

Sonographic Evaluation of Synovium of Wrist Joint in Rheumatoid Arthritis Patients during Activity

Ayman M. Ibrahim, Haytham M. Nasser, Nesma A.H Mohammed Saleh

Department of Radiodiagnosis, Faculty of Medicine, Ain Shams University

Corresponding author: Nesma A.H. Mohammed Saleh, Mobile: +201274656552, E-mail: Nesmasaleh@hotmail.com

ABSTRACT

Background: Rheumatoid arthritis (RA) is an inflammatory rheumatic disease with progressive course affecting articular and extra-articular structures resulting in pain, disability and mortality. Persistent inflammation leads to erosive joint damage and functional impairment in the vast majority of patients. The onset of disease is not similar in all patients but varies in regard to type, number, and the pattern of joint involvement. The course of disease may be also different according to the presence or absence of several variables including genetic background, frequency of swollen joints, autoantibody in the serum and the severity of inflammatory process.

Objective: The aim of this study was to demonstrate the role of Ultrasonography and Power Doppler in diagnosis of activity of rheumatoid arthritis in the hands and wrist joints among different aged population, compared with the laboratory investigations.

Patients and Methods: This study was carried out in Radiology department of Ain Shams university hospitals. Twenty-five patients known patients with rheumatoid arthritis suspecting activity will underwent assessment by ultrasonography and power Doppler of both wrist and hand joints.

Result: US & PD are highly sensitive and specific in detection of activity of the Rheumatoid Arthritis in correlation to laboratory investigations. So, they can be used as non-invasive methods in detection of RA activity changes in wrist and hand joints.

Conclusion: Both ultrasonography and power doppler are good predictors for activity in rheumatoid arthritis patients

Keywords: Ultrasonography (US), Power Doppler (PD), rheumatoid arthritis (RA).

INTRODUCTION

Rheumatoid arthritis (RA) is a chronic inflammatory disease associated with significant functional limitations and disability ⁽¹⁾.

The wrist joint is one of the joints that are affected early in the course of the rheumatoid arthritis. It shows the rheumatic changes such as bone erosions, joint effusion and tendinopathy. So, the wrist joint changes with rheumatoid arthritis could be used for diagnosis of the disease activity ⁽²⁾.

The use of Doppler techniques, including power, color and spectral Doppler, has greatly increased in rheumatology in recent years. This is due to the ability of Doppler US to detect pathological vascularization within joints and periarticular soft tissues, thereby demonstrating the presence of active inflammation ⁽³⁾.

US & PD are commonly used to assess soft tissue pathology, detect fluid collection and measure synovial vascularity due its capability to provide data that can be used to evaluate the level of joint inflammation and assess rheumatoid arthritis. It can also be used to visualize cartilage and bone surfaces. The real-time capability of ultrasonography allows dynamic assessment of joint and tendon movements to visualize the structural abnormalities ⁽⁴⁾.

AIM OF THE WORK

Our goal in this study is to demonstrate the role of Ultra-sonography and Power Doppler in diagnosis of activity in rheumatoid arthritis in the hands and wrist joints among different ages population and correlate it with the laboratory investigation.

PATIENTS AND METHODS

Patients: During a period of 7 months duration from Decemeber 2017 to June 2018, twenty-five patients were enrolled in the study. All patients proved rheumatoid patients for suspicion of activity, US& PD examination were done. **The study was approved by the Ethics Board of Ain Shams University.**

Inclusion criteria: All patients with clinical suspicion of active Rheumatoid Arthritis. No age or sex predilection.

Exclusion criteria: No Exclusion criteria.

US imaging: Each MCP and wrist joints will be scanned longitudinally and transversely from the dorsal view, with the joint in 20° of palmar flexion and will be documented in the longitudinal and transverse view in B mode and colourmode. All data was saved in a digital archiving computer system. For adjustment, we chose constant parameters that are a pulse repetition frequency of 551 Hz, a B mode frequency of 12.0 MHz, a colour mode frequency of

9.0 MHz, a gain of 70 dB, and a low filter. Stored images were evaluated on a 21 inch screen. Intra-articular colour density will be quantified in the longitudinal and transverse views within a user defined region of interest by computer aided image analysis. On longitudinal and transverse scans, the border of the respective region of interests was defined as previously described (longitudinal scans: tendon of the muscle extensors (top), the joint cavity (base), and the convex articular surfaces of corresponding bones (lateral border); transverse scans: tendons of the muscles extensors (top), the joint cavity (base), and the skin surface (lateral border).

Statistical analysis: Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 23. Data was summarized using mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. P-values less than 0.05 were considered as statistically significant.

RESULTS

The study included 25 patients presented to the Rheumatology clinic, Ain Shams University by symptoms suggestive of Rheumatoid Arthritis activity.

The study was conducted over a period of 7 months from Decemeber 2017 to June 2018.

The age of the study group ranged from 25 to 66 years. The female patients comprised the majority of our cases presenting 88% (Fig. 1).

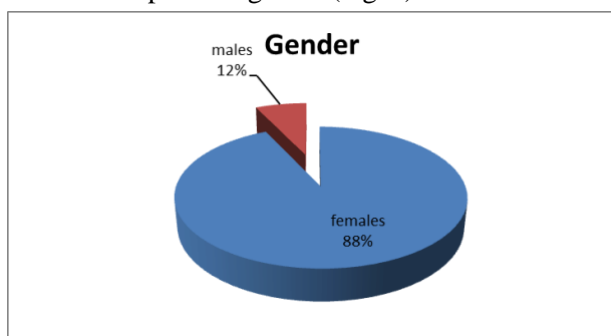


Fig. (1): Pie chart illustrating the gender distribution among our study group.

Regarding the clinical presentation, morning stiffness was the main presenting symptom, manifesting in 22 of 25 patients (88%). Other symptoms were small joint pain represented (100%) & limitation of movements (56%) (Fig. 2).

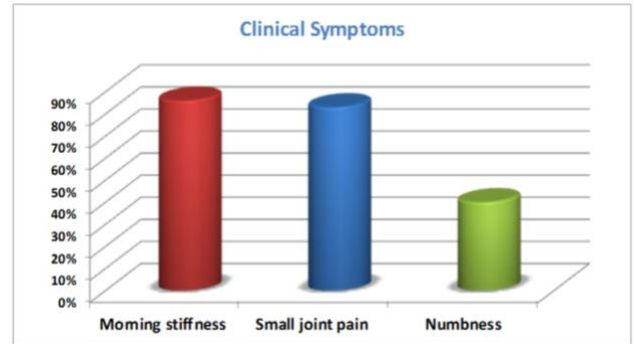


Fig. (2): Column graph illustrating the percentage of presenting symptoms of patients.

On clinical examination, all patients had tenderness of both hands (100%), while 56% of the patients had limitation of movement of small hand joints (Fig. 3).

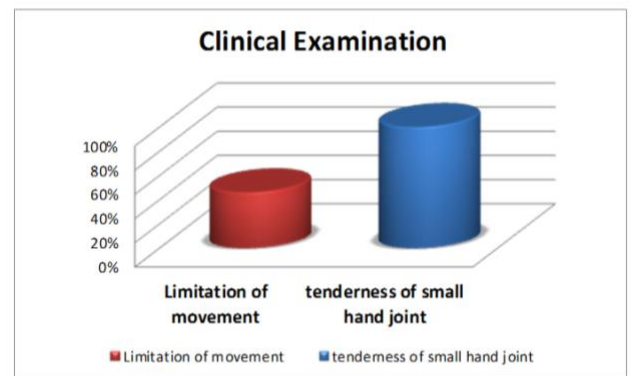


Fig. (3): Column graph illustrating the findings of clinical examination of both wrist and hand joints.

All patients included in this study underwent Ultrasound and power Doppler examination for both wrist and hand joints and all the patients (100%) had sonographic findings of RA.

Table (1): Illustrates the relation between gender and synovial hypertrophy.

			Synovial hypertrophy		Total
			-ve	+ve	
Gender	F	Number	3	25	28
		%	100.0%	92.3%	93.3%
Gender	M	Number	0	2	2
		%	0.0%	7.4%	6.7%
Total		Number	3	27	30
		%	100.0%	100.0%	100.0%
Chi-square tests					
		Value	P		
Pearson Chi-square		0.330	0.566		

By Power Doppler examination, 7 patients with synovial hypertrophy showed disease activity (6 females [24.2%] and one male [4%]) (Fig.4).

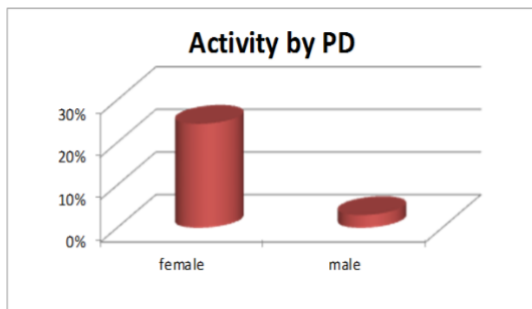


Fig. (4): Column graph illustrating percentage of patients with disease activity by PD.

According to the semi-quantitative scoring system for evaluation of the disease activity in patients with synovial hypertrophy, 6 patients were [Grade I] (22%), 4 patients were [Grade II] (14%) and 2 patients were [Grade III] (7%) (Fig.5).

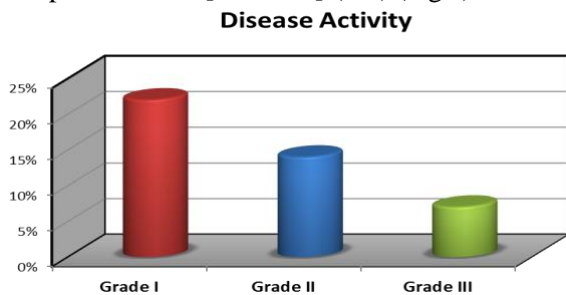


Fig. (5): Illustrates the semi-quantitative score for disease activity.

Of the total 25 patients with positive US findings, 12 patients (44%) had median nerve compression (11 females [40%] and one male [3%]).

Tendonopathy was seen in 11 patients 44% (9 females [36%] and two males [8%]).

Joint effusion was seen in only 7 patients (28%) 6 females (24%) and one male patient (4%), while bony erosions were seen in 7 females (28 %) (Fig.6).

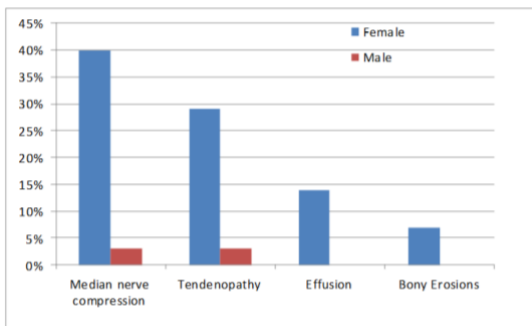


Fig. (6): Column graph illustrating the percentage of different sonographic findings of RA among males and females in the study group.

All patients underwent laboratory investigations for Rheumatoid Arthritis (Serum RF, ACCP, CRP and ESR).

Of 25 patients, 25 (100%) showed elevated serum CRP& ESR and 19 (76%) patients showed elevated ACCP & RF. 4 patients were sero-negative and 21 were sero-positive RA (Fig.7).

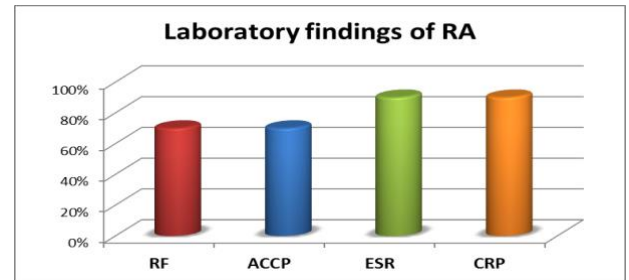


Fig. (7): Column graph illustrate the laboratory findings of RA.

All the previous sonographic findings were compared with laboratory results of RA (as a standard method for diagnosis).

We noticed that all patients who were sonographically positive for RA (synovial hypertrophy was the main findings), were also positive by laboratory results.

So, the additive value of US& PD is highly accurate in detection of activity in RA with 100 % sensitivity and specificity compared to laboratory results (Fig.8).

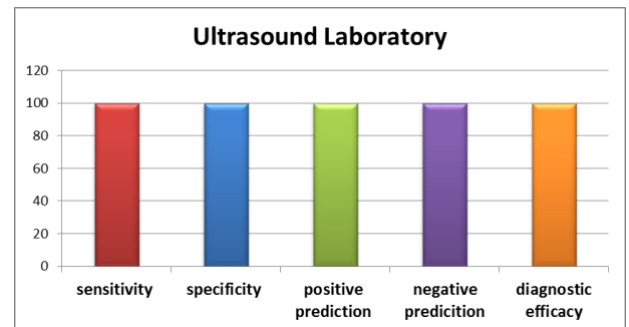


Fig. (8): Clustered column graph illustrating the sensitivity, specificity, positive, negative predictive values and diagnostic efficacy of US & PD.

DISCUSSION

Rheumatoid Arthritis is a chronic disease characterized by periods of disease flares and remissions. In rheumatoid arthritis, multiple joints are usually, but not always, affected in a symmetrical pattern⁽⁵⁾.

Chronic inflammation of rheumatoid arthritis can cause permanent joint destruction and deformity. Damage to joints can occur early and does not always correlate with the severity of RA symptoms⁽⁶⁾.

It initially involves the synovium of the joints leading to synovial thickening, synovial hyperemia, and pannus formation; later on, bone erosions and destruction and deformity of the joints will occur ⁽⁵⁾.

Synovitis is the initial presentation of the disease, which can be better treated, controlled, and prevented from progression if it is diagnosed in early stage⁽⁵⁾.

As the disease progresses, symptoms often spread to the wrists, knees, ankles, elbows, hips and shoulders. In most cases, symptoms occur in the same joints on both sides of the body ⁽⁷⁾.

About 40 percent of the people who have rheumatoid arthritis also experience signs and symptoms that don't involve the joints. Rheumatoid arthritis can affect many non-joint structures ⁽⁷⁾.

Rheumatoid arthritis occurs when the immune system attacks the synovium surrounding the joints. The resulting inflammation thickens the synovium, which can eventually destroy the cartilage and bone within the joint. The tendons and ligaments that hold the joint together weaken and stretch. Gradually, the joint loses its shape and alignment ⁽⁶⁾.

Evaluation of hand arthritis being the most common site of rheumatoid arthritis (RA) is important for diagnosis and evaluation of disease activity. As new imaging methods, joint ultrasonography (US) is currently used in RA ⁽⁷⁾.

US is an excellent tool for detecting synovitis and is better than X-rays for showing bone changes in the majority of patients with RA activity⁽⁸⁾.

US can detect subclinical synovitis which not well appreciated with clinical assessment alone. The link between synovial vascularity and ultimate joint damage makes the differentiation between inactive and actively inflamed synovium in the rheumatoid joint which is an important issue in management of patients RA and can be done by using PDUS ⁽⁸⁾.

The aim of this study is to detect the Ultrasound & Power Doppler findings in patients clinically suspected to have Rheumatoid Arthritis activity.

This study included 25 patients referred from Rheumatology clinic to Ultrasound unit of Radio-diagnosis department at Ain Shams University Hospitals.

The age of patients ranged from 25 to 66 years old. The female patients representing the majority of our cases, 88% of the cases.

The current study agreed with *Kawashiri et al.*⁽⁹⁾; *Rezaei et al.*⁽¹⁰⁾; *El-Gobashy et al.*⁽⁶⁾ and *Issar et al.*⁽⁵⁾ whose studies showed predominant female patients with 76%, 75%, 88% and 75% incidence respectively, yet our results disagreed with *Filer et al.*⁽¹¹⁾ whose study revealed male predominance (55%).

Symptoms of RA are morning stiffness, joints pain (specially the small joints), limitation of movement and deformity (in advanced disease process).

In the current study, the clinical presentation of patients was as follow: 22 patient presented by morning stiffness (representing 88%), 25 patient had small joint pain (representing 100%) and 14 patients had limitation of movement (representing 56%). This agreed with *Kawashiri et al.*⁽⁹⁾ whose study showed that, the most common presenting symptom was morning stiffness 65.2%, followed by small joint pain (61.3%). Also, in agreement with *Szkudlarek et al.*⁽¹²⁾ study that showed that about 80% of the patients presented by small joints pain.

US & PD examination showed that 25 patients (100%) had synovial hypertrophy, 7 patients showed activity by PD (28%), 12 patients showed median nerve compression (44%), 9 patients had tendinopathy (44 %) and 2 patients (8%) had bony erosions.

The reported results of the present study agreed with *Kawashiri et al.*⁽⁹⁾ that showed synovial hypertrophy in all patients (100%), yet the percentage of patients with disease activity by PD was more than in the current study (91.8 %). Also, his study showed more patients with bony erosions (22 %) than those detected in our study (8%).

By applying the semi-quantitative scoring system, there were 55% Grade 0, 22% Grade I, 14% Grade II and 7 % Grade III. Our study disagreed with *Hammer et al.*⁽¹³⁾ that showed Grade 0 in 8.7%, Grade I in 19.3 %, Grade II in 39.4% and Grade III in 32.6%

The present study revealed elevated ACCP & RF in 76 % & 84% of patients and ESR in 100% of patients. This is similarly related to the study by *Kawashiri et al.*⁽⁹⁾ that showed laboratory results of elevated ACCP (anti cyclic citrullinated peptide) in 72%, RF in 70% and ESR in 100% of the patients included in their study, *Filer et al.*⁽¹¹⁾ which showed elevated ACCP & RF in 64 % and *Issar et al.*⁽⁵⁾ which showed elevated RF in 70% & ACCP in 54% of patients.

The ongoing study, the additive sensitivity and specificity of US & PD in detection of Rheumatoid Arthritis was 100%. This is higher than the results of *Issar et al.*⁽⁵⁾ and *El-Gobashy et al.*⁽⁶⁾ whose studies showed 88% & 95% sensitivity, and 80% & 85% specificity respectively.

Despite advantages, there are some limitations of this technology. US is considered to be an operator-dependent technology with poor repeatability. Even with advances in the resolution of the transducers, deeper structures are difficult to visualize as the higher-frequency transducers have lower tissue penetration. Acquisition of US skills takes time depending on trainee's hand-eye coordination skills. A long training period may be an important limiting factor in its popular use. In addition, examination of multiple joints in the clinical setting can be time consuming. Evidence is accumulating for focused examination with concentration on a small number of active joints to reduce examination time.

Another limitation of our study is the small number of included patients. So, further studies with larger number of patients for better and more reliable results are recommended.

CONCLUSION

US & PD are highly sensitive and specific in detection of activity of the Rheumatoid Arthritis similar to laboratory investigations. So, they can be used as noninvasive methods in detection of RA activity changes in wrist and hand joints.

REFERENCES

- Bhasin S and Cheung PP (2015):** The role of power Doppler ultrasonography as disease activity marker in rheumatoid arthritis. *Dis Markers*, 15(20): 325-909.
- Goldring SR and Gravalles EM (2013):** Pathogenesis of bone erosions in rheumatoid arthritis. *Curr Opin Rheumatol.*, 12(3):195-9.
- Porta F, Radunovic G, Vlad V et al. (2012):** The role of Doppler ultrasound in rheumatic diseases. *Rheumatology*, 51(6):976-82.
- Hau M, Schulz H, Tony HP et al. (2011):** Evaluation of pannus and vascularisationmetacarpophalangeal and proximal interphalangeal joint in RA by resolution ultrasound. *Rheumatology*, 40(11):397-409.
- Issar P, Nadiger VM, Hiran S et al. (2016):** Ultrasound and magnetic resonance imaging correlation of the wrist and metacarpophalangeal joints with comparison to laboratory investigations. *Indian Journal of Rheumatology*, 11(4):186-191.
- El-Gobashy M, El-azizy H, Hussein M et al. (2015):** Role of ultrasound and MRI in detection of Hand and wrist Joints erosions in Rheumatoid Arthritis patients, comparative study with laboratory results, 83 (1): 615-620.
- Rowbotham EL and Gringer AJ (2015):** Rheumatoid arthritis: Ultrasound versus MRI. *American Journal of Roentgenology*, 197: 541-6.
- Wakefield RJ, Gibbon W, Conaghan PG, O'connor P, McGonagle D, Pease C (2015):** The value of sonography in the detection of bone erosions in patients with rheumatoid arthritis: A comparison with conventional radiography. *Arthritis and Rheumatism*, 43: 2762-70.
- Kawashiri SY, Kawakami A, Iwamoto N et al. (2013):** The power Doppler ultrasonography score from 24 synovial sites or 6 simplified synovial sites, including the metacarpophalangeal joints, reflects the clinical disease activity and level of serum biomarkers in patients with rheumatoid arthritis. *Rheumatology (Oxford)*, 50:962-5.
- Rezaei H, Torp-Pedersen S, af Klint E et al. (2014):** Diagnostic utility of musculoskeletal ultrasound in patients with suspected arthritis: a probabilistic approach. *Arthritis Res Ther.*, 16:448.
- Filer A, De Pablo P, Allen G et al. (2011):** Utility of ultrasound joint counts in the prediction of rheumatoid arthritis in patients with very early synovitis. *Ann Rheum Dis.*, 70:500-507.
- Szkudlarek M, Court-Payen M, Jacobsen S et al. (2013):** Interobserver agreement in ultrasonography of the finger and toe joints in rheumatoid arthritis. *Arthritis Rheum.*, 48(4): 955-962.
- Hammer HB, Bolton-King, PBakkeheim V et al. (2017):** Examination of intra and interrater reliability with a new ultrasonographic reference atlas for scoring of synovitis in patients with rheumatoid arthritis. *Ann Rheum Dis.*, 70:1995-8.