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Comparison of ultrasound-doppler and magnetic resonance imaging findings in rheumatoid arthritis of hand and wrist

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Abstract---Background: To evaluate the ultrasound - Doppler findings in Rheumatoid arthritis of hand and wrist and to compare the ultrasound Doppler findings with Magnetic resonance imaging (MRI) findings. Methods: This prospective study included 30 patients satisfying -The 2010 American college of Rheumatology/European League against Rheumatism criteria. Patients underwent clinical, laboratory and imaging assessment. Imaging evaluation include ultrasound- Doppler examination of accessible aspects of all the PIP, 2nd and 5th MCP and wrist joints followed by MRI examination of both wrists and hand pre and post contrast for the detection of synovitis, bone erosion, effusions and tenosynovitis. Results: The sensitivity and specificity of USG for signs of inflammation in wrist joint, with MRI as the reference, were 98.15% and 100% respectively, whereas the overall sensitivity and specificity for signs of inflammation in wrist, 2nd and 5th MCP and PIP joints were 82.35% and 97.67% respectively. The sensitivity and specificity of USG for detecting joint effusion in wrist joint, with MRI as the reference, were 88.23% and 95.35% respectively. The overall sensitivity and specificity for bilateral 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard were 72.22% and 97.67% respectively. The sensitivity and specificity

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of USG for erosions in wrist joint, with MRI as the reference, were 48.21% and 100% respectively. In our study overall sensitivity and specificity of USG for erosions in bilateral 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard is 44.62% and 100% respectively. Conclusion: USG is comparable to MRI for a sensitive detection of the inflammatory soft tissue process in the form of synovitis, tenosynovitis and effusion of wrist joint. USG has got low sensitivity for detecting erosions in wrist, MCP and PIP joints as compared to MRI.

Keywords---Arthritis, Doppler, rheumatoid, ultrasonography.

Introduction

Rheumatoid arthritis (RA) is a chronic systemic disease, of unknown origin that predominantly involves synovial tissue. RA affects 0.5- 1% of global adult population with its prevalence in India being 0.75%. ^[1] RA is characterized by symmetric joint inflammation and destruction that often involves the small joints of hands, feet and the wrist. However any synovial joint may be affected.

Radiographs have traditionally been the mainstay for imaging patients with RA which show erosions, joint space loss and subluxation. It has been recognized that these changes occur late in the disease long after irreversible joint damage. Also radiographs do not directly visualize key structures such as synovium, cartilage and soft tissue.

With the introduction of disease modifying drugs, the need for early demonstration of disease has arisen. Since early changes are non-osseous in nature, ultrasound (US) and magnetic resonance imaging (MRI) of hand and wrists are able to depict erosions earlier and with greater sensitivity than radiographs. ^[2,3] These have been shown to be more sensitive than clinical examination for identifying synovitis.^[4] Over the past ten years the rapid development of US of the musculoskeletal system and the improvements in US equipments have disclosed a new way in assessing soft tissue involvement in rheumatic diseases.^[5,6] US is readily available and allows assessment of multiple joints. Combined with Doppler it is helpful for evaluation and quantification of disease activity. MRI is capable of directly visualizing all the structures seen on ultrasound. In addition, it visualizes bone marrow pathology. According to ESSR^[7] and EULAR recommendations, MRI is currently considered the best, non-invasive, observer-independent imaging modality to evaluate inflammation of joints, tendons, entheses and bone marrow.

Methods

This study was conducted in a tertiary care hospital. The study comprised of 30 patients, satisfying the 2010 American College of Rheumatology/ European league against Rheumatism criteria (Table1) ⁽⁸⁾ without any gross deformity. Patients were evaluated for presenting complaints, laboratory investigations followed by imaging evaluation. Patient having claustrophobia, metallic implants

like stents, heart valves, ear-aids, bony prosthesis, etc., which are not compatible with MRI were excluded from the study. Imaging protocol include ultrasound and Doppler examination of accessible aspects of all the PIP, 2^{nd} and 5^{th} MCP and wrist joints, followed by MRI examination of both wrists and hand pre and post contrast.

Imaging Evaluation

ULTRASOUND: Each joint was assessed for the presence or absence of signs of inflammation (synovitis and joint effusion) and for the presence or absence of bone erosions. Synovitis on ultrasound was defined as an abnormal hypoechoic intraarticular tissue that is non-displaceable and poorly compressible. Erosion on ultrasound imaging was defined as an intraarticular discontinuity of the bone surface that is visible in two perpendicular planes.

DOPPLER: Presence of increased number of vessels in thickened synovium was used for grading of inflammation. This was done as: mild – few scattered vessels, moderate- <50% or severe >50% of the synovial lining exhibiting increased flow. MAGNETIC RESONANCE IMAGING: Each joint was assessed for presence of synovial effusion, thickening and enhancement. Presence of erosions was noted. An erosion was defined as sharply marginated bone lesion with juxtaarticular location and typical signal characteristics that was visible in at least two planes with a cortical break in at least one plane.

Results

In our study age of subjects ranges from 22 to 58 year with median age 32.5 year. There was a definite female predominance, where out of the 30 subjects, 29 patients (96.67 %%) were female and 1 (3.33%) was male. The most common presenting complaints were swelling and pain involving wrist, MCP and PIP joints, noted in 46% of patients. 60% of patients had duration of symptoms less than 2 years. Morning stiffness which was part of the diagnostic criteria for RA was seen in all the patients. Rheumatoid factor was positive in 53.33% of patients. CRP was positive in 33.33% of patients. ESR was raised in all the patients. USG findings seen in our study were synovitis, erosions, effusions and tenosynovitis.

Synovitis- Synovial thickening was the commonest finding on USG. It was seen in 88.33% of patients in wrist joint (figure1).

Erosion- USG detected erosions of wrist joint in 45% patients (figure2).

Effusion- USG detected effusion of wrist joint in 25% patients (figure3).

Tenosynovitis It was noted in 11.66% of our patients (figure3).

Doppler Findings

Doppler showed increased vascularity in 8.33% of patients in wrist joint.

MRI Findings

MRI findings seen in our study were synovial thickening and enhancement, erosions, effusions, tenosynovitis and bone marrow edema.

Synovial thickening and enhancement- Synovial thickening and enhancement were detected in wrist joint in 90% of patients.

Erosions- In our study MRI detected erosions of wrist joint in 93.33% patients.

Effusion- MRI detected effusion in 36.67% patients in wrist joint.

Tenosynovitis- It was found in 11.66% of our patients.

Bone marrow edema - MRI detected bone marrow edema in bones of wrist joint in 20%.

Ultrasound Versus MRI

Signs of inflammation- The sensitivity and specificity of USG for signs of inflammation in wrist joint, with MRI as the reference, were 98.15% and 100% respectively. The sensitivity of USG for detecting signs of inflammation is higher for wrist joints as compared to MCP and PIP joints. In our study overall sensitivity and specificity of USG for signs of inflammation in bilateral 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard was 82.35% and 97.67% respectively. Difference between USG and MRI for detection of synovitis is not statistically significant (p > 0.05). (figure 1&5).

Effusion- The sensitivity and specificity of USG for detecting joint effusion in wrist joint were 88.80% and 95.35% respectively. The overall sensitivity and specificity for 2^{nd} MCP, 5^{th} MCP, PIP and wrist joints with MRI as a reference standard were 82.35% and 97.67% respectively. In our study, no significant statistical difference (p > 0.05) has been found between USG and MRI detection of effusion. (figure 3&5).

Erosions- The sensitivity and specificity of USG for erosions in wrist joint, with MRI as the reference, were 48.21% and 100% respectively. The difference between USG and MRI is statistically significant (p < 0.05) for wrist joint. In our study overall sensitivity and specificity of USG for erosions in bilateral 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard were 44.62% and 100% respectively.(figure2 &4).

Statistical analysis- The collected information on age, gender, duration of symptoms, site of involvement, morning stiffness, RF and CRP were analyzed using SPSS software. Descriptive analysis was performed with proportion reported within 95% confidence interval. Chi-squared test was performed to compare proportions and P- value of less than 0.05 was considered to be statistically significant.

Discussion and Comparison with Other Studies

Rheumatoid arthritis is chronic systemic disease, characterized by symmetric joint inflammation and destruction that often involves the small joints of hands, feet and the wrist. Early diagnosis is essential for optimal treatment of chronic inflammatory arthritis. Synovitis is an early sign of the disease and frequently affects the wrists, MCP joints, and PIP joints. This study examined the accuracy of ultrasound for detecting joint pathology like synovial inflammation, erosions and effusion in small joints of hands and wrist taking MRI as reference standard. In our study all 30 patients were subjected to ultrasound and MRI examination of bilateral hands and wrists after noting relevant history, clinical examination and laboratory investigation findings. A total of 60 wrist joints, 120 MCP joints and 300 PIP joints were evaluated.

Demographic and baseline characteristics

There were 29 female patients and 1 male patient and the average age was 32.5 years. Age of cases ranged from 22-58 years. 96.67% of patients were in the age range of 21 to 50 years. The average age of presentation is lower as compared to the usual age of presentation reported in previous studies. This is possibly due to emphasis on early diagnosis as newer drugs can modify the course of disease and thus have an impact on long term prognosis. Revision of diagnostic criteria in 2010 (Table1) ⁽⁸⁾ and utility of USG and MRI in identifying abnormalities have made early diagnosis possible. These coupled with exclusion of patients with deformities as presenting symptom from the study are the possible factors for the lower age seen in our study. The most common presenting complaints were swelling and pain involving wrist, MCP and PIP joints, noted in 46% of patients. 60% of patients had duration of symptoms less than 2 years. Morning stiffness which is part of the diagnostic criteria for RA was seen in all the patients.

Biochemical abnormalities

Rheumatoid factor was positive in 53.33% of patients. This is similar to a study of 119 patients by Singh et al ^[9] from India in which RF was positive in 64.7% of patients and indicates that it is not sensitive for diagnosis of RA. CRP was positive in 33.33% of patients. ESR was raised in all the patients.

Ultrasound Findings

USG findings seen in our study were synovitis, erosions, effusions and tenosynovitis.

Synovitis Synovial thickening was the commonest finding on USG. It was seen in 88.33% of patients in wrist joint. It was seen as abnormal hypoechoic intraarticular tissue that was nondisplaceable and poorly compressible.

Erosion USG detected erosions of wrist joint in 45% patients. Erosions were detected as intraarticular discontinuity of the bone surface that was visible in two perpendicular planes.

Effusion USG detected effusion of wrist joint in 25% patients. Effusion appeared anechoic on sonography, with no evidence of flow on Doppler imaging.

Tenosynovitis It was noted in 11.66% of our patients. It was seen as hypoechoic thickening of the synovial sheath. In our study, the most commonly involved tendon was extensor carpi ulnaris.

Doppler Findings

Doppler showed increased vascularity in 8.33% of patients in wrist joint Relative lack of active inflammation of synovial thickening was seen in our patients possibly due to intake of anti-inflammatory drugs for pain relief.

MRI Findings

MRI findings seen in our study were synovial thickening and enhancement, erosions, effusions, tenosynovitis and bone marrow edema.

Synovial thickening and enhancement: Synovial thickening and enhancement were detected in wrist joint in 90% of patients. Synovial thickening showed greater than normal enhancement on gadolinium-enhanced T1- weighted images.

Erosions: In our study MRI detected erosions of wrist joint in 93.33% patients. They were seen as sharply marginated bone lesions with juxtaarticular location

and were visible in at least two planes with a cortical break in at least one plane. These had typical signal characteristics – hypointense on T1 weighted and hyperintense on T2 weighted images. High signal on T2-weighted images is due to inflammatory tissue or fluid. The former showed enhancement with intravenous gadolinium contrast.

Effusion MRI detected effusion in 28.33% patients in wrist joint. Effusion showed high signal intensity on T2-weighted MR images and low signal intensity on T1 weighted images. No enhancement was seen on fat-suppressed gadolinium enhanced T1-weighted MR images.

Tenosynovitis It was found in 11.66% of our patients. MRI revealed thickening of the synovial sheath around the tendon with marked enhancement on fat-sup pressed gadolinium-enhanced T1-weighted images.

Bone marrow edema MRI detected bone marrow edema in bones of right wrist joint in 26.67% and of left wrist in 13.33% of patients. It was detectable as an ill-defined area of high signal intensity on STIR T2-weighted images and was hypointense on T1W images.

Ultrasound Versus MRI

Signs of inflammation In our study overall sensitivity and specificity of USG for signs of inflammation in bilateral 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard was 82.35% and 97.67% respectively. These results are in concordance with those reported by Sckudlarek et al^[10]. They have reported sensitivity and specificity of USG for the detection of synovitis in MCP and PIP joints as 70% and 78%. Similarly a study examining interphalangeal joints with both USG and MRI as well as with conventional radiography and clinical examination showed good agreement between ultrasound and MRI in the detection of synovitis. Therefore; it concluded that ultrasound was a reliable and valid method of assessment of synovitis ^[11].

Our results are similar as the difference between USG and MRI for detection of synovitis is also not statistically significant (p value > 0.05).

Effusion

The overall sensitivity and specificity for 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard were 82.35% and 97.67% respectively. This marginal low sensitivity of USG for effusion as compared to synovitis can be explained by the difficulty to differentiate between coexisting synovitis and effusion separately especially in small joints. However there were few false positive cases also in our study. This can be explained on the basis of studies which have reported that USG is superior to MRI at detecting small quantities of fluid within the joint ^{[12].} In our study, no significant statistical difference (p value > 0.05) has been found between USG and MRI detection of effusion.

Erosions

The sensitivity and specificity of USG for erosions in wrist joint, with MRI as the reference, were 48.21% and 100% respectively. The difference between USG and MRI is statistically significant (p Value < 0.05) for wrist joint indicating that USG

is not good for detection of erosions in wrist joint. This can be explained by close apposition of carpal bones and thus difficulty in differentiating erosions from intercarpal joints. There are very few studies comparing USG and MRI for wrist erosion. Hoving et al. ^[13] have suggested that MRI is better than USG in this area and that further studies are mandatory to explore the value of USG in wrist erosion detection.

The sensitivity and specificity for erosions in 2nd MCP joint are 28.57% and 100% respectively. Sckudlarek et al.^[9] have reported sensitivity and specificity of USG for the detection of erosions in MCP and PIP joints as 59% and 98% respectively when compared with MRI. Similar finding have been reported by Rahmani et al.^[14] who have found sensitivity and specificity of USG for detection of bone erosions in finger joints as 63% and 98% respectively. The low sensitivity of USG for detection of erosion in finger joints seen in our study is possibily due to large size of linear transducer used resulting in poor accessibility of MCP joints. In our study overall sensitivity and specificity of USG for erosions in bilateral 2nd MCP, 5th MCP, PIP and wrist joints with MRI as a reference standard were 44.62% and 100% respectively.

Conclusion

Our data shows that ultrasound allows a sensitive detection of the inflammatory soft tissue process in the form of synovitis, tenosynovitis and effusion. Although there are heterogeneous results regarding the sensitivity of USG for erosion detection. Since synovial changes are the earliest manifestation, it appears to be a very useful tool in RA. Further, it is a cheap, fast, noninvasive method that is well suited for multiple joints assessment during one session. It also allows real time dynamic joint assessment. Although MRI is considered as a reference standard for RA imaging but it has certain disadvantages like higher cost, contrast administration, limited number of joints sites feasible for examination at one time and potential for motion artefacts.

Thus, ultrasonography has a definite role in diagnosis of early RA. We propose its routine use in diagnosis and management of RA patients. It can also be used for monitoring the response to treatment although standardization and validation is required to ensure reproducibility and reliability.

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TABLE 1

Classification Criteria for Rheumatoid Arthritis

Score of >= 6/10 is needed for classification of a patient as having definite Rheumatoid Arthritis

		Score
Joint involvement	1 large joint (shoulder, elbow, hip, knee, ankle)	0
	2–10 large joints	1
	1–3 small joints (MCP, PIP, Thumb IP, MTP, wrists)	2
	4–10 small joints	3
	>10 joints (at least 1 small joint)	5
Serology	Negative RF and negative ACPA	0
	Low-positive RF or low-positive anti-CCP antibodies (3 times ULN)	2
	High-positive RF or high-positive anti-CCP antibodies (>3 times ULN)	3
Acute-phase reactants	Normal CRP and normal ESR	0
	Abnormal CRP or abnormal ESR	1
Duration of symptoms	< 6 weeks	0
	>= 6 weeks	1

Note: These criteria are aimed at classification of newly presenting patients who have at least 1 joint with definite clinical synovitis that is not better explained by another disease.



showing hypoechoic soft tissue thickening in volar aspect of wrist joint representing synovitis(arrow) Figure 2 Transverse sonogram of wrist joint showing erosion of scaphoid bone seen as irregularity of bony cortex(arrow)



Figure 3 Transverse sonogram of wrist joint showing hypoechoic thickening around extensor carpi ulnaris tendon representing tenosynovitis. Mild fluid is also noted around tendon (arrow)



FIGURE 4 A to C: MRI Axial (A) TIW image (B) &(C) T1W FS image pre and post contrast showing erosions of carpal bones which are hypointense on TIW ,isointense on T1W FS image and shows marked post contrast enhancement on T1W FS CE image.



FIGURE 5 A and B: MRI Axial (A) STIR image (B) TIW FS CE image- showing synovial thickening and effusion in wrist joint. It shows hyperintense signal on STIR image. There is evidence of post contrast enhancement on TIW FS CE image. Within it a nonenhancing

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