

Wrist MRI Arthrogram v Wrist Arthroscopy: What are we Finding?

Aatif Mahmood*, James Fountain, Naveen Vasireddy and Mohammed Waseem

Macclesfield District General Hospital, Victoria Road, Macclesfield, SK10 3BL, UK

Abstract: The aim of the study was to compare the radiological findings of wrist arthrogram with wrist arthroscopy. This allowed us to establish the accuracy (sensitivity, specificity) of MRI arthrogram as a diagnostic tool. Thirty patients (20 female and 10 male) have undergone both wrist MRI arthrogram and wrist arthroscopy over the last 3 years at a District General Hospital. The mean age at arthrogram was 42.4 years with an average 6.7 month interval between the two procedures.

The MRI arthrogram was reported by a consultant radiologist with an interest in musculoskeletal imaging and the arthroscopies performed by two upper limb surgeons. Patients who underwent both procedures were identified. The arthrogram reports and operation notes were examined for correlation. Three main areas of pathology were consistently examined: TFCC (triangular fibrocartilage complex), scapholunate and lunotriquetral ligament tears. The sensitivity and specificity of arthrogram was calculated for each. Other areas of pathology were also noted.

In the case of TFCC tears MRI arthrogram had 90% sensitivity and 75% specificity. The lunotriquetral ligament examination with this technique was 100% sensitivity and specificity. However for scapholunate ligament tears it only had 91% sensitivity and 88% specificity.

Wrist arthrogram and arthroscopy are both invasive techniques. In cost terms the arthrogram remains cheaper but is superseded by arthroscopy as it is both diagnostic and therapeutic.

Keywords: Chronic wrist pain, arthrogram, arthroscopy, intrinsic wrist ligaments, magnetic resonance imaging, wrist injuries, wrist joint.

INTRODUCTION

Chronic wrist pain can be due to various causes. Tears of the various ligaments in the wrist joint are one such important cause. Plain x-ray is often employed as the first line of investigation, but it does not provide information regarding radiolucent structures. Arthrography has gained popularity in these patients as it can delineate the wrist ligaments, but it has been noted to have a high incidence of false positive and false negative findings [1, 2]. Diagnostic accuracy can be improved when magnetic resonance imaging (MRI) is used with arthrography [3]. Arthroscopy has been more useful in this context and is considered by some to be the gold standard [1, 2, 4]. In addition it can be used as a diagnostic tool as well as a treatment modality.

The purpose of our study was to evaluate the sensitivity and specificity of the MR arthrogram in the identification of tears of the scapholunate ligament (SLL), lunotriquetral ligament (LT) and triangular fibrocartilage complex (TFCC) when compared to findings at subsequent arthroscopy of the wrist.

MATERIALS AND METHODS

Patients who underwent both MRI arthrogram and wrist arthroscopy for the evaluation of post-traumatic chronic wrist pain between November 2006 and August 2009 were

identified from hospital records. All patients had normal findings on plain x-rays and had complained of continuing wrist pain. Patients with fractures, arthritis or carpal instability were excluded from this study.

With the help of 25 G needle, 0.5 mls of Optiray (Ioversol, Mal-linckrodt Medical Imaging, Ireland) was injected into the radiocarpal compartment by a posterior approach with fluoroscopic guidance. With the tip of needle confirmed to be in the radiocarpal compartment, between 3-4 mls of 2.5 mmol/L solution of gadopentetate dimeglumine (Magnevist, Schering, Germany) was injected. This was the only compartment of the wrist that was injected. MRI was performed within 30 mins of injection on a 1.5 T Philips scanner (Achieva series, Best Medical syste, Netherland) using a FlexM surface coil. Coronal T1, Coronal T1 FS, Coronal T2 FS, Coronal T2 GE, 3D WATSf & Axial T2 scans were obtained. The Coronal scans were of 3 mm slice thickness with a 0.3 mm interslice gap. The Axial scans were of 4 mm thickness with a 0.4 mm interslice gap.

MRI arthrogram was reported by a consultant radiologist with an interest in musculoskeletal imaging and all arthroscopies performed by two consultant upper limb surgeons. The arthrogram reports and operation notes were examined for correlation. Three main areas of pathology were consistently examined: TFCC, scapholunate and lunotriquetral ligament tears. The sensitivity and specificity of arthrogram was calculated for each.

Arthrographic and arthroscopic findings were examined for correlation. If the arthrogram was positive and arthroscopy negative, this was reported as a false positive

*Address correspondence to this author at the Macclesfield District General Hospital, Victoria Road, Macclesfield, SK10 3BL, UK; Tel: +44 (0)78 286 21588; Fax: +44 (0)1625 663153; E-mail: aatifm@gmail.com

examination. A false negative was noted if the arthrogram was normal and a tear was identified at subsequent arthroscopy. The sensitivity and specificity of arthrogram was calculated for each ligament tear.

RESULTS

There were 30 patients in the study. The mean age at the time of arthrogram was 42.4 years (range 20-70 years), with an average 6.7 month gap between the two procedures. There were 11 males and 19 females, 18 dominant and 12 non-dominant hands were involved.

4 patients (13%) had normal arthrograms. The other twenty-six (87%) patients were identified as having ligamentous abnormalities at wrist arthrography (Table 1). The most common isolated injury found at arthrograms was a TFCC tear.

Table 1. Results of MRI Arthrograms (n=30)

Arthrogram Findings	No. of Patients
Normal	4
TFCC tear	12
SL Tear	4
LT tear	0
TFCC and SL Tears	6
TFCC and LT tears	2
SL and LT tears	1
TFCC, SL and LT Tears	1

TFCC – triangular fibrocartilage, SL – scapholunate, LT – lunotriquetral.

At wrist arthroscopy, 5 patients (16%) did not have any abnormalities. Ligamentous injuries were noted in twenty-five patients (84%). Again the most common isolated injury was that of TFCC complex (Table 2).

Table 2. Results of Wrist Arthroscopy (n=30)

Arthroscopic Findings	No. of Patients
Normal	5
TFCC tear	12
SL Tear	4
LT tear	0
TFCC and SL Tears	5
TFCC and LT tears	1
SL and LT tears	1
TFCC, SL and LT Tears	2

TFCC – triangular fibrocartilage, SL – scapholunate, LT – lunotriquetral.

Agreement between the results of arthroscopy and arthrography was seen in 21 patients (70%). Twenty-six patients had abnormal arthrograms; four of these had no injury identified on arthroscopy. Therefore a true positive rate of 84%. 4 patients had normal arthrograms. 3 of these

had abnormalities picked up on arthroscopy. Following arthroscopy, nine patients (30%) had their diagnosis changed. 3 patients with normal MR arthrogram were found to have a ligamentous injury confirmed on arthroscopy. 2 patients had additional injuries which were not picked up on the arthrogram. 4 patients had a normal arthroscopy following the abnormal arthrographic findings (Tables 3 and 4).

Table 3. Changes in Diagnosis Between Arthrography and Arthroscopy (n=9)

Change	No. of Patients
Normal arthrographic findings; injury identified at arthroscopy	3
Abnormal arthrographic findings; additional injury noted at arthroscopy	2
Abnormal arthrographic findings; normal arthroscopic findings	4

For detecting TFCC tears, MR arthrogram had a 90% sensitivity and 75% specificity, positive predictive (PPV) value 85% and negative predictive (NPV) value 80%. Examination of the scapholunate ligament with this technique had 91% sensitivity and 88% specificity, 83% PPV and 88% NPV. A 100% correlation between MR arthrogram and arthroscopy findings was achieved in detecting lunotriquetral tears (Table 5).

DISCUSSION

Chronic wrist pain is often a diagnostic dilemma for the treating surgeon. Various radiographic modalities have been used to improve diagnostic accuracy: arthrography (single or multicompartmental), magnetic resonance imaging (MRI), magnetic resonance arthrography (MRA), CT-arthrography (CTA) and arthroscopy. Multicompartmental arthrography has a low sensitivity, specificity and accuracy in detecting tears of the intrinsic ligaments when compared to arthroscopy [5]. Eynde *et al.* [6] found a low negative predictive value of 8% for arthrography (n =50). In a large retrospective study (n=150) Kevin *et al.* [7] confirmed that a negative arthrogram does not rule out ligamentous pathology. Ritt [8] has abandoned the use of wrist arthrography altogether in his unit, and argues that arthroscopy is the way forward for diagnosis and treatment. His reasons for this include a low sensitivity of arthrogram and its inability to assess the quality of surrounding tissue.

Magnetic resonance imaging gained popularity because of better soft-tissue contrast and multiplanar capability. However, without intra-articular contrast, it is unreliable in diagnosing tears of the intrinsic ligaments. Hoby *et al.* [9] looked at the published diagnostic performance of MRI. They found a high specificity (90%), but a low sensitivity (70%) and an accuracy of 85% in comparison to arthroscopy. They concluded that MRI was unreliable without intra-articular contrast medium.

Combining arthrography with MRI not only increases visualisation of the intrinsic ligaments but also makes lesions more detectable and increases the accuracy [10, 11]. Dijke

Table 4. Results of Arthrography Compared with Arthroscopy

Case	Age/Sex	Arthrography	Arthroscopy	Assessment
1	30/M	-TFCC, +SL, -LT	-TFCC, +SL, -LT	Agreement*
2	50/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
3	42/F	-TFCC, +SL, -LT	-TFCC, +SL, -LT	Agreement
4	70/M	+TFCC, +SL, -LT	+TFCC, +SL, -LT	Agreement
5	49/M	+TFCC, +SL, -LT	+TFCC, +SL, -LT	Agreement
6	54/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
7	49/F	+TFCC, +SL, -LT	+TFCC, -SL, -LT	false +ve
8	20/M	-TFCC, +SL, -LT	-TFCC, -SL, -LT	false +ve
9	49/F	+TFCC, -SL, -LT	-TFCC, -SL, -LT	False +ve
10	32/F	+TFCC, +SL, .LT	+TFCC, +SL, -LT	Agreement
11	20/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
12	39/M	+TFCC, -SL, +LT	+TFCC, -SL, +LT	Agreement
13	61/M	+TFCC, -SL, +LT	+TFCC, +SL, +LT	False -ve
14	22/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
15	48/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
16	56/M	+TFCC, +SL, -LT	+TFCC, +SL, -LT	Agreement
17	38/M	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
18	21/F	-TFCC, -SL, -LT	-TFCC, -SL, -LT	Agreement
19	42/F	-TFCC, +SL, -LT	-TFCC, +SL, -LT	Agreement
20	49/F	+TFCC, +SL, +LT	+TFCC, +SL, +LT	Agreement
21	38/F	-TFCC, -SL, -LT	+TFCC, -SL, -LT	false -ve
22	40/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
23	38/F	+TFCC, +SL, -LT	+TFCC, +SL, -LT	Agreement
24	41/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
25	36/M	-TFCC, -SL, -LT	-TFCC, +SL, -LT	False -ve
26	50/F	+TFCC, -SL, -LT	+TFCC, -SL, -LT	Agreement
27	45/F	+TFCC, -SL, -LT	-TFCC, -SL, -LT	False +ve
28	54/M	-TFCC, -SL, -LT	+TFCC, -SL, -LT	False -ve
29	34/M	-TFCC, +SL, +LT	-TFCC, +SL, +LT	Agreement
30	29/F	+TFCC, -SL, -LT	-TFCC, -SL, -LT	False +ve

*Agreement between results of arthrography and arthroscopy. TFCC – triangular fibrocartilage complex, SL – scapholunate, LT – lunotriquetral.

Table 5. Correlation Between MR Arthrogram and Arthroscopy

	<i>Sensitivity</i>	<i>Specificity</i>	<i>Positive Predictive Value (PPV)</i>	<i>Negative Predictive Value (NPV)</i>
TFCC	90%	75%	85%	80%
SL	91%	88%	83%	88%
LT	100%	100%	100%	100%

TFCC – triangular fibrocartilage complex, SL – scapholunate, LT – lunotriquetral.

et al. [12] and Braun *et al.* [13] concluded that MRA had equivalent results to diagnostic arthroscopy for evaluating TFCC, intrinsic and extrinsic ligaments and has the potential to replace diagnostic arthroscopy.

Since the first description of wrist arthroscopy by Chen in 1979 [14], it has become a vital tool for surgeons. It allows direct visualisation of the wrist joint, obviating the need for open arthrotomy and thus decreases morbidity. The

exceptional view of the wrist joints interior has made it the gold standard for comparing other diagnostic techniques. However, as with all other techniques it has its limitations. It is more invasive and expensive than other techniques, it is unable to visualise all areas of the wrist and lastly, not all pathology is related to clinical findings [8]. In their study of 47 wrist arthroscopies, Westkaemper *et al.* [15] concluded that a negative arthrogram cannot exclude wrist pathology; if the clinical examination point to a suspicion of ligamentous tear, arthroscopy is the method of choice. They further showed a high rate of patient satisfaction, with a low rate of complications and quick recovery. Edward *et al.* reported on 190 patients who underwent arthroscopic evaluation for chronic wrist pain. Tenderness was not necessarily associated with exact ligament injury. However, arthroscopy provides a precise delineation of the extent of injury can help plan surgical reconstruction as well as providing evaluation for future treatments [16]. Arthroscopy results should be interpreted with caution. A negative arthroscopy does not always exclude pathology and positive findings are not necessarily the source of patient's symptoms. Defects in the intrinsic ligaments could be symptomatic or asymptomatic. 50-80% of people have a communication defect in the asymptomatic wrist [17-19].

Although MR arthrography has a sensitivity and specificity >90% in detecting tears of TFCC and intrinsic ligaments, it cannot differentiate between traumatic and degenerative tears or symptomatic and asymptomatic ones [20]. Nevertheless, in a prospective study Yin *et al.* [21] concluded that the results of bilateral three-compartmental wrist arthrography influenced surgeons' decision making, leading to a more conservative management. Perforations of the SLL and LTL increase in frequency with age, are often asymptomatic and correlate poorly with the patients' symptoms [22]. Noncommunicating TFCC defects located at the proximal side near its ulnar attachment are more strongly associated with symptomatic wrists [22, 23]. Radial sided communicating defects are more commonly seen in the contralateral asymptomatic wrist [18, 22-24]. On the other hand, communicating defects that involve the dorsal segment of SLL and lunate attachment of SLL are frequently symptomatic [10, 25]. Asymptomatic degenerative tears are seen in the proximal portion of SL and LT ligaments [25]. The age of the patient, clinical history and location of the tear must be carefully correlated when planning treatment.

Meier *et al.* [26] compared MR arthrography with wrist arthroscopy in 125 patients. They reported a sensitivity of 94% and specificity of 89% for TFCC lesions, PPV 91% and NPV 93%. Sensitivity and specificity of 99% and 92% respectively for complete scapholunate ligament tears, PPV and NPV 100% and 99% respectively. 25% sensitivity and 99% specificity for lunotriquetral tears.

In another prospective, blinded study using a 1.5T scanner Schmitt *et al.* [27] demonstrated sensitivity 97.1%, specificity of 96.4%, PPV 97.1%, NPV 96.4% for TFCC lesions. The results for complete scapholunate tears were: sensitivity 91.7%, specificity 100%, PPV 100%, NPV 99.1%. Partial tears: sensitivity 62.5%, specificity 100%, PPV 100%, NPV 94.8%. They noted only three lesions of lunotriquetral ligament.

Our results are comparable to the previously reported studies [26-28]. Limitations of this study are the small sample size and the retrospective nature of the study. Moreover, patients were followed up by the operating surgeon, which can introduce bias.

CONCLUSION

Findings from our study support previous published results which suggest that although as yet it is unable to replace arthroscopy, MR arthrogram offers an adequate alternative due to high sensitivity in detecting intrinsic ligamentous injuries. As not every injury requires surgical debridement, MR arthrogram can reduce the number of diagnostic arthroscopies. These patients can benefit from conservative rehabilitation and avoid the risk of general anaesthesia.

ACKNOWLEDGEMENT

Declared none.

CONFLICT OF INTEREST

Declared none.

REFERENCES

- [1] Cooney WP. Evaluation of chronic wrist pain by arthrography, arthroscopy, and arthrotomy. *J Hand Surg Am* 1993; 18(5): 815-22
- [2] Roth JH, Haddad RG. Radiocarpal arthroscopy and arthrography in the diagnosis of ulnar wrist pain. *Arthroscopy* 1986; 2(4): 234-43.
- [3] Bora Jr F, Osterman A, Maitin E, Bednar J. The role of arthroscopy in the treatment of disorders of the wrist. *Contemp Orthop* 1986; 12(4): 28-36.
- [4] Joshy S, Ghosh S, Lee K, Deshmukh SC. Accuracy of direct magnetic resonance arthrography in the diagnosis of triangular fibrocartilage complex tears of the wrist. *Int Orthop* 2008; 32(2): 251-3.
- [5] Weiss AP, Akelman E, Lambiase R. Comparison of the findings of triple-injection cinearthrography of the wrist with those of arthroscopy. *J Bone Joint Surg Am* 1996; 78(3): 348-56.
- [6] Vanden Eynde S, De Smet L, Fabry G. Diagnostic value of arthrography and arthroscopy of the radiocarpal joint. *Arthroscopy* 1994; 10(1): 50-3.
- [7] Chung KC, Zimmerman NB, Travis MT. Wrist arthrography versus arthroscopy: a comparative study of 150 cases. *J Hand Surg Am* 1996; 21(4): 591-4.
- [8] Ritt MJ. Arthroscopy: the giant leap forward in wrist surgery? *J Hand Surg Br* 2001; 26(3): 238-40.
- [9] Hobby JL, Tom BD, Bearcroft PW, Dixon AK. Magnetic resonance imaging of the wrist: diagnostic performance statistics. *Clin Radiol* 2001; 56(1): 50-7.
- [10] Valeri G, Ferrara C, Carloni S, Soccetti A, Giovagnoni A. Magnetic resonance arthrography in chronic wrist pain. *Radiol Med* 1999; 97(1-2): 19-25.
- [11] Maizlin ZV, Brown JA, Clement JJ, *et al.* MR arthrography of the wrist: controversies and concepts. *Hand (NY)* 2009; 4(1): 66-73.
- [12] van Dijke CF, Wiarda BM. High resolution wrist MR arthrography at 1.5T. *JBR-BTR* 2009; 92(1): 53-9.
- [13] 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(11): 1515-24.
- [14] Chen YC. Arthroscopy of the wrist and finger joints. *Orthop Clin North Am* 1979; 10(3): 723-33.
- [15] Westkaemper JG, Mitsionis G, Giannakopoulos PN, Sotereanos DG. Wrist arthroscopy for the treatment of ligament and triangular fibrocartilage complex injuries. *Arthroscopy* 1998; 14(5): 479-83.
- [16] North ER, Meyer S. Wrist injuries: correlation of clinical and arthroscopic findings. *J Hand Surg Am* 1990; 15(6): 915-20.
- [17] Cantor RM, Stern PJ, Wyrick JD, Michaels SE. The relevance of ligament tears or perforations in the diagnosis of wrist pain: an arthrographic study. *J Hand Surg Am* 1994; 19(6): 945-53.

- [18] Cerezal L, Abascal F, Garcia-Valtuille R, Del Pinal F. Wrist MR arthrography: how, why, when. *Radiol Clin North Am* 2005; 43(4): 709-31, viii.
- [19] Brown JA, Janzen DL, Adler BD, *et al.* Arthrography of the contralateral, asymptomatic wrist in patients with unilateral wrist pain. *Can Assoc Radiol J* 1994; 45(4): 292-6.
- [20] Herbert TJ, Faithfull RG, McCann DJ, Ireland J. Bilateral arthrography of the wrist. *J Hand Surg Br* 1990; 15(2): 233-5.
- [21] Yin Y, Evanoff BA, Gilula LA, Littenberg B, Pilgram TK, Kanterman RY. Surgeons' decision making in patients with chronic wrist pain: role of bilateral three-compartment wrist arthrography--prospective study. *Radiology* 1996; 200(3): 829-32.
- [22] Zanetti M, Linkous MD, Gilula LA, Hodler J. Characteristics of triangular fibrocartilage defects in symptomatic and contralateral asymptomatic wrists. *Radiology* 2000; 216(3): 840-5.
- [23] Ruegger C, Schmid MR, Pfirrmann CW, Nagy L, Gilula LA, Zanetti M. Peripheral tear of the triangular fibrocartilage: depiction with MR arthrography of the distal radioulnar joint. *AJR Am J Roentgenol* 2007; 188(1): 187-92.
- [24] Yin YM, Evanoff B, Gilula LA, Pilgram TK. Evaluation of selective wrist arthrography of contralateral asymptomatic wrists for symmetric ligamentous defects. *AJR Am J Roentgenol* 1996; 166(5): 1067-73.
- [25] Linkous MD, Pierce SD, Gilula LA. Scapholunate ligamentous communicating defects in symptomatic and asymptomatic wrists: characteristics. *Radiology* 2000; 216(3): 846-50.
- [26] Meier R, Schmitt R, Krimmer H. Wrist lesions in MRI arthrography compared with wrist arthroscopy. *Handchir Mikrochir Plast Chir* 2005; 37(2): 85-9.
- [27] Schmitt R, Christopoulos G, Meier R, *et al.* Direct MR arthrography of the wrist in comparison with arthroscopy: a prospective study on 125 patients. *Rof* 2003; 175(7): 911-9.
- [28] Berna-Serna JD, Martinez F, Reus M, Alonso J, Domenech G, Campos M. Evaluation of the triangular fibrocartilage in cadaveric wrists by means of arthrography, magnetic resonance (MR) imaging, and MR arthrography. *Acta Radiol* 2007; 48(1): 96-103.

Received: January 9, 2012

Revised: April 24, 2012

Accepted: April 25, 2012

© Mahmood *et al.*; Licensee *Bentham Open*.

This is an open access article licensed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>) which permits unrestricted, non-commercial use, distribution and reproduction in any medium, provided the work is properly cited.