



## Original Research Article

## Joint involvement in Rheumatoid arthritis: Sonographic evaluation in comparison with Radiography

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## ABSTRACT

**Background:** The aim of this study was to evaluate the role of ultrasonography (including power doppler) in assessing the joint involvement in Rheumatoid Arthritis (RA) and its comparison to radiographic changes.

**Materials and Methods:** 55 patients with RA underwent ultrasound and radiographic examination of wrist and hand with laboratory investigations. 25 subjects were taken as controls. Following points were specifically looked in ultrasound – synovitis, synovial hypertrophy, effusion, cartilage thickness, swelling of tendon, osteophytes, erosions. Erosion sites were compared using radiographs. Ultrasonography was performed by two radiologists and inter-observer agreement was calculated.

**Results:** Out of total 55 cases, 44 cases were classified as early RA and 11 cases as advanced RA. Out of 25 control subjects, 3 subjects had a lesion – atypical for RA, however – all 3 had previous trauma at that site. Inter-observer agreement was excellent. Intra-articular erosions were seen in all cases of advanced RA and in only 26/44 cases in early RA cases. Tenosynovitis was seen in 21/44 cases of early RA while only one case of advanced RA showed tenosynovitis. There was reduced cartilage thickness in all patients of advanced RA while none was observed in early RA cases. Synovial hypertrophy and synovial effusion were almost similar in both early and advanced RA cases. Ultrasonography detected erosions in 37/54 cases while radiography detected erosions in only 11/54 cases.

**Conclusions:** Sonography can be used as a primary modality to diagnose RA especially early RA, which helps in reducing disabilities by early aggressive treatment. It is more sensitive than radiography in detecting erosions.

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### 1. Introduction

Wrists and hands are involved in many pathological conditions. Their involvement is always associated with disability in performing regular activities on the part of the patient and difficulty in diagnosing on part of the treating clinician due to lack of specific diagnostic criteria.

Common causes of the chronic wrist pain include fractures, ligament tears, radioulnar subluxation, erosive

and non-erosive arthritis, osteoarthritis, avascular necrosis of carpal bones, neoplasms, tendinopathy, neuropathy and various infections.

Rheumatoid arthritis (RA) is a chronic inflammatory disease of unknown aetiology marked by a symmetric, peripheral polyarthritis. The major abnormalities of RA appear in the synovial joints as soft tissue swelling caused by synovial hypertrophy, effusion, bursal and tendon sheath swelling.<sup>1</sup> Marginal erosions are due to inflamed synovium destroying the cortex and underlying bone and they occur initially at the bare area: the margins where synovium is not

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covered by cartilage. These findings can occur in unison or as an isolated entity depending upon the duration and the activity of the disease. Presence of erosions in early RA is associated with bad prognosis and it may also guide in the choosing the appropriate therapy.<sup>2</sup>

Appropriate treatment of RA in its early stages helps in reduction of disabilities.<sup>3</sup> There is limited scope of physical examination and lab tests for early diagnosis of RA. And even radiographic changes are seen in the late course of the disease.<sup>4</sup> Ultrasound is superior to clinical examination in detecting synovitis.<sup>5</sup> Power doppler has been used to assess the disease activity and there is a good correlation between Doppler hyperaemia and histologically detected pannus.<sup>6</sup> Ultrasound is non-invasive, readily available, portable and inexpensive modality which can be used to examine multiple joints at a time. It can also be used to evaluate extra-articular entities such as enthesopathies and tenosynovitis.<sup>7,8</sup> The study has also compared the radiography and ultrasonography in detection of osteophytes and erosions. The aim of the current study was to evaluate the role of ultrasonography (including power doppler) in assessing the joint involvement in RA and its comparison to radiographic changes.

## 2. Materials and Methods

### 2.1. Patients

Approval of Institutional ethical committee was taken. 55 patients who were diagnosed with RA according to ACR/EULAR criteria were included in the study. The study was conducted in a tertiary care hospital (Navodaya Medical College Hospital and Research Centre, Raichur) from March 2018 to January 2020.

Details regarding history and physical examination were collected. Conventional radiograph of the affected hand was obtained in standard views.

Serological markers like Rheumatoid factor (RF), C-reactive protein (CRP) and Anti-citrullinated protein antibody (anti-CCP) were estimated.

25 subjects were taken as controls who came for ultrasonography of the different part of the body (other than wrist). Both the groups were age matched. Radiographs were not taken for control groups as ethical committee did not grant permission.

### 2.2. Ultrasonography

Ultrasonography was performed in all cases using Samsung Medison SA800 machine using high frequency (6-12Mhz) linear array transducer. Ultrasound was performed by two radiologists who were blinded to the clinical and laboratory data. Scanning of wrist and hand was performed with the patient seated, with hands resting on the examination table. Examinations were carried out on both sides for comparison. Colour and power doppler were used as

and when required to evaluate blood flow with standard settings of the machine. Following points were specifically looked – synovitis, synovial hypertrophy, effusion, cartilage thickness, swelling of tendon, osteophytes, erosions etc.

### 2.3. Statistical analysis

After collecting the data, it was entered in Microsoft excel. Frequency and percentages were calculated for qualitative data. Inter-observer agreement was calculated. Data was analyzed by using “IBM SPSS Statistics” (version 16.0). Analysis was done by using Student ‘t’ test and chi-square test. All statistical tests were applied at a significance level of “ $\alpha=0.05$ ” (p value < 0.05).

## 3. Results

Out of 25 control subjects, 3 subjects had a lesion – atypical for RA, however – all 3 had previous trauma at that site. The study subjects consisted of 55 individuals with 41 females and 14 males (females>males). Majority of the patients belonged to the age group of 41-50 years. Out of total 55 cases, 44 cases were classified as early RA and 11 cases as advanced RA.

The sonographic findings that were observed were synovial hypertrophy, synovial effusion, intra-articular erosions, tenosynovitis and reduced cartilage thickness (Tables 1 and 2). Positive power doppler signals were seen in hypertrophied synovial tissues in few cases. Inter-observer agreement was excellent with kappa value of 0.87 (95% CI 0.77-0.93). Intra-articular erosions were seen in all cases of advanced RA and in only 26/44 cases (59%) in early RA cases. Tenosynovitis was seen in 21/44 cases (48%) of early RA while only one case (9%) of advanced RA showed tenosynovitis. Tenosynovitis was most commonly seen in extensor group of tendons around the wrist (18/21 cases – 86%). It was seen in only 3/21 cases (14%) in flexor group of tendons. There was reduced cartilage thickness in all patients of advanced RA while none of the early RA case showed reduced cartilage thickness. Synovial hypertrophy and synovial effusion were almost similar in both early and advanced RA cases. In both early and advanced RA, synovial hypertrophy and intra-articular erosions were found predominantly in wrist and inter-carpal joints. Raised CRP, RA factor and anti-CCP antibody was found in both early and advanced cases of RA (Table 3).

Of the extensor group, extensor carpi ulnaris (ECU) was very commonly involved followed by extensor digitorum (ED). In the flexor compartment, flexor digitorum superficialis (FDS) and flexor carpi radialis (FCR) were commonly involved.

Ultrasonography detected erosions in 37/54 (69%) cases while radiography detected erosions in only 11/54 (20%) of cases (Table 4). Ultrasonography detected osteophytes in

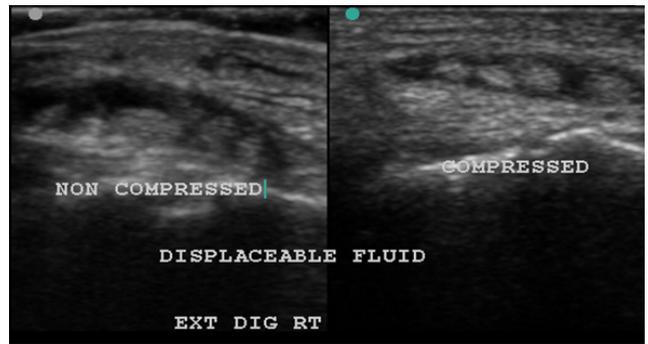
8/54 (15%) cases while radiography detected osteophytes in only 3/54 (6%) of cases.

**Table 1:** Sonographic findings in early RA (n=44)

S.No	Sonographic Feature	No. of cases	Percentage
1.	Synovial hypertrophy (SH)	42	95.45%
2.	Synovial effusion (SE)	04	9.09%
3.	Intra articular erosions (IAE)	26	59.09%
4.	Tenosynovitis (TSYN)	21	47.72%
5.	Reduced cartilage thickness (RCT)	-	-

**Table 2:** Sonographic findings in advanced RA (n=11)

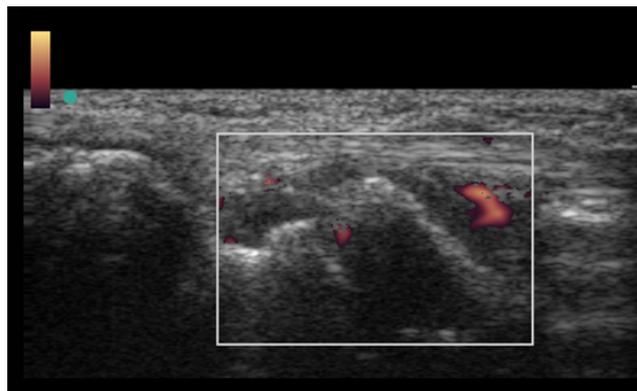
S.No	Sonographic feature	No. of cases	Percentage
1.	Synovial hypertrophy	11	100%
2.	Synovial effusion	00	00
3.	Intra articular erosions	11	100%
4.	Tenosynovitis	01	9.09%
5.	Reduced cartilage thickness	11	100%



**Fig. 2:** Longitudinal ultrasound demonstrates synovial fluid effusion around the extensordigitorum tendon.



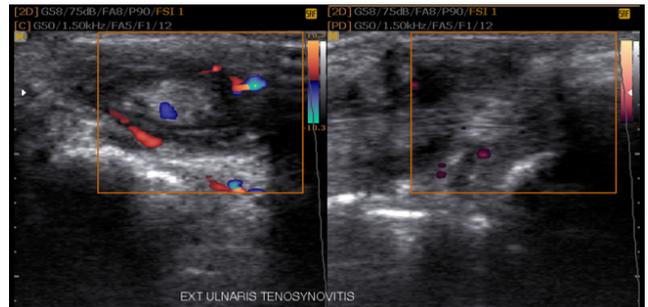
**Fig. 3:** Longitudinal ultrasound demonstrates intra-articular erosions on ulnar side of inter-carpal joint with pannus. While plain radiograph of the same patient is normal.



**Fig. 1:** Longitudinal ultrasound demonstrates synovial hypertrophy in mid inter-carpal joint with power doppler signal.

#### 4. Discussion

Early treatment and intervention of RA reduces the future possible occurrence of deformities and disabilities.<sup>9</sup> This led to the need of new diagnostic methods which can diagnose early RA with good accuracy. MRI is one such modality, but is expensive and time consuming. Thus, use of Ultrasonography in early diagnosis of RA began and it showed to have good sensitivity. Few previous studies have concluded that ultrasonography can be used to detect erosions in hands in RA.<sup>10-12</sup> Only few studies among



**Fig. 4:** Transverse ultrasound demonstrates tenosynovitis of Extensor carpi ulnaris tendon.

them have compared ultrasound with radiography for the detection of erosions. Thus, aim of our study was to evaluate the role of ultrasonography in the diagnosis of RA (particularly early RA) and comparison with radiography in the detection of erosions.

Proliferative synovitis is the earliest pathologic change seen in rheumatoid arthritis and is usually but not exclusively bilateral and symmetric.<sup>13</sup> Approximately 96% of our patients had this finding at presentation. It's presence in symmetric distribution involving wrist, intercarpal, metacarpophalangeal (MCP), proximal interphalangeal (PIP) joints in varying proportions increases the probability of the disease being RA.<sup>14</sup> This fact is even more reinforced by the chronicity of symptoms.

**Table 3:** Serological changes in early and advanced RA

Serological Marker	Early RA	Percent	Advanced RA	Percent
	N=44		N=11	
Raised CRP	34	77.27%	10	90.90%
RA factor +nt	23	52.27%	07	63.63%
Anti CCP +nt	N=27	48.14%	N=8	62.50%

**Table 4:** X-Ray and hrus (High-resolution ultrasound) Comparison - detecting osteophyte and erosions.

Modality	Erosions N=37	Percentage	Osteophytes N=8	Percentage
X-Ray	11	29.72%	3	37.5%
USG	37	100%	8	100%

The widely accepted method for synovial hypertrophy quantification with greyscale ultrasound is the semiquantitative scale.<sup>15</sup> 0 indicates no intra-articular changes, and 1–3 indicates mild, moderate, and large synovial hypertrophy. We also found application of this quantification system in our group easier and effective. Both dorsal and volar scans can be used to detect joint effusion and synovial hypertrophy (Figures 1 and 2). Backhaus et al found 86% of positivity when scanning volar side of the hand compared to dorsal one, with only 14% positivity of dorsal synovitis alone in clinically affected joints.<sup>16</sup> Ostergaard et al found only a third of patients having synovitis on both volar and dorsal side of the fingers, in the majority of cases synovitis being limited to volar-43% or dorsal- 27%.<sup>17</sup> In our study, we found it easier to demonstrate synovial hypertrophy (SH) on examining dorsal aspect of MCP, intercarpal, wrist joints and volar aspect of PIP joints. The difficulty arose when there was no power Doppler signal (inactive pannus). In such cases the abnormal thickened soft tissue lying in joint space was considered as SH.

Detection of bone erosions at the time of RA diagnosis is related to a poor long-term functional and radiographic outcome,<sup>18</sup> and the presence of erosions in early undifferentiated arthritis is a risk factor for developing persistent arthritis.<sup>19</sup> When compared with radiography, US is definitely more sensitive in identifying the presence of erosions during initial patient evaluation of RA patients.<sup>20</sup> The findings of our study is in agreement with findings proposed by Bajaj et al. 2007.<sup>20</sup> Out of the 37 patients, where erosions were evident on HRSG, X-ray was positive in only eleven cases. Detection of erosions early in the disease is predictive of an aggressive disease course.<sup>21</sup> Thus, US also helps in determining prognosis.

Intra articular erosions were greatest in the wrist followed by the metacarpophalangeal (MCP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints respectively.<sup>22</sup> In agreement with study stated here, 18 and 17 patients had involvement of wrists and Intercarpal joints (ICJ) respectively in our study, out of total 26 patients who had erosive early RA (Figure 3). In fact, in

our study, out of total 55 patients, 12 (8 in early RA and 4 in advanced RA) had only involvement of wrists and ICJ. MCP and PIP were involved in only 4 and 2 patients respectively. And in advanced RA, wrists and ICJ were invariably involved (all the patients had involvement of wrists and ICJ). In the wrist, erosion distribution was concentrated in the radiocarpal and medial carpometacarpal complex.<sup>22</sup> Our findings were also in agreement with the conclusions of J C Buckland-Wright.<sup>22</sup> Probably least important were the PIP joints when evaluation of erosions were concerned. Thus, examination of wrists and ICJ for evaluation of RA cannot be overemphasised. It can be noted that erosions were detected more on ultrasound than radiograph as ultrasound is a three-dimensional modality while radiograph is a two-dimensional one.

The diagnostic accuracy of sonography in the detection of erosions could not be calculated as ultrasound detected more erosions than radiographs and radiography is the gold standard for the detection of erosions. Therefore, it was just a comparison study between Radiography and Ultrasonography.

Tenosynovitis is commonly an accompanying sonographic finding in patients of early RA. Various hand tendon abnormalities were described in early stages of the disease in RA: widening of the tendons sheaths, loss of normal fibrillar echostructure, irregularity of the tendon margins.<sup>23</sup> In our study, widening of the tendon sheath due to hypo-echoic irregular synovial thickening was the common abnormality seen as shown in figure 4 (76% of total tenosynovitis). It may or may not be associated with synovial effusion. Alternatively, synovial effusion can be seen without synovial hypertrophy. Least common sonographic finding was the altered tendon echotexture (seen only in 24%). Although any tendon may be affected, the flexor digitorum, extensor digitorum, and extensor carpi ulnaris (ECU) were frequently involved.<sup>24</sup> Extensor group of tendons were commonly involved in our study group (86%). One interesting observation in our study was the involvement of ECU. Isolated ECU involvement without involving other tendons was seen in 6 patients (29%). And two of these patients had tenosynovitis of ECU as the

only initial finding without any evidence of synovitis. On follow-up, these two were later diagnosed as RA. Thus, we find the study conducted by Siri Lillegraven et al. 2011 agreeable.<sup>25</sup>

As the disease progresses there will be cartilage destruction, there by reducing the joint space. Tendon contractures which result in joint deformity are also common during this stage. However, role of sonography lies in preventing their occurrence rather than detecting them.

## 5. Conclusions

Sonography can be used as a primary modality to diagnose rheumatoid arthritis, especially early rheumatoid arthritis, which helps in reducing disabilities by early aggressive treatment. It is more sensitive than radiography in detecting erosions.

## 6. Limitations

Major limitation of the study is that Ultrasonography is operator dependant. Correlation with MRI would have helped in better diagnostic outcome.

## 7. Source of Funding

No financial support was received for the work within this manuscript.

## 8. Conflict of Interest

The authors declare they have no conflict of interest.

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