

# The Comparison of Joint Erosion in Conventional Radiographs between Rheumatoid Arthritis Patients and Arthralgia Patients without Arthritis Findings

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## Abstract

**Background:** Rheumatoid arthritis (RA) is a systemic autoimmune disorder characterized by chronic inflammation leading to joint erosions and functional impairment. Early detection of joint damage is critical for effective treatment and improved patient outcomes. This study evaluates the diagnostic utility of conventional radiography in detecting joint erosions in RA patients compared to individuals with arthralgia without arthritis findings.

**Methods:** This retrospective cross-sectional study included 42 RA patients diagnosed based on the 2010 ACR/EULAR classification criteria and 44 age- and gender-matched individuals with arthralgia but no arthritis findings. Conventional radiographs of hand and foot joints were evaluated for erosions by a single rheumatologist in a blinded fashion. Intra-observer reliability was assessed using Cronbach's alpha. Statistical analyses were conducted using t-tests, chi-square tests, and Mann-Whitney U tests.

**Results:** Hand radiographs showed significantly higher erosion counts in RA patients compared to the arthralgia group ( $p < 0.01$ ). Erosion rates in foot joints were less prevalent and showed no significant difference between groups ( $p > 0.99$ ). Intra-observer reliability for hand radiographs was excellent (Cronbach's alpha: 0.897), underscoring the reliability of conventional radiography. However, foot radiographs exhibited reduced evaluability due to technical challenges.

**Conclusion:** Hand radiographs are a reliable and practical tool for early detection and monitoring of joint erosions in RA, particularly in hand joints. Foot radiographs, though less reliable, may require methodological enhancements for broader applicability. Conventional radiography remains a cost-effective diagnostic approach while advanced imaging modalities such as MRI and ultrasonography offer complementary benefits.

**Keywords:** Rheumatoid arthritis, conventional radiography, joint erosion, diagnostic imaging, arthralgia.

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## INTRODUCTION

Rheumatoid arthritis (RA) is a chronic autoimmune disease marked by persistent synovial inflammation. This process leads to progressive cartilage loss and bone erosion. RA affects approximately 0.5% to 1% of the population and causes cumulative joint damage, functional disability, and impaired quality of life.(1) Erosions are central features of the disease and are associated with worse long-term outcomes.(2) Early detection is essential for guiding treatment, particularly in the initial phase, when timely intervention may alter disease progression.(3)

Conventional radiography is widely used for evaluating structural joint damage in RA. It helps identify bone erosions and joint space narrowing and remains a standard imaging method in clinical and research settings.(4) Although ultrasound and MRI are more sensitive for early changes, radiographs are still preferred in many settings due to their low cost, reproducibility, and broad availability.(5, 6) Several scoring systems, including the Sharp and Larsen methods, have been developed to quantify joint damage and monitor disease progression over time.(4, 7)

Erosions are commonly considered a specific feature of RA. However, studies have reported erosive changes in individuals without established arthritis, including those with non-specific arthralgia or even healthy subjects.(8) This challenges the diagnostic specificity of erosions, particularly in the early or preclinical stages of the disease. The clinical relevance of erosions in individuals who do not meet RA classification criteria is not well defined. It remains unclear whether these findings indicate early RA or represent non-inflammatory processes.

This study aimed to compare the presence of radiographic erosions in hand joints between patients with rheumatoid arthritis and individuals presenting with arthralgia but lacking clinical signs of arthritis. By providing comparative data between these groups, we sought to explore whether conventional radiography may assist in differentiating rheumatoid arthritis from non-inflammatory joint symptoms in routine clinical evaluation.

## MATERIALS AND METHODS

### *Study Design and Participants*

This retrospective cross-sectional study involved 42 patients aged 18 years and older diagnosed with RA based

on the 2010 ACR/EULAR classification criteria for a minimum of six months between December 2014 and December 2015, and 44 individuals presenting with arthralgia, but lacking arthritis findings based on anamnesis and physical examination between June 2017 and June 2018. The inclusion criteria for RA patients required a minimum of six months' diagnosis and the absence of arthritis findings in the arthralgia group. Exclusion criteria included pregnancy, age below 18 years, and refusal to participate.

### *Radiological Evaluation*

An experienced rheumatologist evaluated the conventional radiographs of the hand and foot joints for the presence of bone erosions. Erosions were defined as discrete, well-demarcated interruptions in the normally smooth cortical bone contour, most often located at the marginal (bare) areas of synovial joints, where cartilage is absent. These lesions typically appear as small, irregularly shaped lucencies with sharp borders and are considered characteristic findings in inflammatory joint diseases such as rheumatoid arthritis. The definition was based on established radiographic criteria used in rheumatologic imaging literature.(4, 9) Although validated scoring systems such as Sharp or Larsen were not used, binary visual assessment was performed to mirror routine clinical practice.

All radiographs were anonymized by assigning sequential numbers and then randomly reordered prior to evaluation. The rheumatologist was blinded to all clinical and demographic data. To assess intra-observer reliability, the same evaluator re-examined the radiographs one month later in a different random sequence. This second evaluation was performed solely for reproducibility analysis and not for clinical follow-up. Agreement between the two assessments was analyzed statistically.

### *Ethical Approval*

The research complied with the Declaration of Helsinki and obtained approval from the pertinent ethics committee (Decision No. 2018/1538, dated October 26, 2018).

### *Data Collection*

Demographic and clinical data were retrospectively gathered from patient records and electronic health re-

cords. The parameters analyzed encompassed age, gender, rheumatoid factor (RF) and anti-cyclic citrullinated peptide (anti-CCP) antibody status, arthritis duration, arthralgia duration, and the presence and quantity of joint erosions identified through direct radiographs. Arthritis duration in the RA group was defined as the time (in months) from the onset of joint symptoms to the date of radiographic evaluation. Similarly, arthralgia duration in the arthralgia group was defined as the time (in months) from the onset of joint pain (without clinical signs of arthritis) to the radiographic assessment date.

### **Statistical Analysis**

Statistical analyses were performed using IBM SPSS Statistics version 22.0 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was employed to evaluate the normality of continuous variables. For normally distributed data, independent samples t-tests were applied; for non-normally distributed data, the Mann-Whitney U test was used. Categorical variables were examined utilizing the chi-square test or Fisher's exact test, depending on expected cell counts. Paired categorical data within the RA group (e.g., comparison of erosion presence in hand versus foot joints) were analyzed using the McNemar test. The intra-observer agreement between the initial and subsequent radiographic assessments was evaluated using the intraclass correlation coefficient (ICC) and Cronbach's alpha coefficients. A p-value of less than 0.05 was deemed statistically significant.

## **RESULTS**

### ***Demographic, Clinical, and Serological Characteristics of the Study Groups***

The mean age of the 42 patients diagnosed with rheumatoid arthritis (RA) was  $55.1 \pm 11.8$  years. Among them, 35 (83.3%) were female and 7 (16.7%) were male. In the arthralgia group (n = 44), the mean age was  $55.0 \pm 11.8$  years, with 37 (84.1%) female and 7 (15.9%) male participants. There were no statistically significant differences between the groups in terms of age and sex distribution ( $p = 0.978$  and  $p > 0.99$ , respectively).

In the RA group, the mean time from the onset of initial joint symptoms to the date of radiographic assessment (arthritis duration) was  $54.2 \pm 32.5$  months, with a medi-

an of 56.5 months (range: 8–161). Regarding serological parameters, rheumatoid factor (RF) positivity was observed in 64.3% of patients, and anti-cyclic citrullinated peptide (anti-CCP) antibody positivity in 47.6%.

In the arthralgia group, the mean time from the onset of joint pain to radiographic assessment (arthralgia duration) was  $7.3 \pm 3.8$  months, with a median of 7.0 months (range: 2–24).

### ***Comparison of Erosion Positivity Between Paired Joint Groups in RA Patients***

An intra-group analysis was conducted among patients with rheumatoid arthritis to compare the distribution of erosions between hand and foot joints within the same individuals. The presence of erosions was more frequently observed in the hand joints, including both the wrists and small joints, compared to the corresponding joints in the feet. This pattern was consistent when the wrist and small joints were analyzed separately. In all comparisons, the difference in erosion positivity between hand and foot joints was statistically significant ( $p < 0.05$ ) (Table 1).

### ***Comparative Evaluation of Erosion Presence by Joint Region Between RA and Arthralgia Groups***

The frequency of joint erosions was compared between patients with rheumatoid arthritis (RA) and those in the arthralgia group for each anatomical region. A significantly higher number of individuals in the RA group exhibited erosions in the hand joints compared to the arthralgia group ( $p < 0.05$ ).

In particular, erosions were more commonly observed in the right and left wrist joints and in the right and left small hand joints among RA patients. All of these differences were statistically significant.

In contrast, there were no significant differences between the two groups regarding the presence of erosions in the foot joints, including both the ankle and small joints ( $p > 0.05$ ) (Table 2).

### ***Intra-Observer Reliability Assessment***

To assess intra-observer reliability, all radiographic images were re-evaluated by the same investigator one month after the initial reading. In the first evaluation, a

Table 1. Comparison of Erosion Positivity Between Paired Joint Regions in RA Patients

Comparison	Hand Only Positive (n)	Foot Only Positive (n)	Both Positive (n)	Both Negative (n)	p-value*
Total Hand Joints vs Total Foot Joints	12	1	4	25	0.003
Hand Wrist vs Foot Wrist	7	0	2	33	0.016
Hand Small Joints vs Foot Small Joints	13	1	2	26	0.002

\*p-values were calculated using McNemar test.

Table 2. Joint-Based Comparison of Erosion Positivity Between RA and Arthralgia Groups

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Joint Region	RA Erosion n (%)	RA Patients with Evaluated Radiographs (n)	Arthralgia Erosion n (%)	Arthralgia Patients with Evaluated Radiographs (n)	p-value (test)
Total hand joints	16 (38.1%)	42	5 (11.4%)	44	0.008*
Right wrist	7 (17.5%)	40	0 (0.0%)	42	0.015**
Right small hand joints	14 (35.0%)	40	5 (11.9%)	42	0.027*
Left wrist	8 (20.0%)	40	0 (0.0%)	42	0.007**
Left small hand joints	10 (25.0%)	40	2 (4.8%)	42	0.023*
Total foot joints	5 (11.9%)	42	4 (9.1%)	44	0.941**
Right ankle	1 (2.9%)	34	0 (0.0%)	34	>0.99**
Right small foot joints	4 (11.8%)	34	4 (11.8%)	34	>0.99**
Left ankle	1 (3.0%)	33	0 (0.0%)	34	>0.99**
Left small foot joints	2 (6.1%)	33	2 (5.9%)	34	>0.99**

p-values were calculated using Pearson's chi-square test (\*), or Fisher's exact test (\*\*), depending on expected cell counts.

RA: Rheumatoid arthritis

total of 58 erosions were identified (51 in the RA group and 7 in the arthralgia group), whereas 46 erosions were recorded in the second evaluation (39 in the RA group and 7 in the arthralgia group).

When erosion counts were compared between the first and second assessments for both hand and foot joints, no statistically significant differences were observed (Table 3).

When analyzed separately, the reproducibility of erosions in the hand joints was markedly higher than in

the foot joints. In the overall cohort, 82.9% of the erosions identified in hand joints during the first evaluation were also detected in the second evaluation, compared to only 18.0% in foot joints. This pattern was consistent in subgroup analyses of RA and arthralgia patients (Table 4).

Intra-observer agreement was further evaluated using the intraclass correlation coefficient (Cronbach's alpha), which was calculated as 0.897 (95% CI: 0.842–0.933;  $p < 0.001$ ), indicating a high level of consistency.

**Table 3. Comparison of Erosion Counts Between First and Second Evaluations in RA and Arthralgia Groups**

Parameter	First Evaluation (n)	Second Evaluation (n)	p-value
Total erosions	58	46	0.105
Hand joint erosions	47	43	0.429
Foot joint erosions	11	3	0.074

Statistical test: Wilcoxon signed-rank test.

**Table 4. Table 4. Intra-Observer Reproducibility of Erosion Positivity Between First and Second Evaluations (%)**

Group	Hand Joints 1→2 (%)	Foot Joints 1→2 (%)	Hand Joints 2→1 (%)	Foot Joints 2→1 (%)
All patients	82.9%	18.0%	90.6%	66.6%
RA patients	86.0%	25.0%	92.5%	66.6%
Arthralgia group	50.0%	0.0%	66.6%	66.6%

1→2: Proportion of erosions detected in the first evaluation that were confirmed in the second evaluation.

2→1: Proportion of erosions detected in the second evaluation that were also present in the first evaluation.

All values are expressed as percentages.

RA: Rheumatoid arthritis

## DISCUSSION

The present study aimed to determine whether conventional radiographs can differentiate between patients with rheumatoid arthritis and individuals with arthralgia who do not exhibit clinical signs of arthritis, based on the presence of joint erosions. The results showed that erosion rates were significantly higher in the hand joints of RA patients, particularly in the wrists and small joints. In contrast, no significant difference was found in the foot joints between the two groups. These findings emphasize the diagnostic value of hand radiographs in clinical practice, especially for the early identification of structural joint damage in settings where advanced imaging modalities may not be accessible.

Previous research has highlighted that the detection of symmetric erosions in small joints, particularly the metacarpophalangeal and wrist joints, serves as a distinguishing feature of rheumatoid arthritis and contributes significantly to its early diagnosis.(10)

RA patients exhibited significantly higher erosion rates in hand joints compared to the arthralgia group. This difference was consistently observed in both wrists and small joints, underscoring the value of conventional radiography in assessing joint damage. Erosions are a hallmark of RA and are associated with poor long-term outcomes.(11, 12) Detecting these changes early supports the making of timely therapeutic decisions. Hand radiographs, therefore, remain a key tool in diagnostic algorithms for suspected RA, particularly in early-stage disease.

This pattern is consistent with findings from prior investigations, which have shown a markedly higher prevalence of erosions in hand joints compared to the feet among patients with rheumatoid arthritis, underscoring the superior diagnostic yield of hand radiographs.(13)

In contrast, no significant difference was found in foot joint erosions between the RA and arthralgia groups. Reproducibility was also markedly lower in foot radiographs, with only 18.0% of initial findings confirmed in the second assessment. Technical factors such as anatomical complexity, overlapping structures, and suboptimal positioning likely contributed to this discrepancy. It has also been demonstrated that while erosions may

occasionally be detected in the feet during early stages of disease, hand radiographs generally offer greater sensitivity and diagnostic reliability in clinical practice. (14) Supporting this observation, earlier studies have reported that conventional radiographs are diagnostically more sensitive in detecting erosions in hand joints than in the feet, where anatomical complexity and technical limitations reduce evaluability.(15) Previous research has similarly reported limited diagnostic yield from foot radiographs and suggested oblique projections as a potential solution to improve evaluability, although their clinical adoption remains limited.(16)

Radiographic erosions were also identified in a subset of individuals with arthralgia. These findings align with prior evidence that erosions may occur in non-RA individuals, particularly in those with subclinical inflammation or in the preclinical phase of RA.(8, 17) Since ultrasonography was not performed in this group, the presence of subclinical synovitis could not be excluded. Studies employing power Doppler ultrasonography have demonstrated its ability to detect early inflammation and predict disease progression in individuals at risk.(18, 19) Incorporating ultrasonography in such populations may improve early identification and risk stratification.

The findings corroborate the existing literature, which emphasizes the diagnostic and prognostic value of hand radiographs in RA, especially in early-stage disease.(4, 6, 7) However, the absence of formal scoring systems in this study limited the capacity to quantify erosion severity or assess longitudinal progression. Although visual identification is a common clinical practice, validated scoring methods such as the Sharp, Larsen, or Simple Erosion Narrowing Score (SENS) offer enhanced reproducibility and tracking over time.(9, 20, 21)

Conventional radiography remains the most accessible and widely used imaging method, particularly in resource-limited settings. Digital radiography offers additional advantages, including reduced radiation exposure and improved image resolution. When integrated with artificial intelligence-based analysis tools, digital platforms may further enhance the precision, consistency, and speed of erosion detection.(4, 22) In recent studies, AI-supported systems demonstrated potential

to assist clinicians in both screening and monitoring disease progression through automated interpretation of radiographic data.

Moreover, combining conventional radiography with advanced imaging modalities—termed *composite imaging*—can improve diagnostic yield. For example, the concurrent use of ultrasound enables the identification of early synovitis, while MRI may detect bone marrow edema and subtle erosions that are invisible to radiographs.(5, 23) These strategies are particularly beneficial in patients with ambiguous symptoms or early undifferentiated arthritis. Optimizing such multimodal approaches through standardized protocols and clinician training may significantly enhance diagnostic accuracy in RA care.

The study demonstrated high intra-observer reliability for hand radiographs, as indicated by a Cronbach's alpha of 0.897. This supports the reproducibility of visual erosion assessment in the hands of experienced individuals. Prior studies have also reported that evaluating radiographs in a chronological sequence, rather than in random order, can further improve observer agreement and efficiency.(24) However, reproducibility was notably lower in the foot joints, reinforcing the need for technical improvements and standardized protocols to enhance image quality and consistency in interpretation in this region.(25)

A key strength of this study is the blinded and repeated evaluation of all radiographs by a single experienced rheumatologist, ensuring a high degree of intra-observer reliability. Moreover, the direct comparison between RA and arthralgia groups provides valuable insight into the diagnostic value of radiography in varying clinical settings. However, several limitations must be acknowledged. First, the retrospective and single-center design may restrict the generalizability of the findings. Second, inter-observer variability was not assessed, which limits the external reproducibility of the visual erosion assessments. Third, although visual binary evaluation reflects routine clinical practice, the absence of validated radiographic scoring systems such as the Sharp, Larsen, or van der Heijde-modified methods precludes quantification of erosion severity and longitudinal tracking of structural damage. Fourth, imaging in the arthral-

gia group was restricted to conventional radiography without adjunct modalities such as ultrasound or MRI; therefore, the presence of subclinical synovitis could not be excluded, which may explain the erosive findings observed in a minority of these individuals. Lastly, the relatively long disease duration in the RA group (mean over four years) may limit the applicability of these results to patients with early or undifferentiated RA, where radiographic findings may be more subtle and less specific.

The current results reinforce the clinical value of hand radiographs as a reliable and cost-effective diagnostic tool in the early stages of RA. Foot radiographs, while potentially informative, remain less consistent and may require methodological improvements for broader clinical use. Future research should aim to incorporate ultrasonography in arthralgia cohorts to assess for subclinical inflammation, standardize radiographic techniques—particularly for the feet—and implement validated scoring systems to facilitate longitudinal assessment. Prospective, multicenter studies integrating composite imaging and emerging technologies such as AI may offer promising pathways to refine diagnostic strategies and personalize treatment in rheumatoid arthritis.

Hand radiographs demonstrated clear diagnostic value in distinguishing rheumatoid arthritis from non-inflammatory joint symptoms, showing higher erosion rates and reproducibility than foot radiographs. These findings support their role as a first-line imaging tool in early RA evaluation. The presence of erosions in arthralgia patients underscores the possible role of subclinical inflammation and highlights the importance of adjunct imaging methods when clinical findings are inconclusive. Despite limitations related to design and methodology, this study affirms the clinical utility of conventional radiography and emphasizes the need for improved foot imaging protocols and integrated diagnostic approaches in future research.

## REFERENCES

1. Finckh A, Gilbert B, Hodkinson B, Bae SC, Thomas R, Deane KD, et al. Global epidemiology of rheumatoid arthritis. *Nat Rev Rheumatol*. 2022;18(10):591-602.
2. Llopis E, Kroon HM, Acosta J, Bloem JL. Conventional Radiology in Rheumatoid Arthritis. *Radiol Clin North Am*. 2017;55(5):917-41.
3. Aletaha D, Neogi T, Silman AJ, Funovits J, Felson DT, Bingham CO, 3rd, et al. 2010 Rheumatoid arthritis classification criteria: an American College of Rheumatology / European League Against Rheumatism collaborative initiative. *Arthritis Rheum*. 2010;62(9):2569-81.
4. Sharp JT. Measurement of structural abnormalities in arthritis using radiographic images. *Radiol Clin North Am*. 2004;42(1):109-19.
5. Colebatch AN, Edwards CJ, Østergaard M, van der Heijde D, Balint PV, D'Agostino MA, et al. EULAR recommendations for the use of imaging of the joints in the clinical management of rheumatoid arthritis. *Ann Rheum Dis*. 2013;72(6):804-14.
6. Salaffi F, Carotti M, Beci G, Di Carlo M, Giovagnoni A. Radiographic scoring methods in rheumatoid arthritis and psoriatic arthritis. *Radiol Med*. 2019;124(11):1071-86.
7. Drosos AA, Pelechas E, Voulgari PV. Conventional radiography of the hands and wrists in rheumatoid arthritis. What a rheumatologist should know and how to interpret the radiological findings. *Rheumatol Int*. 2019;39(8):1331-41.
8. Ulijn E, den Broeder N, Ten Cate D, van Overdijk K, Demirel H, Landewé R, et al. Limited Diagnostic and Prognostic Value of Routine Radiographs in Newly Presenting Arthritis Suspected of Rheumatoid Arthritis: A Retrospective Study. *Arthritis Care Res (Hoboken)*. 2024;76(4):497-502.
9. Ravindran V, Rachapalli S. An overview of commonly used radiographic scoring methods in rheumatoid arthritis clinical trials. *Clin Rheumatol*. 2011;30(1):1-6.
10. Peterfy C, Conaghan P, Østergaard M. Radiography in rheumatoid arthritis. 2020:177-94.
11. Bombardier C, Barbieri M, Parthan A, Zack DJ, Walker V, Macarios D, et al. The relationship between joint damage and functional disability in rheumatoid arthritis: a systematic review. *Ann Rheum Dis*. 2012;71(6):836-44.
12. Goekoop-Ruiterman YP, de Vries-Bouwstra JK, Allaart CF, van Zeben D, Kerstens PJ, Hazes JM, et al. Clinical and radiographic outcomes of four different treatment strategies in patients with early rheumatoid arthritis (the BeSt study): a randomized, controlled trial. *Arthritis Rheum*. 2005;52(11):3381-90.
13. Adnan S, Aziz W, Ahmed A. Radiographic appearance in hands and feet of rheumatoid arthritis patients at a tertiary care hospital in Pakistan. *Pak Armed Forces Med J*. 2015;65:735-8.
14. Priolo F, Bacarini L, Cammisà M, Cerase A, Ferrara R, Della Casa-Alberighi O. Radiographic changes in the feet of patients with early rheumatoid arthritis. GRISAR (Gruppo Reumatologi Italiani Studio Artrite Reumatoide). *J Rheumatol*. 1997;24 11:2113-8.
15. Kellner H, Schmidt W, Rau R. [Imaging procedures in rheumatology. Differential diagnosis using various imaging procedures in rheumatoid arthritis (RA)]. *Z Rheumatol*. 2005;64 8:553-6.
16. Devauchelle-Pensec V, Josseaume T, Samjee I, Dougados M, Combe B, Saraux A. Ability of oblique foot radiographs to detect erosions in early arthritis: results in the ESPOIR cohort. *Arthritis Rheum*. 2008;59(12):1729-34.
17. van Steenberg HW, van Nies JAB, Huizinga TWJ, Bloem JL, Reijnen M, van der Helm-van Mil AHM. Characterising arthralgia in the preclinical phase of rheumatoid arthritis using MRI. *Ann Rheum Dis*. 2015;74(6):1225-32.
18. van de Stadt LA, Bos WH, Meursinge Reynders M, Wieringa H, Turkstra F, van der Laken CJ, et al. The value of ultrasonography in predicting arthritis in auto-antibody positive arthralgia patients: a prospective cohort study. *Arthritis Res Ther*. 2010;12(3):R98.
19. Mankia K, Emery P. Preclinical Rheumatoid Arthritis: Progress Toward Prevention. *Arthritis & rheumatology (Hoboken, NJ)*. 2016;68(4):779-88.
20. Jew NB, Hollins AM, Mauck BM, Smith RA, Azar FM, Miller RH, 3rd, et al. Reliability testing of the Larsen and Sharp classifications for rheumatoid arthritis of the elbow. *J Shoulder Elbow Surg*. 2017;26(1):140-3.
21. Dias EM, Lukas C, Landewé R, Fatenejad S, van der Heijde D. Reliability and sensitivity to change of the Simple Erosion Narrowing Score compared with the Sharp-van der Heijde method for scoring radiographs in rheumatoid arthritis. *Ann Rheum Dis*. 2008;67(3):375-9.
22. Rosa J, Ruta S, Saucedo C, Navarta DA, Catoggio LJ, García-Mónaco R, et al. Does a Simplified 6-Joint Ultrasound Index Correlate Well Enough With the 28-Joint Disease Activity Score to Be Used in Clinical Practice? *J Clin Rheumatol*. 2016;22(4):179-83.
23. Scheel AK, Hermann KG, Ohrndorf S, Werner C, Schirmer C, Detert J, et al. Prospective 7 year follow up imaging study comparing radiography, ultrasonography, and magnetic resonance imaging in rheumatoid arthritis finger joints. *Ann Rheum Dis*. 2006;65(5):595-600.
24. van Tuyll LH, van der Heijde D, Knol DL, Boers M. Chronological reading of radiographs in rheumatoid arthritis increases efficiency and does not lead to bias. *Ann Rheum Dis*. 2014;73(2):391-5.
25. Ørnberg LM, Østergaard M. Assessment of structural damage progression in established rheumatoid arthritis by conventional radiography, computed tomography, and magnetic resonance imaging. *Best Pract Res Clin Rheumatol*. 2019;33(5):101481.

### Abbreviations List

ACR: American College of Rheumatology  
 anti-CCP: Anti-cyclic citrullinated peptide antibody  
 bDMARDs: Biologic disease-modifying antirheumatic drugs  
 CI: Confidence interval  
 CR: Conventional radiography  
 DMARDs: Disease-modifying antirheumatic drugs  
 DIP: Distal interphalangeal joint  
 EULAR: European League Against Rheumatism  
 ICC: Intraclass correlation coefficient  
 IQR: Interquartile range  
 MCP: Metacarpophalangeal joint  
 MTP: Metatarsophalangeal joint  
 MRI: Magnetic resonance imaging

PIP: Proximal interphalangeal joint  
RA: Rheumatoid arthritis  
RF: Rheumatoid factor  
SENS: Simple Erosion Narrowing Score  
SD: Standard deviation  
SPSS: Statistical Package for the Social Sciences  
US: Ultrasonography / Ultrasound

#### **Ethical Approval Statement**

This study was approved by the Non-Interventional Clinical Research Ethics Committee of Necmettin Erbakan University, Meram Faculty of Medicine (Decision No: 2018/1538, dated 26 October 2018). The study was conducted in accordance with the principles of the Declaration of Helsinki.

#### **Consent for Publication**

Not applicable. The study does not contain any individual person's identifiable data, images, or personal details requiring consent for publication.

#### **Availability of Data and Materials**

The datasets generated and analyzed during the current study are not publicly available due to institutional data protection policies but are available from the corresponding author on reasonable request.

#### **Competing Interests**

The authors declare that they have no competing interests.

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#### **Author Contributions**

Mehmet Emin Gerek designed the study, collected clinical data, performed statistical analyses, interpreted the results, and drafted the manuscript. Recep Tunç performed and interpreted all radiographic evaluations, contributed to the study design, supervised the methodology, and critically revised the manuscript for important intellectual content. Both authors read and approved the final manuscript.

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