axial T2 (TSE)	2443	100	10	3	1	256×512	4
Sagittal T1 (TSE)	896	24	10	2.5	0.3	256×135	1
Coronal STIR (TSE)	2380	33	12	2.5	0.3	256×192	2

Preliminary scout localizers in axial, coronal and sagittal planes were done.

The remaining 41 patients underwent double injection into the mid carpal, and radio carpal joints.

Radiocarpal injection: The needle was advanced 0.5 cm distal to Lister's tubercle at the dorsum of the radius, either the needle was volarly angulated 10–15° to avoid striking the dorsal lip of the radius, or the joint was flexed over a sponge, and the needle was advanced perpendicular to the joint.

Three to four milliliter of contrast mixture was injected into the mid carpal compartment, until the patient felt some pressure in the joint, then radio carpal injection was done using 4–5 ml or more if communication with the distal radioulnar joint (DRUJ) was established.

The patient was transferred to the MRI unit after 30 min and active exercise of the joint was advised to ensure uniform dispersion of the contrast.

The same surface coil was used and T1 fat suppression sequences (TR 550, TE 24, FOV 10, SL 2.5, gap 0.3 MATRIX 256×516, NEX 4) in coronal, axial and sagittal planes were done, also coronal T1 3D FFE was done (TR 25 TE 5 FOV 100, SL 1.5, MATRIX 224×516, NSA 2).

2.2. The statistical methods in establishing the results

Data were statistically described in terms of range, mean ± standard deviation (±SD), frequencies (number of cases) and percentages when appropriate. Accuracy was represented using the terms sensitivity, specificity, +ve predictive value, −ve predictive value, and overall accuracy. All statistical calculations were done using computer programs Microsoft Excel 2003 (Microsoft Corporation, NY, USA) and SPSS (Statistical

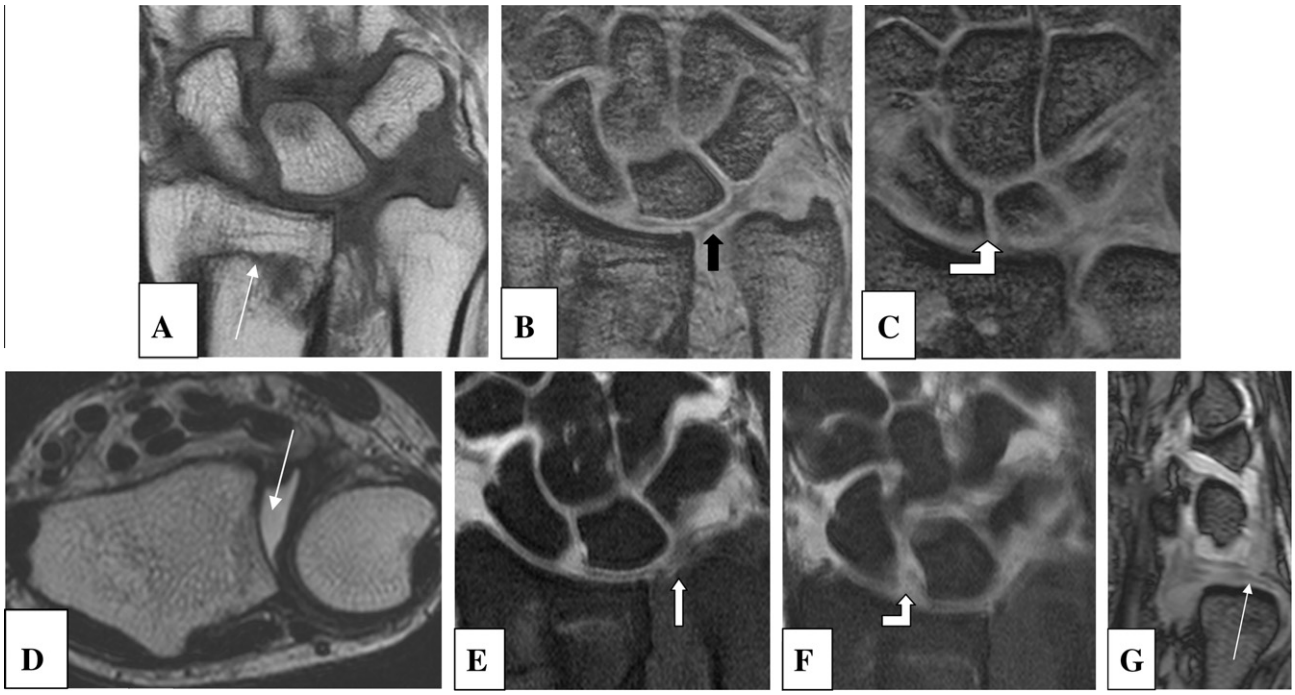


Fig. 1 Male patient with pain at the dorsum of the left wrist after direct trauma underwent conventional MRI. Coronal T1 WI (A) revealed: malunited fractured distal radius (long arrow). Coronal T2 3D FFE WIS (B & C) shows altered signal of the central part of the TFC limited to its distal articular surface (black arrow) suggesting partial tear, and torn SL (scapholunate) ligament (curved white arrow). Axial T2 WIS (D) shows subluxation of the DRUJ, with moderate effusion noted (arrow). Intra articular injection was done into the mid carpal compartment, with free leakage of contrast into the radio-carpal joint space through the scapholunate interval, followed by MRA. Coronal T1 fat suppressed MR arthrographic images (E & F) show partial central tear of the TFC (arrow) class I–A, as well as tear of the SL ligament (curved arrow). Sagittal T1 3D FFE MR arthrographic image (G) shows partial tear of the TFC (arrow).

Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows.

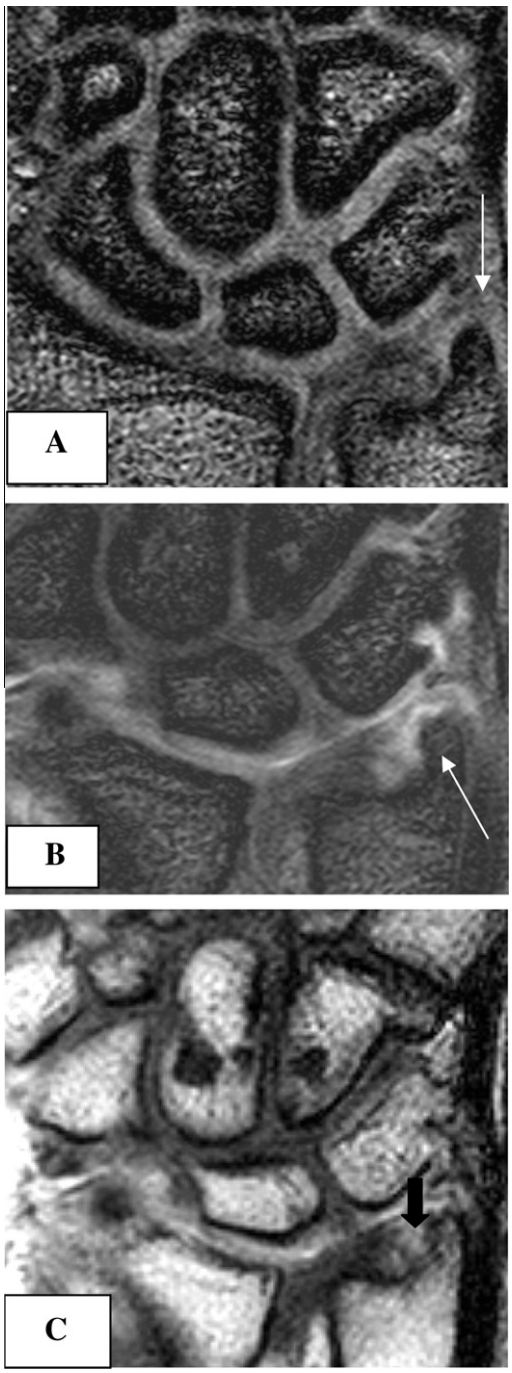


Fig. 2 Male patient was complaining of chronic right sided ulnar wrist pain, he had a history of old trauma to the wrist and underwent conventional MRI. Coronal T2 3D FFE WIS (A) revealed: detachment of the peripheral attachment of the TFC to the ulnar styloid (arrow). Single intra articular injection into the radio-carpal compartment was done, followed by MRA. Coronal T1 3D FFE & T1 MR arthrographic images (B & C) confirmed the presence of peripheral TFC tear at the attachment to the ulnar styloid process (white & black arrows), being outlined by the injected contrast. Multiple cystic degenerations are seen within the carpal bones.

3. Results

3.1. Conventional MRI findings

The TFC (triangular fibro-cartilage) was normal in 24 patients (47.1%), abnormal (either degenerated or torn) in 27 patients (52.9%), of which 19 patients (37.2%) showed actual tear (Fig. 1(B) & Fig. 2(A)), while 8 patients (15.6%) showed only signs of degeneration (Fig. 3(A&B) & Fig. 4(A)), with the frequency and percentage of the different types of abnormalities delineated in Tables 2–4.

*The difference in the total number of TFC lesions from 27 to 28 is seen because one case harbored two pathologies within the TFC.

3.2. MR arthrography findings

The TFC was found to be normal in 19 patients (37.3%), abnormal in 32 patients (67.2%), with 31 (60.7%) showing actual tears (Fig. 1(E&G), Fig. 2(B&C), & Fig. 3(C&D)) while 2 (3.9%) showed only signs of degeneration (Fig. 4 (D&E)), with the frequency and percentage of the different types of abnormalities delineated in Tables 5 and 6.

*The difference in the total number of TFC lesions from 32 to 33 is seen because one case harbored two pathologies within the TFC.

Tear of the ulnar collateral ligament (forming the lateral boundary of the TFC) with capsular disruption, and consequent extra articular leakage of the injected contrast was detected in two patients.

An intimate relationship was found during this study between the detection of DRUJ (distal radioulnar joint) subluxation, and the diagnosis of TFC lesions (being the major stabilizing factor of this joint) Table 7. Among 32 patients with TFC lesions 24 patients had DRUJ subluxation (Fig. 1(D), Fig. 3(E) & Fig. 4(C)), while eight patients showed normal DRUJ. Among 19 patients with free TFC, only two showed mild DRUJ subluxation, and was secondary to a tear in one of the radio ulnar ligaments.

4. Comparative statistical analysis

Comparing the sensitivity of conventional MRI versus MRA to achieve accurate diagnosis was done by correlating the final diagnosis of each modality with the results of arthroscopy Table 8 & chart 1.

- Thirty-three TFC lesions were detected by MRA, while 31 lesions were detected by conventional MRI. Arthroscopy revealed 35 lesions, with MRA missing two patients, these missed lesions on MRA were small & peripherally located tears, pointing toward the diminished sensitivity of MRA in depicting these types of tears.
- Arthroscopy detected a full thickness tear in one patient, which was diagnosed as a partial thickness tear on MRA.

5. Discussion

The anatomy of the wrist is complex and its structures are small, with ligaments and cartilage measuring in the order

of millimeters, necessitating high-contrast and high-resolution imaging. In recent years, magnetic resonance imaging (MRI), and magnetic resonance arthrography (MRA) have greatly matured and proven efficacious for the diagnosis of internal derangements of the wrist (1,2).

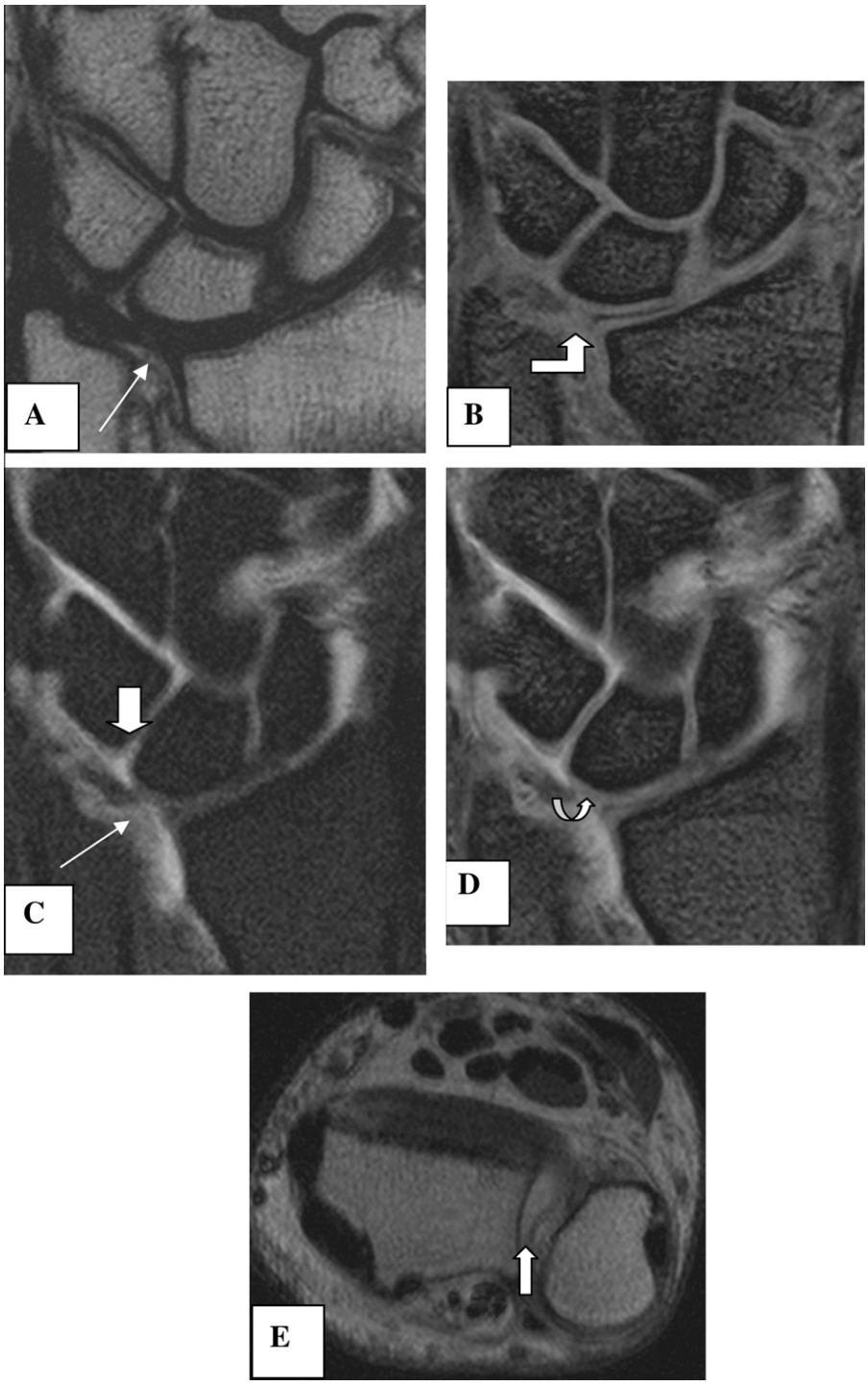


Fig. 3 Male patient complaining of chronic ulnar sided right wrist pain, with no history of trauma underwent conventional MRI. Coronal T2 & T2 3D FFE (A & B) revealed a central area of attenuation with altered signal within the TFC (arrow). Evidence of subluxation of the DRUJ is also noted. Intra articular injection into the mid carpal compartment was performed, with leakage into the radio carpal compartment through the luno-triquetral interval, also leakage was observed into the DRUJ, MRA was then done. Coronal fat suppressed T1 WI (C) & T1 3D FFE (D) MR arthrographic images revealed: a large central defect within the TFC class II–C (straight & curved arrows), with leakage of the injected contrast into the DRUJ, delineating the tear. Also a linear bright contrast signal is seen traversing the LT ligament (small arrow), denoting underlying tear. Axial T1 MR Arthrographic image (E) shows subluxation of the DRUJ, with dorsal subluxation of the ulnar head.

Table 2 The frequency and percentage of the different pathological appearances of the TFC on MRI.

TFC	Frequency	Percentage
No tear	24	47.1
Central attenuation with abnormal signal	7	13.7
Central tear	10	19.6
Peripheral tear	4	7.8
Radial attenuation with abnormal signal	1	2.0
Radial tear	5	9.8
Distal abnormal signal	1	2.0
Total abnormality	28	54.9
Total	51	100.0

Table 3 The frequency and percentage of the Palmer classification of the different TFC lesions on MRI, with 14 traumatic tears (27.4%), 5 degenerative tears (9.8%) and 9 degenerative lesions (15.6%).

Palmer classification	Frequency	Percentage
I-A	6	11.8
I-B	4	7.8
I-D	4	7.8
II-A	5	9.8
II-B	4	7.8
II-C	3	5.9
II-D	1	2.0
II-E	1	2.0
Total lesions	28	54.9
No tear	24	47.1

Table 4 shows the frequency and percentage of tears within the radioulnar ligaments (volar & dorsal), which are components of the TFCC (triangular fibro-cartilage complex), and can be a cause or result of DRUJ subluxation.

Radioulnar ligament	Frequency	Percentage
No tear	44	86.3
Torn volar	6	11.8
Torn dorsal & volar	1	2
Total	51	100.0

Combination of the advantages of conventional arthrography with the direct visualization of structures on magnetic resonance (MR) imaging made magnetic resonance arthrography (MRA) the preferred modality for imaging patients with internal derangement of the wrist (3).

Triangular fibrocartilage complex (TFCC) tear is a common cause for pain and instability in the wrist. Tears of the TFCC may not be apparent on clinical examination alone, and a variety of radiographic tools have been used to enhance the accuracy of diagnosis (4).

The terms communicating (full thickness) and noncommunicating (partial thickness) defects are used in the discussion of TFCC abnormalities. The presence of contrast material in the DRUJ after radiocarpal injection or in the radiocarpal compartment after DRUJ injection indicates a communicating defect in the TFC (5).

Noncommunicating tears involving the proximal and distal aspects of the TFCC can be demonstrated following injection of the DRUJ and radiocarpal joints respectively (6).

Noncommunicating defects which are typically located on the proximal side of the TFC near its ulnar attachment have a more reliable association with symptomatic wrists than do communicating defects (5).

In this study, the patients were divided into two main groups; patients with (traumatic) etiology (30 patients), and patients with no history of trauma degenerative type (21 patients); we used the Palmar classification to categorize the TFC lesions, combined with thorough history taking.

This classification correlates with Thomas et al. (7) studies where they also categorized their patients according to the underlying etiology; traumatic and degenerative, utilizing the Palmer classification regarding TFC lesions.

In our study patients were examined first by nonenhancing conventional MRI, followed by MRA, for better delineation of the internal structures, and accurate diagnosis.

This conformed to Zeev et al. (6) who stated that joint distension by contrast injection, visualization of contrast leakage, allows better evaluation of subtle abnormalities such as a partial ligamentous tear or cartilage defects.

Thomas et al. (7) compared conventional MR imaging with MR arthrography and concluded that the accuracy of diagnosis can be improved with the addition of an intra articular injection.

In our study injection was done through a dorsal approach, starting by the mid carpal compartment, where 10 patients displayed active leakage into the radio carpal joint, obviating the need for additional injection, while the remaining 41 patients showed no evidence of communication and additional injection into the radio carpal joint was done under fluoroscopic guidance.

Nineteen patients showed leakage into the DRUJ after radio carpal injection, denoting indirectly an existing defect within the TFC. Injection into the DRUJ was not done in our study because of the discomfort for the patients, and time constraints.

Schmitt et al. (8) agreed with double injection into the mid carpal and radio carpal joint compartments, while Suraj et al. (5) & Lynne et al. (9) agreed that single radio carpal injection followed by fat suppressed gadolinium sensitive sequences is sufficient.

Amrami, 2006 (10) considered the single compartment arthrography to be more definitive and that the interpretation of multi-compartment injections on the static MRI images obtained after arthrography is complex, since there is no available ''subtraction'' technique and it can be difficult to sort out which ligaments are completely or partially torn and what the direction of the contrast flow has been.

Amrami preferred a single compartment injection planned with the referring surgeon, performing a single injection in the most clinically relevant compartment and then adding additional injections if a tear is not seen on the conventional arthrogram preceding MRI examination.

Marco et al. (11), advocated the need for triple compartment injection for better delineation of peripheral partial TFC tears.

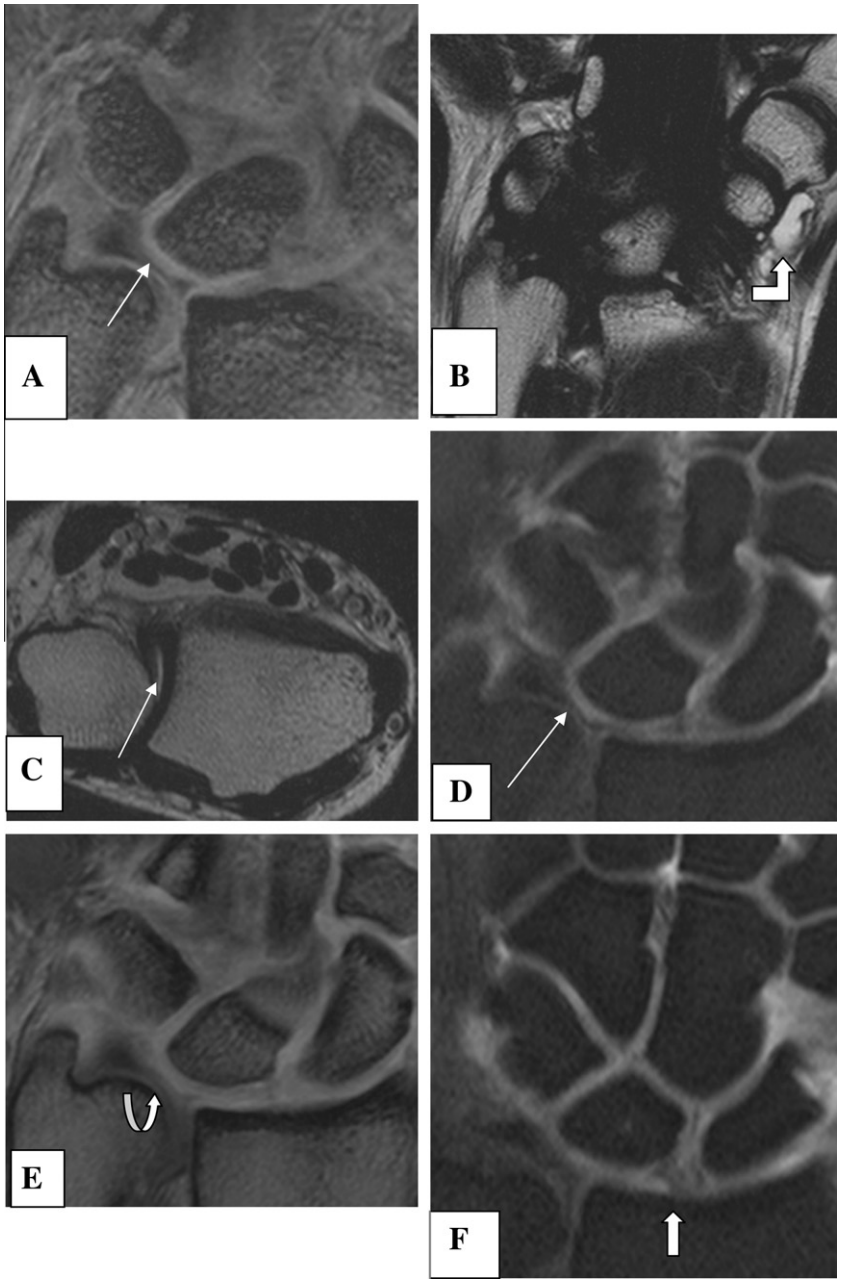


Fig. 4 Male patient complaining of pain of the right wrist following a history of direct trauma underwent conventional MRI. Coronal T2 3D FFE (A) shows markedly attenuated central part of the TFC (arrow). Coronal T2 WI (B) shows a small ganglion cyst seen related to the scapho-trapezoid joint (curved arrow). Axial T2 WI (C) shows mild subluxation and effusion at the DRUJ (arrow). Intra articular injection into both mid carpal and radio-carpal joint compartments was performed, followed by MRA: coronal Fat suppressed T1 & T1 3D FFE MR arthrographic images (D & E) show attenuation of the central TFC, with intra substance enhancement (straight and curved arrows), yet with no definite tear. (F) Coronal T1 Fat suppressed image shows bright contrast signal traversing the SL (scapho-lunate) ligament suggesting partial tear.

In our study conventional MRI diagnosed ten patients out of 51 with central tears, four patients with peripheral (ulnar) tears, five patients with radial tears (between traumatic and degenerative), one patient with abnormal signal, yet with no tear, at the distal attachment of the TFC (ulno-lunate & ulno-triquetral ligaments), and eight patients showed signs of degeneration. The remaining 24 patients had normal TFC.

MRA done after contrast injection showed that 16 patients out of 51 had central tears, eight patients had peripheral (ulnar) tears, six patients had radial tears, one patient with distal (ulno-lunate & ulno-triquetral) tear, and two patients showed signs of degeneration, proving the greater sensitivity of MRA for detecting central and peripheral tears, compared to conventional MRI. Fourteen patients showed concomitant TFC perforation as part of the ulno-lunate impaction syndrome.

These results were compared with the arthroscopic findings; they showed that regarding TFC lesions un-enhanced MRI

Table 5 Shows the frequency and percentage of the different pathological appearances of the TFC on MRA.

TFC	Frequency	Percentage
No tear	19	37.3
Central attenuation with abnormal signal	1	2.0
Central tear	16	31.4
Peripheral tear	8	15.7
Radial attenuation with abnormal signal	1	2.0
Radial tear	6	11.8
Distal tear	1	2.0
Total abnormality	33	64.9
Total	51	100.0

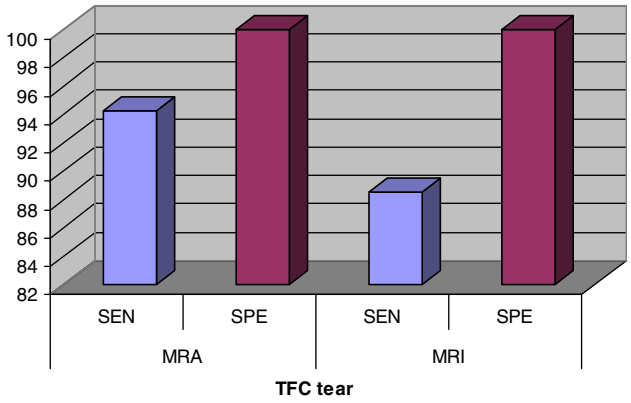


Chart 1 TFC lesions.

Table 6 The frequency and percentage of the Palmer classification of the different TFC lesions on MRA, with 23 traumatic tears (45%), 8 degenerative tears (15.6%), and 2 degenerative lesions (3.9%).

Palmer classification	Frequency	Percentage
I-A	9	17.6
I-B	8	15.7
I-C	1	2.0
I-D	5	9.8
II-A	1	2.0
II-B	1	2.0
11-C	4	7.8
II-D	3	5.8
II-E	1	2.0
Total lesions	33	64.7
N0 tear	19	37.2

displays sensitivity (SEN) of 88.57%, specificity (SPE) of 100%, with four false negative results, and showing accuracy (ACC) of 90.9%. MRA showed a SEN of 94.2%, SPE of 100%, with two false negative results, and ACC of 95.45%.

Hobby et al. (12), who reviewed 11 publications on the diagnostic performance of MRI, found that standard MRI is highly specific but not sensitive in detecting TFC lesions, demonstrating an overall accuracy of 85%, a sensitivity of 70%, and a specificity of 90% if compared to arthroscopy as the gold standard, while our study showed higher values than the fore mentioned ones.

Our study was in accordance with Thomas et al. (7) who found that the diagnostic performance of MRI is improved by MRA making lesions more conspicuous when they are outlined by contrast material in a distended joint space.

This agreed with Braun et al. (4) where their study concluded that MRA was of equal value when compared to diagnostic arthroscopy and has the potential to replace it. In their series, intra-articular contrast helped to diagnose 20 of 41 lesions which were not visualized on non-contrast-sensitive sequences. It was particularly helpful in the diagnosis of defects of the ulnar attachments of the TFC.

Zanetti et al. (13) stated that standard MRI despite showing a high accuracy for central and radial sided TFC tears (Palmer's class IA, ID and class II tears), MRI is less accurate for peripheral tears of the ulnar attachment (Palmer's class IB and

Table 7 TFC lesions (by MRA) versus DRUJ subluxation cross tabulation.

			DRUJ subluxation		Total
			Negative	Positive	
Overall TFC-MRA	NAD	Count	17	2	19
		% within DRUJ subluxation	68.0%	7.7%	37.3%
	Positive	Count	8	24	32
		% within DRUJ subluxation	32.0%	92.3%	62.7%
Total		Count	25	26	51
		% within DRUJ subluxation	100.0%	100.0%	100.0%

Table 8 A comparison between the sensitivity, specificity and accuracy of MRA & MRI regarding TFC lesions correlated with the arthroscopic findings.

	MRA			MRI		
	Sensitivity	Specificity	Accuracy	Sensitivity	Specificity	Accuracy
TFC tear	94.2%	100%	95.45%	88.57%	100.00%	90.91%

IC). The poor performance of MR for these tears was attributed to the presence of high-signal vascularized fibrous tissue between the two ulnar attachments, which can mimic a tear (14).

These findings conform to our study since MRI detected four patients only with peripheral tears, while MRA diagnosed eight patients, correlating with the results of Zanetti & Haims et al. (13,14).

Schmitt et al. (8) conducted a prospective trial over 125 patients, where MRA results were compared with those of arthroscopy, and revealed 70 patients with TFC lesions, showing SEN of 94%, SPE of 89%, our study showed higher results regarding the SPE, while it shows the same sensitivity (94%).

Also our study coincided with Thomas et al. (7) who conducted their study on 45 patients, comparing the results of un-enhanced MRI, with both MRA & MD CT arthrography, in their study un-enhanced MRI diagnosed eight central and three ulnar TFC tears, showing a SEN, & SPE, of 31–60%, & 96–100%. However our sensitivity (88.5%) was higher than theirs. Regarding MRA they showed SEN, & SPE, of 71–93%, & 96–100%, which matches with our results.

In our study two patients (post traumatic) had tears of the ulnar collateral ligament, associated with capsular disruption, and consequent extra articular leakage of the injected contrast in the soft tissues at the dorsum of the hand around the ulnar styloid process, yet with intact ulnar attachment of the TFC, as was interpreted on MRA, yet on arthroscopy they were interpreted as peripheral tears.

In literature this point was debatable between the different authors, Machiels et al. (15) described dorsal peripheral detachment of the TFCC as a tear located at the dorso ulnar floor of the ECU tendon sheath. The tear can extend further into the ulnar collateral ligament. Disruption of ECU tendon sheath results in tendon instability. Machiels et al. (15) concluded that in patients with a history of trauma and without rheumatoid arthritis who present with pain in the dorsal aspect of the wrist near the ulnar styloid along the trajectory of the ECU, contrast opacification of the tendon sheath, as well as extravasation of contrast into the dorsal ulnar and peristyloid soft tissue are pathognomonic features of dorsal peripheral detachment of the TFCC.

Arons et al. (16) described the defect of UCL (ulnar collateral ligament) distal to the intact TFC and exiting into the floor of the ECU tendon sheath. Such cases of ''ulnar capsular leak'' were described as tears of the UCL without associated injury to the TFC or ulnar attachments of the TFC.

In the current study, we reached a conclusion that TFC tears were often associated with DRUJ (distal radioulnar joint) instability, also the presence of DRUJ instability was a clue to meticulously search for TFC tears, being the major stabilizing factor of this joint. Among 32 patients with TFC lesions, 24 patients (92.3%) showed DRUJ instability, while eight only displayed normal DRUJ, while in 19 patients, with normal TFC, only two patients showed DRUJ instability due to underlying osteo-arthritic changes, while the remaining 17 patients (68%) had normal DRUJ.

This finding was in accord with Zeev et al. (6) who stated that peripheral tears of the TFC can be associated with instability of the distal radioulnar joint (DRUJ), also conformed to Peter and Nader, 2009 (17) who found that the mechanism for dorsal subluxation and dislocation of the ulnar head is associated with TFCC avulsion and attenuation of the palmar radioulnar ligament.

Also we agreed with Shih Jui-Tien et al. (18) who mentioned that if the TFCC is disrupted or altered, the wrist becomes unstable. Thus, if the tears were missed, it would cause progressive instability in the DRUJ and arthritic changes. In chronic cases, tears with degenerative changes of the TFCC will be combined with DRUJ instability. They conducted a study over 27 patients with chronic TFC tears, and their radiological examination revealed 23 patients (85.2%) with DRUJ instability.

Limitations in this study included; a few numbers of patients (seven) were excluded from the final comparative statistical analysis due to their lack of arthroscopic correlation. Additionally the time between MR imaging and arthroscopic surgery was not immediate (mean, 2.5 months; range, 1 week to 6 months). This may have been a potential cause of error as patients could theoretically have injuries that occurred during the interval; however, we consider this to be minimal.

MR arthrography cannot replace arthroscopy; however, it could be a potent additional tool for wrist imaging. It can facilitate the diagnosis and the indication for surgery of the wrist and help to reduce arthroscopic interventions for purely diagnostic purposes and without any therapeutic consequences (1).

6. Conclusion

We believe that direct MR arthrographic imaging is well suited for detecting intra-articular lesions of the wrist. The presented diagnostic results of MR arthrography are superior to the results of un-enhanced MRI. Direct MR arthrography as a reliable diagnostic tool is strongly recommended if lesions of the triangular fibrocartilage complex are suspected.

References

(1) Khoury Viviane, Harris Patrick G, Cardinal É tienne. Cross-sectional imaging of internal derangement of the wrist with arthroscopic correlation. Semin Musculoskeletal Radiol 2007;11:36–47.
(2) Braun H, Watanabe Atsuya, Souza Felipe, Vezeridis Peter S, Blazar Philip, Yoshioka Hiroshi. Ulnar-sided wrist pain. II. Clinical imaging and treatment. Skeletal Radiol 2010;39(9):837–57.
(3) Rüegger Christoph, Schmid Marius R, Pfirrmann Christian WA, Nagy Ladislav, Gilula Louis A, Zanetti Marco. Peripheral tear of the triangular fibrocartilage: depiction with MR arthrography of the distal radioulnar joint. AJR 2007;188:187–92.
(4) Braun H, Kenn W, Schneider S, Graf M, Sandstede J, Hahn D. Direct MR arthrography of the wrist: value in detecting complete and partial defects of intrinsic ligaments and the TFCC in comparison with arthroscopy. Rofo 2003;175:1515–24.
(5) Joshy Suraj, Lee Kenneth, Deshmukh Subodh C. Accuracy of direct magnetic resonance arthrography. In the diagnosis of triangular fibrocartilage complex tears of the wrist. Int Orthop (SICOT) 2008;32:251–3.
(6) Maizlin Zeev V, Brown Jacqueline A, Clement Jason J. MR Arthrography of the wrist: controversies and concepts. Am Assoc Hand Surg 2009;4:66–73.
(7) Moser Thomas, Dosch Jean-Claude, Moussaoui Akli. Wrist ligament tears: evaluation of MRI and combined MDCT and MR arthrography. AJR 2007;188:1278–86.

(8) Schmitt R, Christopoulos G, Meier R, Coblenz G, Fröhner S, Lanz U, Krimmer H. Direct MR arthrography of the wrist in comparison with arthroscopy: a prospective study on 125 patients. Rofo 2003;175(7):911–9.
(9) Steinbach Lynne S, William E, et al.. Special focus session, MR arthrography. Radiographic 2002;22:1223–46.
(10) Amrami KK. Magnetic resonance arthrography of the wrist: case presentation and discussion. J Hand Surg Am 2006;31:669–72.
(11) Zanetti Marco, Saupe Nadja, Nagy Ladislav. Role of MR imaging in chronic wrist pain. Eur Radiol 2007;17:927–38.
(12) Hobby JL, Tom BD, Bearcroft PW, Dixon AK. Magnetic resonance imaging of the wrist: diagnostic performance statistics. Clin Radiol 2001;56:50–7.
(13) Zanetti M, Saupe N, Nagy L. Role of MR imaging in chronic wrist pain. Eur Radiol 2007;17:927–38.
(14) Haims AH, Schweitzer ME, Morrison WB, Deely D, Lange R, Osterman AL, et al.. Limitations of MR imaging in the diagnosis of peripheral tears of the triangular fibrocartilage of the wrist. Am J Roentgenol 2002;178:419–22.
(15) Machiels F, Moermans JP, Brutus JP. Arthrographic and CT arthrographic findings in dorsal peripheral detachment of the triangular fibrocartilaginous complex. JBR-BTR 2001;84:114–7.
(16) Arons MS, Fishbone G, Arons JA. Communicating defects of the triangular fibrocartilage complex without disruption of the triangular fibrocartilage: a report of two cases. J Hand Surg Am 1999;24:148–51.
(17) Tsai Peter C, Paksima Nader. The distal radioulnar joint. Bull NYU Hosp Jt Dis 2009;67(1):90–6.
(18) Jui-Tien Shih, Yao-Tung Hou, Hung-Maan Lee, Chuan-Ming Tan, Ming-Chun Chang. Chronic triangular fibrocartilage complex tears with distal radioulnar joint instability: a new method of triangular fibrocartilage complex reconstruction. J Orthop Surg 2000;8(1):1–8.