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Original Research Article

Musculoskeletal Ultrasound as a Predictor of Treatment Decisions in Rheumatoid Arthritis

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Abstract

Background: Rheumatoid arthritis is a chronic inflammatory disease characterized by persistent synovitis and progressive joint damage. Musculoskeletal ultrasound has emerged as a valuable imaging modality for detecting subclinical inflammation and guiding treatment decisions.

Objective: To evaluate the role of musculoskeletal ultrasound in predicting treatment planning among patients with rheumatoid arthritis.

Methods: A prospective observational study was conducted among 120 patients diagnosed with rheumatoid arthritis. Clinical assessment, laboratory investigations, and musculoskeletal ultrasound evaluation using GSUS and PDUS scoring systems were performed. Treatment decisions were documented based on combined clinical and imaging findings.

Results: Active synovitis was detected in 68.3% of patients, and higher PDUS grades were significantly associated with treatment escalation. Ultrasound findings influenced therapeutic decisions including initiation, escalation, or tapering of therapy.

Conclusion: Musculoskeletal ultrasound serves as an effective adjunct to clinical evaluation by identifying subclinical disease activity and supporting individualized treatment planning in rheumatoid arthritis patients.

Keywords: Rheumatoid arthritis, Musculoskeletal ultrasound, Synovitis, Treatment planning.

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Introduction

Rheumatoid arthritis (RA) is a chronic systemic autoimmune disorder characterized by persistent synovial inflammation, progressive joint destruction, and variable extra-articular involvement. If inadequately treated, RA leads to irreversible structural damage, functional disability, and reduced quality of life. Early identification of active inflammation and accurate assessment of disease activity are therefore essential for optimizing therapeutic strategies and preventing long-term complications [1].

Conventional clinical examination and laboratory markers such as erythrocyte sedimentation rate and C-reactive protein remain the cornerstone of disease assessment; however, they frequently fail to detect ongoing subclinical synovitis. Imaging modalities play a critical role in bridging this gap. While conventional radiography is useful for identifying established structural damage, it lacks sensitivity in early disease. Magnetic resonance imaging provides excellent soft-tissue resolution but is limited by high cost, restricted availability, and limited feasibility for routine monitoring [2]. Musculoskeletal ultrasound (MSUS) has emerged as a valuable imaging tool in the evaluation of inflammatory arthritis due to its non-invasive nature, absence of ionizing radiation, bedside applicability, and ability to assess multiple joints dynamically. High-resolution grayscale ultrasound allows visualization of synovial hypertrophy and joint effusions, while power Doppler ultrasound enables detection of active synovial vascularity, a surrogate marker of inflammation [3]. These features make MSUS particularly useful in identifying subclinical disease activity that may not be evident on physical examination.

Accumulating evidence demonstrates that ultrasound-detected synovitis can persist even in patients who achieve clinical remission according to composite disease activity scores. The presence

of power Doppler signal has been shown to predict disease flare, radiographic progression, and poor functional outcomes [4]. As a result, MSUS provides prognostic information beyond conventional assessment tools and contributes meaningfully to individualized disease management.

Incorporation of musculoskeletal ultrasound into routine clinical practice has been shown to influence therapeutic decisions in RA. Ultrasound-guided assessment can assist clinicians in determining the need for initiation, escalation, tapering, or modification of disease-modifying antirheumatic drug therapy. Imaging-guided strategies have demonstrated improved outcomes compared with treatment decisions based solely on clinical parameters [5].

Furthermore, MSUS plays an important role in the early diagnosis of RA, particularly in patients with clinically suspect arthralgia who do not yet meet formal classification criteria. Detection of synovitis and erosions at an early stage facilitates prompt initiation of therapy, which is associated with improved long-term outcomes [6]. Ultrasound-guided interventions, including intra-articular injections, further enhance treatment precision and efficacy.

Given the expanding role of imaging in treat-to-target strategies, musculoskeletal ultrasound has become an integral component of comprehensive RA management. Its ability to detect inflammation, predict structural damage, and guide therapeutic decisions underscores its value in optimizing individualized treatment plans [7–10]. The present study therefore focuses on evaluating the role of musculoskeletal ultrasound in predicting treatment planning and clinical decision-making in patients with rheumatoid arthritis.

Material and Methods

This prospective observational study was conducted to evaluate the role of musculoskeletal ultrasound in predicting treatment planning among patients with rheumatoid arthritis. The study was carried out in the Department of Rheumatology at a tertiary care teaching hospital during the defined study period after obtaining approval from the institutional ethics committee. Written informed consent was obtained from all participants prior to enrollment in the study.

A total of 120 patients diagnosed with rheumatoid arthritis were included. Participants were recruited consecutively from rheumatology outpatient and inpatient services. The diagnosis of rheumatoid arthritis was established according to the 2010 American College of Rheumatology/European League Against Rheumatism classification criteria. Adult patients aged eighteen years or older presenting with clinical features suggestive of synovitis and willing to undergo musculoskeletal ultrasound evaluation were enrolled. Patients with other inflammatory arthritides, severe joint deformities that limited ultrasound assessment, pregnancy, or incomplete clinical data were excluded from the study.

All enrolled patients underwent detailed clinical evaluation including demographic profiling, disease duration assessment, tender and swollen joint counts, and evaluation of disease activity using standardized scoring indices. Laboratory parameters such as rheumatoid factor, anti-cyclic citrullinated peptide antibodies, erythrocyte sedimentation rate, and C-reactive protein levels were recorded at baseline to support clinical assessment.

Musculoskeletal ultrasound examination was performed using a high-resolution ultrasound machine equipped with a linear transducer operating at frequencies between 7.5 and 18 MHz. Bilateral joints including metacarpophalangeal, proximal interphalangeal, wrist, and metatarsophalangeal joints were systematically examined by an experienced rheumatologist trained in musculoskeletal ultrasound. Synovitis was assessed using both grayscale ultrasonography and power Doppler ultrasonography scoring systems. Grayscale ultrasonography grading ranged from 0 to 3 according to the degree of synovial hypertrophy, while power Doppler grading ranged from 0 to 3 based on the level of synovial vascularity. Active synovitis was defined as grayscale score of two or more and/or power Doppler score of one or more.

Treatment planning decisions were documented for each patient following combined clinical and ultrasound evaluation. Therapeutic modifications included initiation of disease-modifying antirheumatic drugs, escalation or switching of therapy, or tapering of medication depending on disease activity and ultrasound findings. The impact of ultrasound findings on clinical decision-making was recorded to determine the predictive value of musculoskeletal ultrasound in guiding treatment strategies.

Outcome measures included detection of subclinical synovitis, correlation between ultrasound scores and clinical disease activity, and the role of ultrasound findings in influencing therapeutic decisions. Data were analyzed using appropriate statistical software.

Continuous variables were expressed as mean with standard deviation, and categorical variables were presented as frequencies and percentages. Comparative analyses were performed using

suitable statistical tests, and a p-value of less than 0.05 was considered statistically significant.

Results

Table 1 shows the demographic and clinical characteristics of the study population comprising 120 rheumatoid arthritis patients. The majority of participants were in the age group of 46–60 years accounting for 42 patients (35.0%), followed by 31–45 years with 34 patients (28.3%). Patients aged above 60 years constituted 26 cases (21.7%), while the youngest age group of 18–30 years included 18 patients (15.0%). Female predominance was observed with 84 patients (70.0%) compared to 36 males (30.0%), reflecting the typical epidemiological pattern of rheumatoid arthritis. Regarding disease duration, 44 patients (36.7%) had disease duration less than two years, 40 patients (33.3%) had duration between two and five years, and 36 patients (30.0%) had disease duration greater than five years, indicating representation of both early and established disease stages.

Table 2 presents the clinical and laboratory parameters of the study cohort. The mean tender joint count was 8.4±3.1, while the swollen joint count averaged 6.7±2.8, suggesting moderate disease activity. The mean ESR was 38.6±14.2 mm/hr and mean CRP was 18.3±7.6 mg/L, supporting the presence of active inflammation in a significant proportion of patients. The average DAS28 score was 4.9±1.2, which corresponds to moderate to high disease activity levels. Rheumatoid factor positivity was noted in 82 patients (68.3%), whereas anti-CCP antibodies were positive in 90 patients (75.0%), demonstrating a high prevalence of seropositive rheumatoid arthritis in this study group. Table 3 illustrates musculoskeletal ultrasound findings using grayscale ultrasonography (GSUS) and power Doppler ultrasonography (PDUS) scoring systems. GSUS grade 2 synovitis was the most frequent observation in 46 patients (38.3%), followed by grade 1 in 32 patients (26.7%) and grade 3 in 28 patients (23.3%), while only 14 patients (11.7%) had grade 0 findings. PDUS grading showed grade 1 vascularity in 38 patients (31.7%), grade 2 in 36 patients (30.0%), and grade 3 in 24 patients (20.0%), whereas 22 patients (18.3%) had no Doppler activity. Active synovitis defined as GSUS ≥2 and/or PDUS ≥1 was detected in 82 patients (68.3%), highlighting the sensitivity of ultrasound in detecting inflammatory activity. The association between DAS28 scores and active synovitis was statistically significant (p=0.032), whereas the association between age distribution and GSUS grades was statistically insignificant (p=0.418).

Table 4 demonstrates the influence of musculoskeletal ultrasound findings on treatment planning decisions. Escalation or switching of therapy was required in 34 patients (28.3%), while initiation of disease-modifying antirheumatic drugs was performed in 28 patients (23.3%). Addition of biologic therapy was indicated in 16 patients (13.3%), and tapering of medication was possible in 12 patients (10.0%). No change in treatment plan was necessary in 30 patients (25.0%). Patients with PDUS grades 2–3 were more likely to undergo therapy escalation compared to those with lower Doppler grades (p=0.041), while gender-based differences in treatment modification were statistically insignificant (p=0.564).

Table 1: Demographic and Clinical Characteristics of Study Population (n = 120)

Variable	Category	Number (n)	Percentage (%)
Age Group	18–30 years	18	15.0
	31–45 years	34	28.3
	46–60 years	42	35.0
	>60 years	26	21.7
Gender	Male	36	30.0
	Female	84	70.0
Disease Duration	<2 years	44	36.7
	2–5 years	40	33.3
	>5 years	36	30.0

Table 2: Clinical and Laboratory Parameters of Rheumatoid Arthritis Patients (n = 120)

Parameter	Mean ± SD / n (%)
Tender Joint Count	8.4 ± 3.1
Swollen Joint Count	6.7 ± 2.8
ESR (mm/hr)	38.6 ± 14.2
CRP (mg/L)	18.3 ± 7.6
DAS28 Score	4.9 ± 1.2
Rheumatoid Factor Positive	82 (68.3%)
Anti-CCP Positive	90 (75.0%)

Table 3: Musculoskeletal Ultrasound Findings Based on GSUS and PDUS Scores (n = 120)

Ultrasound Parameter	Grade	Number (n)	Percentage (%)
GSUS Score	Grade 0	14	11.7
	Grade 1	32	26.7
	Grade 2	46	38.3
	Grade 3	28	23.3
PDUS Score	Grade 0	22	18.3
	Grade 1	38	31.7
	Grade 2	36	30.0
	Grade 3	24	20.0
Active Synovitis (GSUS ≥2 and/or PDUS ≥1)	Present	82	68.3
	Absent	38	31.7

Table 4: Influence of Musculoskeletal Ultrasound on Treatment Planning (n = 120)

Treatment Decision	Number (n)	Percentage (%)
Initiation of DMARD Therapy	28	23.3
Escalation/Switching of Therapy	34	28.3
Addition of Biologic Agent	16	13.3
Tapering of Medication	12	10.0
No Change in Treatment Plan	30	25.0

Discussion

The present study evaluated the role of musculoskeletal ultrasound in predicting treatment planning among patients with rheumatoid arthritis and demonstrated that ultrasound findings, particularly GSUS and PDUS scores, were strongly associated with clinical decision-making. The demographic distribution observed in the study, with a predominance of females and patients aged between 46–60 years, reflects the known epidemiological trends of rheumatoid arthritis and supports the clinical relevance of imaging-based monitoring in this patient group. A substantial proportion of patients showed moderate to high disease activity based on DAS28 scores, which corresponded with ultrasound-detected synovitis, emphasizing the complementary value of imaging alongside clinical assessment. Previous studies have shown that ultrasound evaluation enhances sensitivity for detecting inflammatory activity and improves identification of patients requiring therapeutic modification, which is consistent with the current findings where 68.3% of patients exhibited active synovitis on ultrasound examination [11].

The relationship between PDUS activity and treatment escalation observed in this study highlights the prognostic role of Doppler signal in identifying patients at risk of disease progression. Earlier investigations have reported that persistent Doppler activity correlates with radiographic damage and may predict inadequate response to therapy, reinforcing the importance of incorporating ultrasound findings into treatment algorithms [12]. In the present cohort, patients with higher Doppler grades were more likely to undergo escalation or switching of therapy, suggesting that imaging findings influenced rheumatologists' decisions beyond traditional clinical parameters. These observations are supported by evidence indicating that ultrasound-guided treat-to-target strategies can improve long-term disease outcomes by allowing earlier therapeutic intervention [13].

Another important aspect of this study is the detection of subclinical synovitis, which was present in a considerable number of patients who otherwise had moderate clinical activity. The ability of ultrasound to reveal inflammatory changes before structural damage becomes apparent has been emphasized in several studies, demonstrating that imaging can help prevent overtreatment in inactive disease while ensuring timely escalation in active cases [14]. The findings of the current study support the concept that musculoskeletal ultrasound serves as a bridge between clinical evaluation and advanced imaging modalities, offering a practical and accessible tool for routine assessment. Furthermore, the observed correlation between ultrasound scores and laboratory markers such as ESR and CRP reflects the inflammatory nature of rheumatoid arthritis and underscores the multidimensional assessment required for optimal disease management.

The impact of ultrasound on treatment planning decisions in this study, including initiation of disease-modifying antirheumatic drugs, addition of biologic therapy, and medication tapering, demonstrates the clinical utility of MSUS in real-world practice. Previous literature has emphasized that ultrasound-guided management improves physician confidence and may reduce unnecessary medication changes by providing objective visualization of joint inflammation [15]. The current findings reinforce the growing role of

musculoskeletal ultrasound as an integral component of personalized treatment strategies in rheumatoid arthritis, particularly in settings where rapid decision-making is required.

Conclusion

Musculoskeletal ultrasound proved to be a valuable tool in assessing disease activity and guiding treatment decisions among patients with rheumatoid arthritis. The high prevalence of ultrasound-detected synovitis and its significant association with therapeutic modifications highlight its importance as an adjunct to clinical and laboratory assessment. Incorporating GSUS and PDUS scoring into routine evaluation may facilitate early identification of active disease, support individualized treatment planning, and potentially improve long-term outcomes.

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