

Role of Magnetic Resonance Imaging and Ultrasonography in Diagnosis and Follow Up Rheumatoid Arthritis in Hand and Wrist Joints

Ahmed Mohamed Safwat Zaki, Waleed Mohamed Abd El Hamid Hetta,
Omar Hussein Omar, Ahmed Fathy Abdel Ghany

Department of Radiodiagnosis, Faculty of Medicine, Ain Shams University, Cairo, Egypt
Corresponding author: Ahmed Fathy Abdel Ghany ,email: monaabdelaal2005@yahoo.com

ABSTRACT

Aim of the work: to compare the role of ultrasonography and magnetic resonance imaging in the diagnosis of wrist joint affection in patients with rheumatoid arthritis. **Patients and methods:** this study included 50 patients diagnosed as rheumatoid arthritis (41 females and 9 males) with mean age 43 years; they were subjected to high resolution ultrasound and MRI of the wrist joint for the dominant affected wrist clinically. Comparison and correlation between both modalities was done. **Results:** our results showed agreement between ultrasound and MRI in the assessment of synovial inflammation, activity and bone erosions in wrist joint in rheumatoid arthritis patients. **Conclusion:** we concluded that both modalities were comparable and close to each others as regards the bony erosions and synovial hypertrophy and inflammation in the wrist joints in patient with rheumatoid arthritis and the ultrasound was useful tools in detection of erosions and synovial inflammation so can be used in patients without erosions on conventional x ray and also can be used in follow up and monitoring the patients with established diagnosis of rheumatoid.

Keywords:.....

INTRODUCTION

Rheumatoid Arthritis (RA) is a chronic systemic autoimmune disorder of unknown etiology characterized by symmetrical joint synovitis and pain. RA has a wide clinical spectrum and may vary from mild non-erosive disease to severe inflammation and joint damage with extra-articular manifestations. The wrist and hand joints were affected early in the disease process, with some deformities occurring in the first two years of the disease⁽¹⁾.

Rheumatoid arthritis is characterized by proliferative, hypervascularized synovitis, resulting in bone erosion, cartilage damage, joint destruction and long-term disability. The absence of effective treatment to prevent joint destruction has limited the need for more sensitive imaging techniques. Availability of these powerful and expensive drugs has created new demands on radiologists to identify patients with aggressive rheumatoid arthritis at an early stage to affect the therapeutic management of these patients⁽²⁾.

In rheumatoid arthritis (RA), hyperemia caused by vasodilatation is one of the earliest detectable pathologic alterations at the beginning of joint inflammation, and angiogenesis, as one of the key prerequisites for pannus formation, plays a crucial role in the initiation and perpetuation of synovitis⁽³⁾.

Radiographs have traditionally been the mainstay for imaging patients with rheumatoid arthritis; findings such as soft-tissue swelling, periarticular osteopenia, joint space loss, joint

subluxation, and marginal erosions are all features that may be seen. However, information regarding the synovium is much more difficult to assess on radiographs. Both ultrasound and MRI are sensitive for the detection of synovitis and both are superior to radiography⁽⁴⁾.

MRI had excellent results in evaluation of early RA. MRI wrist demonstrated bone erosions, synovial hypertrophy, synovitis and tenosynovitis. Other signs include tendinitis, enthesitis, ligament and tendon tears, bone marrow edema and joint effusions⁽⁵⁾.

Ultrasonography is an imaging technique that has attracted much interest in the field of rheumatology in recent years. As a result of technological improvements and wide availability, ultrasonography has the potential to facilitate diagnosis of RA and improve the assessment of disease activity⁽¹⁰⁾. This study aimed to compare the role of ultrasonography and magnetic resonance imaging in the diagnosis of wrist joint affection in patients with rheumatoid arthritis.

PATIENTS AND METHODS

Fifty rheumatoid arthritis (RA) patients were included in this study, from the Rheumatology and Rehabilitation outpatient clinic from private centers. This study was conducted during the period 2015 to 2017 and included 41 females and 9 males with a mean age of 43.

The inclusion criteria: clinical diagnosis of rheumatoid arthritis (RA) according to The American Rheumatism Association 1987 revised

criteria for the classification of rheumatoid arthritis. No apparent deformities of the wrist and hand joints clinically and X ray revealed either subtle changes or normal study.

All patients were subjected to ultrasound examination and MRI study.

- Ultrasonography of the wrist joint was performed using GE LOGIQ P6 Pro ultrasound machines using a linear array transducer with a frequency of 7.5-12 MHz. During examination of wrist joints the patient was examined while sitting upright, with the hand placed on a cushion and fully pronated then supinated.

For the wrist: dorsal longitudinal scan followed by dorsal transverse scan were done followed by palmar examination to evaluate:

- Presence of pannus (synovial hypertrophy) and assessment of synovial vascularity (synovitis) using power Doppler.
- Presence of erosions and their number.
- Presence of joint effusion.

- Assessment of tendons for tenosynovitis or tendon rupture

US examination for joint effusion and synovitis, erosions were carried out by grey-scale imaging, and synovial vascularization was assessed by PD according to OMERACT definitions of pathology⁽⁶⁾.

Magnetic resonance examination of the dominant wrist was performed using Philips Intera 1.5 T (closed) patients were placed in prone position with the hand above the head and dedicated wrist coil was used. Three dimensional coronal T1WIs and STIR WIs were acquired and axial T1WIs of the wrist, while the patient remained motionless in the MR unit 0.05 mmol/kg body weight of Gadoteric acid (DOTAREM, Guerbet, France) injected intravenous in the contra lateral arm via cannula that has been inserted before the examination acquisition of 3D coronal and axial T1WIs of the wrist performed using the parameters in table 1.

Table 1: MRI technical parameters

	TR	TE	Matrix	FOV	Flip angle
T1WIs	540	22	216x152	150 (coronal) 80 (axial)	90
STIR WIs	1700	60	240x143	150 (coronal) 80 (axial)	90
Post contrast T1WIs	540	22	216x152	150 (coronal) 80 (axial)	90

The study was approved by the Ethics Board of Ain Shams University.

Statistical analysis

Data were statistically described in terms of mean □ standard deviation (□ SD) and range, or frequencies (number of cases) and percentages when appropriate. Comparison between MRI and US results was done using McNemar test and Chi square test when appropriate. Agreement was tested using kappa statistic. Correlation between various variables was done using Spearman rank correlation equation for non-normal variables. *p* values less than 0.05 was considered statistically significant. All statistical calculations were done using computer programs SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows.

RESULTS

Fifty adult rheumatoid arthritis patients diagnosed as RA according to the 1987 revised American College of Rheumatology (ACR) criteria for classification of rheumatoid arthritis were included in this study.

There were 41 females (82%) and 9 males (18%), their ages ranged from 20 to 66 years with a mean age of 43 years ± 10.5. The disease duration ranged from one year to 18 years with a mean of 6.20 years ± 4.2

Synovial hypertrophy and inflammation

- φ **42** wrist joints (**84%**) were found to have pannus (Both active and inactive) among them 30 wrist joints (60 %) were found to have increased vascularity by PDUS with frequency as demonstrated in table 2.

Table 2: frequency of synovitis (Increased vascularity) of wrist joints by power Doppler ultrasound

	Frequency	Percent
Normal	20	40.0
Mild	13	26.0
Moderate	10	20.0
Severe	7	14.0

Joint Effusion

8 wrist joints (16 %) were found to have effusion.

Signs of bone destruction in the form of erosions were found in 30 wrist joints (60%) as shown in table 3.

Table 3: frequency of erosions in wrist joints by ultrasound

No of erosions	Frequency	Percent
0	20	40.0
1	20	40.0
2	9	18.0
3	1	2.0

In the MRI results for assessment of synovial inflammation 46 wrist joints (92%) were found to have pannus (Synovial hypertrophy) , evaluation of synovial enhancement in the post contrast study (synovitis) revealed 38 wrist joints (76 %) were active as seen in table 4.

Table 4: synovial activity (Synovitis) score in wrist joints by MRI

	Frequency	Percent
Normal	12	24.0
Mild	24	48.0
Moderate	5	10.0
Severe	9	18.0

MRI examination detected joint effusion in 18 wrist joints (36%) with erosions were detected in 37 wrist joints (74 %) with frequency as seen in table 5.

Table 5: distribution of erosions among wrist joints by MRI

No of erosions	Number of wrist joints	Percent
0	13	26.0
1	2	4.0
2	12	24.0
3	16	32.0
4	6	12.0
6	1	2.0

Ultrasound detected synovial hypertrophy (pannus) in 42 wrist joints, while MRI was detected in 46 wrist joints , both modalities agreed in 42 patients and ultrasound missed synovial hypertrophy in 4 joints detected by MRI as seen in table 6.

Table 6: comparison between US and MRI in the detection of synovial hypertrophy (Pannus) of wrist joints.

		Synovial hypertrophy by ultrasound		Total
		Absent	Present	
Synovial hypertrophy by MRI	Absent	4	0	4
	Present	4	42	46
Total		8	42	50

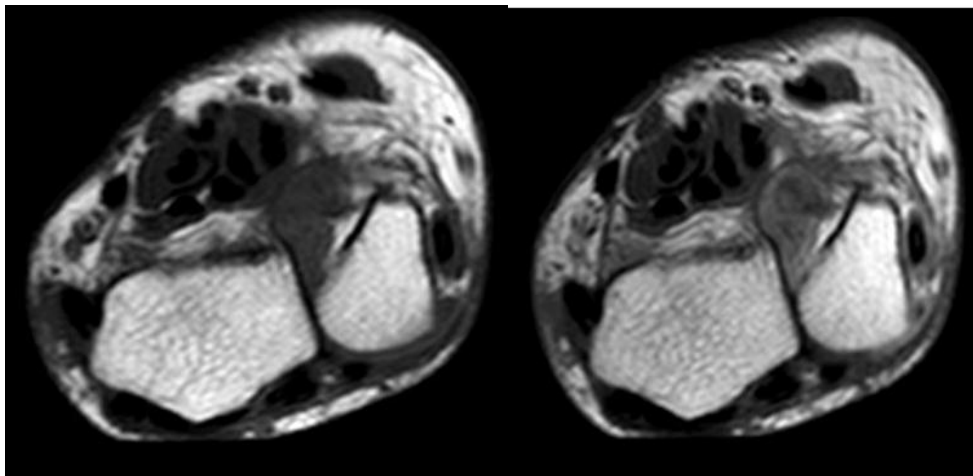
Power Doppler ultrasound detected increased vascularity within 30 wrist joints (60 %) denoting active synovitis and MRI detected synovial enhancement within 38 wrist joints (76%) denoting active synovitis, both scoring systems agreed in the assessment of synovitis degree in 20 wrist joints. PDUS missed detection of synovitis in 9 joints detected by MRI, 7 of them were estimated by MRI to be of mild activity (Grade 1).

Ultrasound detected erosions in 35 wrist joints and MRI detected erosions in 37 wrist joints. Both modalities agreed in 30 wrist joints, ultrasound missed erosions in 7 joints detected by MRI and MRI missed erosions in 5 joints detected by ultrasound as seen in table 7.

Table 7: comparison between US and MRI in the detection of erosions of wrist joints

		N	Erosions ultrasound		Total
			Absent	Present	
Erosions -MRI	Absent	N	8	5	13
	Present	N	7	30	37
Total		N	15	35	50

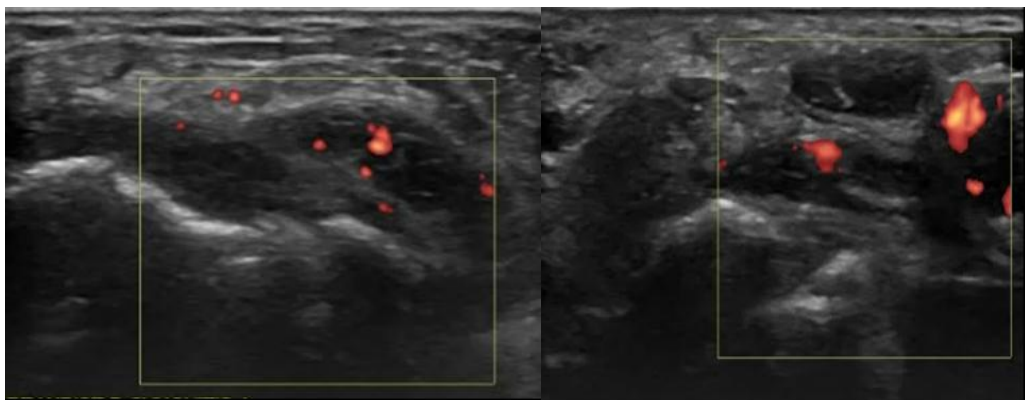
Statistical analysis of these results showed significant correlation (p value < 0.001) and agreement between the techniques in the assessment of synovial activity in wrist joints. Comparison of US and MRI yielded a Kappa value of 0.482 and also significant agreement between the two modalities in the detection of erosions. Comparison of US and MRI yielded a weighted Kappa value of 0.406



(A)

(B)

Pre and post contrast axial T1WIs of the distal radioulnar joint showed marked synovial thickening with moderate enhancement in the post contrast study denoting moderate synovitis.



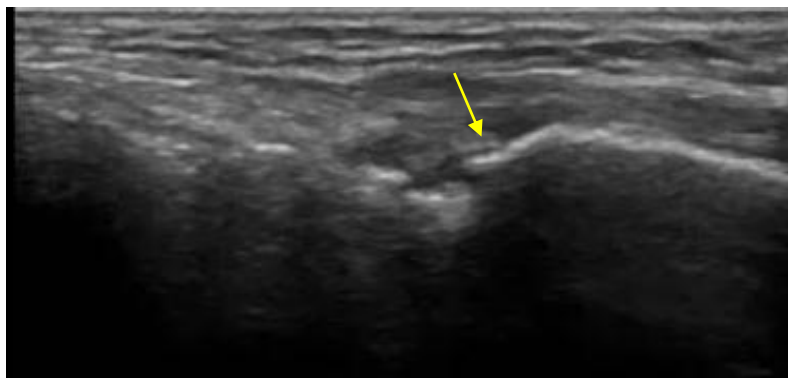
(C)

(D)

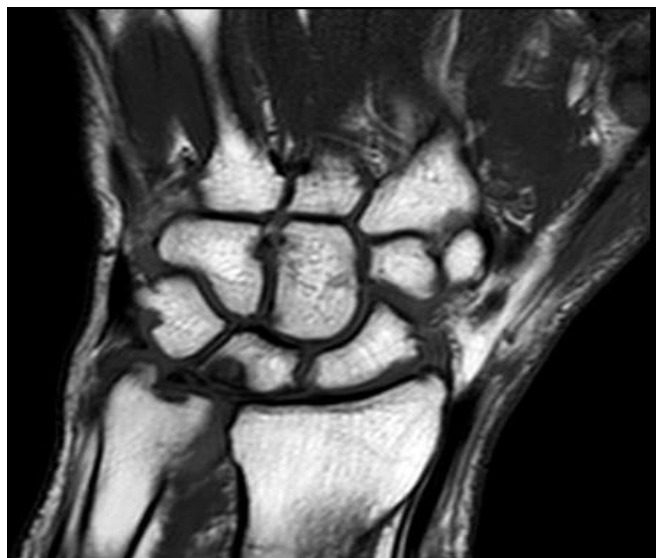
(C,D) PDUS longitudinal images of the wrist showing hypoechoic synovial thickening with increased vascularity suggestive of moderate synovitis



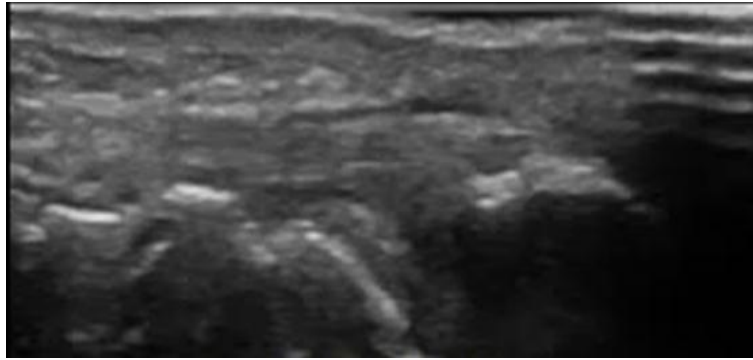
(E) Coronal T1WIs of the wrist showing few carpal erosions and synovial hypertrophy



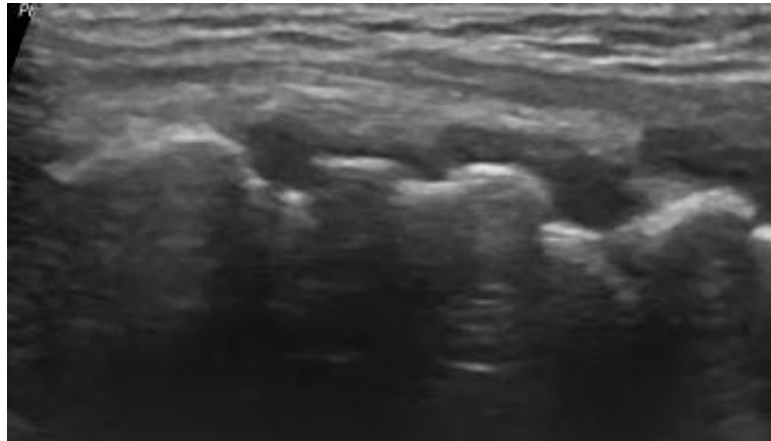
(F) Longitudinal ultrasound image showing carpal erosion.



(G) Coronal T1WIs of the wrist displaying multiple carpal erosions



(H)



(I)

(H,I) longitudinal ultrasound images showing carpal erosions

DISCUSSION

Rheumatoid arthritis (RA) is an inflammatory disease of unknown cause. The inflammation of joints and surrounding tissues and sometimes of extra-articular structures may cause severe disability and increased mortality ⁽⁷⁾. The introduction of anti-tumor necrosis factor- α agents has opened new prospects in therapeutic management of patients with early RA, thereby creating new demands on radiologists to identify patients with aggressive disease at an early stage. As a result, imaging techniques such as MRI and sonography have been developed during the past few years ⁽²⁾.

MRI and ultrasound have been introduced and evaluated in many studies of inflammatory joint diseases in order to provide early diagnosis along with the potential to monitor early changes in inflammation upon treatment. Both modalities have proven useful and more sensitive than conventional methods like radiographs and clinical scores and have a potential importance for guiding treatment of RA ⁽⁸⁾. Our study was performed to compare effectiveness of both power Doppler US and MRI of joints of the hand, in the assessment of synovial inflammation and erosions. Our study demonstrated that ultrasound

detected signs of synovial inflammation (synovial hypertrophy) in 42 wrist joints (84%) among them 30 wrist joints (60%) were found to have increased vascularity upon power Doppler application denoting active synovitis. By MRI synovial hypertrophy was detected in 46 wrist joints (92%) among them 38 wrist joints (76%) showed evidence of synovial enhancement in the post contrast study denoting active synovitis. Our study demonstrated that US is comparable to MRI in detection of erosions and ultrasound detected erosions in 35 wrist joints and MRI detected erosions in 37 wrist joints. Both modalities agreed in 30 wrist joints, ultrasound missed erosions in 7 joints detected by MRI and MRI missed erosions in 5 joints detected by ultrasound.

Terslev and his coworkers ⁽⁹⁾ found total agreement between the two imaging modalities with kappa values of 0.45 and 0.41 for the wrist and MCP joints respectively in detection of synovitis, and significant correlation (p value < 0.001) between color fraction in Doppler ultrasound and synovial thickness in post contrast MRI and those results agree with our study where we found good agreement between both imaging modalities with kappa values of 0.482 and 0.376

for the wrist and MCP joints respectively in detection of active synovitis and significant correlation ($p < 0.001$). As regards signs of bone destruction, in this study ultrasound detected erosions in 57/250 joints (22.8 %) and MRI detected erosions in 62/250 joints (24.8%).

As for detection of bone erosions, **Szkudlarek and his coworkers** ⁽¹⁰⁾ found that US and MRI were similar, in their study at least one modality detected bone erosions in 101 quadrants of MCPs, there was agreement between both modalities regarding the presence of erosions in 49 quadrants (49%) and MRI identified bone erosions in only 26 quadrants (26%). In our study at least one modality detected signs of bone destruction in 27 MCP joints, agreement between both modalities in 15 joints (55.6%), and MRI identified erosions in only 10 MCP joints (37 %), they studied joints using the quadrant as a unit, while in our study we used the joint as a unit.

Another study conducted by **Magnani and his coworkers** ⁽¹¹⁾ compared the ultrasonography and MRI in their capability to detect bone erosions in RA patients, they examined thirteen patients with advanced RA, the wrist joints as well as the MCPs were examined by MRI with contrast and ultrasound, they found no significant difference between both modalities in detecting erosions in wrist joints, and this matches with our results, where both modalities agreed in detecting erosions in 30 wrist joints (81%) out of 37 joints detected by MRI.

We concluded that both modalities were comparable and close to each others as regards the bony erosions and synovial hypertrophy and inflammation in the wrist joints in patient with rheumatoid arthritis and the ultrasound was useful tools in detection of erosions and synovial inflammation so can be used in patients without erosions on conventional x ray and also can be used in follow up and monitoring the patients with established diagnosis of rheumatoid.

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