



Comparison of Digital X-Ray and USG Detected bone Erosion in Newly Diagnosed Rheumatoid arthritis Patients (less than 2 years) Attending a Tertiary Care Hospital in Kolkata

Authors

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Abstract

Introduction: Rheumatoid arthritis (RA) is a chronic inflammatory disease of marked by a symmetric, peripheral polyarthritis. Bone erosion is an integral part of RA, our aim of this study is to find out that among digital radiography and ultrasonography, which investigation picks up bone erosion more easily and earlier, thus picking up deformity earlier.

Methodology: It was cross-sectional study, conducted in the Rheumatology OPD of Medical College, Kolkata during a period of 1 year among 77 adult literate person. Digital radiography and ultrasonography of peripheral joints were done, and comparison was done to find out which modality detected the joint deformity earlier.

Results: In our study population usg was a better modality of imaging than digital radiography for detecting joint deformity in newly diagnosed RA patient.

Introduction

Rheumatoid arthritis is a chronic multisystem of unknown aetiology. The characteristic feature of rheumatoid arthritis is persistent inflammatory synovitis. The potential of synovial inflammation to cause cartilage damage and bone erosion and subsequent changes in joint integrity is the hallmark of the disease¹.

The natural history of the disease is such that the early months of the disease is critical period during which joint damage occurs. So, if a patient presents with 3 or more swollen joints, with metacarpophalangeal, metatarsophalangeal joint

involvement and morning stiffness, it is necessary to assess the condition.

Early diagnosis of rheumatoid arthritis and early disease modifying antirheumatoid drugs (DMARDs) application is the only way to save the patient from crippling disease. Study by Ideguchi, et al,^[2] reported that not only could the disease be halted with therapy, bone erosions in rheumatoid arthritis could even be repaired by reduction in disease activity. This could be achieved even with the help of conventional disease modifying anti-rheumatic drugs.

The recommendation now is to treat the disease to remission, which is the target. Remission is said to have been achieved if the disease activity is lowered below a certain score. However, clinical remission may not always translate into radiological halting of erosion, as has been shown by Molenaar, et al,^[3]. Thus, there is need for investigations which can detect and even quantify the disease for better assessment of the disease.

In a developing country like India, the cost of investigation is a significant factor for most of the patients. From the doctor's point of view, it is also necessary to try to limit the radiation exposure to the patients. Ultrasonography has the advantage of being economic inspite of its sensitivity in assessing both inflammatory and destructive changes.

Ultrasonography has now gained prominence in rheumatology as it can not only be used to diagnose bone erosion, it can simultaneously be used to see ligament, muscle, peripheral nerve and cartilage pathology readily^[4]

Bone erosions can be defined as intra-articular discontinuity of the bone surface that is visible in two perpendicular planes^[5].

Rheumatoid arthritis is a chronic systemic inflammatory disorder that may affect many tissue and organs but principally attack synovial joints. The process involves inflammatory response of the capsule around the joints, secondary hyperplasia of synovial cells, excess synovial fluid formation and development of pannus in the synovium. Pathology of the disease process often leads to destruction of the articular cartilage and ankylosis of the joint. Rheumatoid arthritis can also cause inflammation in pleura, pericardium and sclera. It can also result in nodular lesion in subcutaneous tissue.

Although the cause of rheumatoid arthritis is not known, autoimmunity plays a vital role in both its chronicity and progression. Thus, rheumatoid arthritis is

now considered a systemic autoimmune disease. This can explain that bone erosion, which is a hallmark of rheumatoid arthritis, not only predicts

morbidity; it is also associated increased mortality^[6,7,8].

About 1% of the world's population is afflicted by rheumatoid arthritis. Women are affected 3 times more commonly than the males. Onset is most frequently between ages 40 and 50 years, but people from any age group can be affected.

In addition, individuals with HLA-DR1 and HLA-DR4 serotypes have an increased risk for developing the disorder. It can be disabling and painful condition which can lead to substantial loss of function and mobility if not adequately treated. It is a clinical diagnosis made on the basis of symptoms, physical examination, radiography and laboratory tests. Patients are classified as rheumatoid arthritis if they fulfil the ACR/EULAR criteria for classification.

Materials and Methods

Study area: Rheumatology and medicine out patients department (OPD) of Medical College and Hospital, Kolkata.

Study Population: all patients with newly diagnosed rheumatoid arthritis (less than 2yrs), satisfying inclusion and exclusion criteria and giving informed consent

Study period: January 2016- June 2017

Definition of Problem: Rheumatoid arthritis (RA) is the most common chronic inflammatory arthritis, affecting 0.5% to 1% of the general population worldwide. There is evidence that the overall incidence of RA has been decreasing in recent decades, whereas the prevalence has remained the same because individuals with RA are living longer. Like many other autoimmune diseases, RA occurs more commonly in females than in males, with a 2–3:1 ratio. Pain in joints gradually progressing into joint deformity and disability are important clinical feature of the disease. Diagnosis is made on the basis of clinical feature of chronic arthritis of > 6weeks involving usually more than one small and/or large joint. Laboratory and radiological data provide additional aid to diagnosis. The 2010 ACR EULAR revised —Classification Criterial yields a

score of 0-10. Scores ≥ 6 fulfil the requirement of definite RA diagnosis [51].

Bone erosion is the most characteristic lesion of the disease, which gradually leads to deformity, adding to morbidity associated with the disease.

Sample size

A total of 77 patients were studied

Study variables

All patients were studied on the basis of following variables-

- 1) Demographic evaluation
- 2) Clinical evaluation
- 3) Digital radiography of hands and feet
- 4) Ultrasonography of hands and feet
- 5) Estimation of CBC, ESR and CRP

Inclusion criteria

1. Age more than 15 years
2. Rheumatoid arthritis diagnosed by fulfilling 2010 ACR/EULAR criteria(11)
3. Disease duration less than 2 years

Exclusion criteria

- 1) Patients with chronic renal failure
- 2) Patients with multiple myeloma
- 3) Pregnant patients
- 4) Patients with diabetes mellitus
- 5) Critically ill patients
- 6) Unwilling patients
- 7) Patients with other arthritis (e.g. reactive, gouty, traumatic)

Study design

Hospital based cross-sectional comparative study

Method of data collection

Following entry into study, demographic data of the patients were collected. A thorough history was taken regarding inflammatory arthritis, duration of the disease, drugs taken; adherence to treatment, presence of other diseases was taken. Then digital radiography was done of both hands and both feet.

Ultrasonography of joints was done. The CBC, ESR and CRP values were checked and RF and anti-CCP values were noted. The patients were then grouped according to disease activity and the erosion were observed in x-ray and USG and compared. For a subgroup of patients, the x-ray

and USG evaluation were repeated by a second person, and agreement or disagreement between two persons were also noted

Parameters to be studied

1. Clinical assessment including tender, swollen joint count and pattern of joint involvement
2. Determination of disease activity score
3. Radiographic examination of metacarpophalangeal joints excluding the first joint, proximal inter phalangeal joints of the hand, metatarsophalangeal joint, excluding the first joint
4. Ultrasonography of same joints.

Study Tools

1. Thorough history taking and clinical examination
2. Digital x-ray of hands(PA view) and feet(AP view) using PHILLIPS ALLURA XPER FD 20 machine
3. USG of hands and feet using PHILLIPS ClearVue 850 machine with linear transducer (5-17 MHz)
4. ESR estimation using Westergreen tube
5. CRP estimation using Erba Mannheim CHEM-5 Plus V2 semiautoanalyser using BioSystems reagent
6. CBC analysis using SysMex autoanalyser
7. Rheumatoid Factor estimation
8. Anti-CCP estimation

Results and Analysis

Sex

There were 63 females and 14 male patients with sex ratio M:F=1:4.5

(Table 1, figure 1)

Table 1: Distribution of the study population according to sex (n=77)

Sex	Frequency	Percentage
Female	63	81.8
Male	14	18.2
Total	77	100

Age Distribution

Distribution of study population according to sex

Table 2: Distribution of study population according to sex (n=77).

Age category	Frequency
0-10	0
11-20	0
20-30	0
31-40	6
41-50	17
51-60	38
60-70	16

Conclusion: Most of the study population were between 51-60

Erosions in Right MCP Joints by USG

Number of erosions noted in right sided MCP joint

Table 3: Distribution of study population according to 1st Observers opinion on USG findings of Right sided Meta Carpo Phalangeal Joint (n=77)

Number of erosions	frequency	percent
0	53	68.8
1	20	26.0
2	4	5.2
Total	77	100

Conclusion (1)No erosion could be detected in most of the study population(68.8%)
 (2) On 4 occassions, more than 1 erosion could be detected in themcp joint.

Erosions in Right PIP Joint by USG

Number of erosions noted in right sided PIP joint by USG

Table 11: Distribution of study population according to 1st Observers opinion on USG findings of Right sided proximal interphalangeal joint (n=77)

Number of erosions	frequency	percent
0	71	92.2
1	6	7.8
Total	77	100.0

Conclusion: Bone erosion could be detected in only 6(7.8%) occasions in right PIP joints in the study population using USG.

Erosions in Right MTP Joint by USG

Number of erosions noted in right sided MTP joint

Table 12: Distribution of study population according to 1st Observers opinion on USG findings of Right sided metatarsophalangeal joint (n=77)

Number of erosions	frequency	percent
0	62	80.5
1	15	19.5
Total	77	100.0

Conclusion: Bone erosion could be detected on 15(19.5%) occasions in right MTP joints in study population using USG.

Erosion in Left MCP Joint by USG

Number of erosions noted per MCP joint by 1st observer

Table 13: Distribution of study population according to 1st Observers opinion on USG findings of left sided metacarpophalangeal joint (n=77)

Number of erosions	frequency	percent
0	40	51.9
1	29	37.7
2	8	10.4
Total	77	100.0

Conclusion: (1) Single bone erosion could be detected in 29 (37.7%) joints in left MCP joints
 (2) More than 1 erosions were detected in 8 joints in left MCP joints.

Erosions in Left PIP Joint by USG

Number of erosions noted in left PIP joint by 1st observer

Table 14: Distribution of study population according to 1st Observers opinion on USG findings of left sided proximal interphalangeal joints (n=77)

Number of erosions	frequency	percent
0	69	89.6
1	7	9.1
2	1	1.3
Total	77	100

Conclusion: (1) Single erosion was detected in 7(9.1%) joints among the studypopulation
 (2) More than 1 erosion were detected in 1 joint in the study population

Erosions in Left MTP Joint by USG

Number of erosions detected in left MTP joint by 1st observer

Table 15: Distribution of study population according to 1st Observers opinion on USG findings of left sided metatarsophalangeal joints (n=77)

Number of erosions	frequency	percent
0	58	75.3
1	18	23.4
3	1	1.3
	77	100.0

Conclusion: (1) Single erosion was detected in 18(23.4%) joints in the study population
 (2) More than one erosion was detected in only 1 joint in the study population.

Erosions in Right MCP Joint by X-Ray

Number of erosions detected in right MCP joint by 1st observer

Table 16: Distribution of study population according to 1st Observers opinion on X-ray findings of Right sided metacarpophalangeal joints (n=77)

Number of erosions	frequency	percent
0	62	80.5
1	12	15.6
2	3	3.9
Total	77	100.0

Conclusion: (1) Single erosion was detected in 12 right MCP joints in the study population
 (2) More than 1 bone erosion was detected in 3 right MCP joints in the study population.

Erosions in Right Pip Joint by X-Ray

Number of erosions detected in right PIP joint by 1st observer

Table 17: Distribution of study population according to 1st Observers opinion on X-ray findings of Right sided proximal interphalangeal joints (n=77)

Number of erosions	frequency	percent
0	74	96.1
1	3	3.9
Total	77	100.0

Conclusion: Single erosion was detected in only 3 right MCP joints in the study Population.

Erosions in Right MTP Joint by X-Ray

Number of erosions detected in right MTP joint by 1st observer

Table 18: Distribution of study population according to 1st Observers opinion on X-ray findings of Right sided metatarsophalangeal joints (n=77)

Number of erosions	frequency	percent
0	71	92.2
1	6	7.8
total	77	100.0

Conclusion: Single erosion was detected in only 6 right MTP joints in the study population.

Erosions in Left MCP Joint by X-Ray

Number of erosions detected in left MCP joint by 1st observer

Table 19: Distribution of study population according to 1st Observers opinion on X-ray findings of left sided metacarpophalangeal joints (n=77)

Number of erosions	frequency	percent
0	55	71.4
1	22	28.6
Total	77	100.0

Conclusion: Single erosion was detected in 22 left MCP joints in the study population.

Erosions in Left PIP Joint by X-Ray

Number of erosions detected in left PIP joint by 1st observer

Table 20: Distribution of study population according to 1st Observers opinion on X-ray findings of left sided proximal interphalangeal joints (n=77)

Number of erosions	frequency	percent
0	76	98.7
1	1	1.3
Total	77	100.0

Conclusion: Only 1 erosion was detected in 1 left PIP joint in the study population.

Erosion in Left MTP Joint by X-Ray

Number of erosion detected in left MTP joint by 1st observer

Table 21: Distribution of study population according to 1st Observers opinion on X-ray findings of left sided metatarsophalangeal joints (n=77)

Number of erosions	frequency	percent
0	66	85.7
1	11	14.3
total	77	100.0

Conclusion: Single erosion could be detected in 11(14.3%) left MTP joints in the study population

Comparison of Bone Erosion Detected by USG and X-Ray by the 1st Observer

Table 25: Comparison of the total number of erosions detected by USG and X ray by person 1 (n=77)

	Erosion byUSG	Erosion by X Ray
Mean	1.623376623	0.779220799
Variance	2.079972659	0.805878332
observations	77	77
df	127	
tStat	4.360447306	
P(T<=t)two-tail	0.0000	
T Critical two-tail	1.978819508	

Conclusion: (1) Mean number of erosions detected by USG was 1.62
 2) Mean number of erosions detected by X-ray was 0.78
 (3) USG detects significantly more number of erosions when compared to X-ray (p<0.01)

Discussion

Regarding the distribution of erosions, the MCP joints of the left hand had maximum number of erosions, followed by MCP joints of the right hand, then MTP joints of the left foot, followed by MTP joints of the right foot. A study by Tamas, et al found that most erosions were detected via USG in the 5th MTP heads followed by 2nd and 5th MCP heads. This observation could possibly be because of the ease of patients positioning and the ease of probe positioning.

Most joints had single erosion. however, in right and left 2nd MCP joints 2erosions could be seen on a few occasions. They were seen more using USG than by X-ray.

Among Rheumatoid Factor and anti-CCP, both correlate significantly with bone erosions detected

by USG (p<0.05 and p<0.01, respectively). However, anti-CCP correlates more strongly than rheumatoid factor with bone erosions detected by USG (Pearson coefficient=0.554 and Pearson coefficient=0.29).

The relationship between anti-CCP, rheumatoid factor and bone erosions are similar when erosions detected by X-ray is considered. This finding is similar to the findings reported in the study by Susanna Maddali Bongi, et al, O. Meyer, et al, N. Samanci, et al, Hyun Hee kim, et al, and all of which suggest that that patients who are positive for anti-CCP had more radiographic joint damage on subsequent follow up.

Studies by D. Aleteha, et al and van Steenberg, et al on the contrary found that rheumatoid factor and not anti-CCP is associated with more erosive disease. They also said that anti-CCP has little or no effect on disease activity.

In our study we find that the bone erosion correlates positively with the disease activity. However, our study was a cross-sectional study. so we do not know whether bone erosion correlates better with persistent disease activity or not.

Salaffi, et al and Naredo, et al suggested in their studies that bone erosion correlated better with persistently high disease activity. Joshua F Baker, et al had similar outcome from his study. he additionally found that these erosions were better detected by MRI. Radiography was a poor choice for detection of such erosions.

Among disease activity indices, SDAI correlates maximally with bone erosions (p<0.01, Pearson coefficient=0.552) detected by USG, followed by CDAI (p<0.01, Pearson coefficient=0.549), DAS28-ESR (p<0.01, Pearson coefficient=0.526), DAS28-CRP (p<0.01, Pearson coefficient=0.512). This was likely as SDAI includes all the variables like tender joint count, swollen joint count, CRP, patient’s assessment and physician’s assessment, and gives equal weight age to all the variables.

Bone erosions detected by X-ray however correlate more strongly with DAS28- CRP

($p < 0.01$, Pearson coefficient = 0.511), closely followed by SDAI ($p < 0.01$, Pearson coefficient = 0.509). CDAI ranked third in correlation ($p < 0.01$, Pearson coefficient = 0.504) followed by DSA28-ESR ($p < 0.01$). We could detect a total number of 125 erosion by USG (grey scale) and 60 erosions by digital X-ray among our study population of 77. Student's T test was performed which showed that USG detected significantly more number of erosions when compared to X-ray ($p < 0.01$).

This observation corresponds with the study of R. Wakefield, et al where they detected 6.5 fold more erosions using USG, as compared to X-ray in early rheumatoid arthritis. Robert Lopez Ben, et al, [66] also found that USG could detect erosions which X-ray could not detect.

W. Grassi, et al gave opinion that radiographic detection of small erosion may be delayed due to patient positioning and technical reasons. The multiplanar capabilities of USG allow a careful assessment of bone surfaces on more views than those allowed by standard radiographs. This improves sensitivity of usg in detecting small erosion, especially in areas not seen in standard views. these opinions corroborated perfectly with our experience while conducting the study.

Study by M. Szkudlarek found high inter observer agreement rates for the identification of bone erosions, using ultrasonography of finger and toe joints in RA. Signs of inflammation were more frequently detected with ultrasound than with clinical examination. Ultrasonography may improve the assessment of RA patients by rheumatologists.

Conclusion

In conclusion, this study demonstrates the following findings:

Firstly, in patients with early rheumatoid arthritis, USG (grey scale) is a better investigation as compared to digital X-ray for detection of bone erosion in the 77 subjects studied in our study.

Secondly, disease activity index SDAI correlates maximally with bone erosions detected by USG

and DAS28-CRP correlates maximally with bone erosions detected by X-ray.

Thirdly, anti-CCP correlates better with bone erosion detection than Rheumatoid Factor, though association of both are significant.

Lastly, USG has much better inter-observer agreement than X-ray. Thus USG is a better standardised test than X-ray and may have better reproducibility

Limitation

The limitations of my study are-

- 1) This is a cross-sectional study. single determination of inflammatory marker and disease activity may not always accurately represent course and burden of the disease
- 2) Sample size was small. A larger sample size would have increased the power of the study.
- 3) This was a female predominant study with less male attendance
- 4) Relative subjective feeling of the patients may affect scoring
- 5) A good number of patients are treated at the orthopaedics Out patients department
- 6) This was a single centre study. A multi-centre study involving more number of rheumatologists would have been more desirable.

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