Ankle and foot pathologies in early rheumatoid arthritis, what can ultrasound tell us?

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Abstract

Background: Rheumatoid arthritis (RA) is a systemic autoimmune polyarticular disease. Despite being commonly affected in RA, the ankle and foot do not receive much attention, particularly in early disease. The precise diagnosis of their involvement and its impact on health is a clinical challenge that requires accurate assessment.

Aim: To determine the role of ultrasound in evaluation of ankle and foot pathologies and assess its impact on functional activity in newly diagnosed RA patients.

Methods: The study was conducted on 152 RA patients and 52 healthy controls. Patients were subjected to history taking, clinical examination, and ultrasound scan. Impact on health was measured by health assessment questionnaire, as well as foot function index.

Results: In a cohort of patients with early RA with median duration of 1 month, tibialis posterior (TP) tenosynovitis (45.4%) was the most common pathology, followed by tibiotaral (TTJ) synovitis (39.8%), and peroneal tenosynovitis (39.1%). In terms of disease duration, TTJ ($P = .001$) foot pathologies were less common in early RA and tended to worsen over time, whereas TP ($P = .048$) and peroneal tenosynovitis ($P = .011$) were more common in early RA. In multivariate analysis TTJ, subtalar synovitis, forefoot pathologies, TP tenosynovitis, and Achilles enthesitis were found to be significant predictors of functional disability. The most important predictors of ankle pain were TTJ synovitis, TP tenosynovitis, peroneal tenosynovitis, and plantar fasciitis.

Conclusion: Ankle and foot involvement is a common issue of early RA, and it has a significant impact on quality of life. Ultrasound is a reliable tool for evaluating various abnormalities in this complex area, allowing for better management.

Keywords
ankle, early, foot, rheumatoid arthritis, ultrasound
1 | INTRODUCTION

Rheumatoid arthritis (RA) is a chronic inflammatory disease characterized by changes in the synovial tissue of joints, cartilage, and bone, and, less commonly, extra-articular locations. Foot and ankle pain are common complaints among RA patients throughout the disease’s progression, affecting their overall health. As a result, it is critical to improve their early detection.

Identifying ankle pathologies is critical for initiating treatment as soon as possible to avoid deterioration. Assessing the characteristics of inflammation in the joint and its impact on the functional status of RA patients will allow clinicians to target treatment interventions and improve symptoms.

Ultrasound is a sensitive imaging tool that allows identification of the affected anatomic structures, explaining the cause of ankle pain when present and revealing subclinical disease in asymptomatic ankles. Previous research has shown that ankle joint evaluation is undervalued in many clinical and sonographic scores used for RA patient evaluation and follow up. More effort is required to detect the value of ankle joint examination in RA and the assessment of ultrasonographic signs according to frequency, disease duration, and activity.

Considering the scarcity of studies on the ankle and foot involvement in RA, especially in the early stages of the disease, we decided to investigate the extent of ankle involvement in rheumatoid patients with early disease duration and to emphasize the impact of ankle pathologies on patients’ functional activity.

2 | MATERIALS AND METHODS

A cross-sectional study was conducted on 152 patients diagnosed with RA using the American College of Rheumatology/European League Against Rheumatism criteria with or without ankle pain, as well as 52 healthy controls (age- and gender-matched) with no history of or current joint disease. Patients were chosen from the rheumatology and immunology unit, within 1 year of the study’s start. Patients who were younger than 18 years, who had diabetes or hepatitis C virus infection, who were pregnant, who had overlap with other connective-tissue diseases or previous ankle surgery or trauma, and who received ankle injections were all excluded.

All patients had a history taken that included the following information: age, gender, place of residence, disease duration, presence or absence of ankle pain, and duration of ankle pain if present. For the patient’s ankle pain, a visual analogue scale (VAS) (0-10) was used. The study was approved by the medical ethics research committee at the Faculty of Medicine, Mansoura University. After ensuring confidentiality, each participant in this study provided informed written consent.

Patients were considered symptomatic if there was pain at any joint or soft-tissue structure.

Patients were asked to fill out the following questionnaires to calculate the degree of functional disability of the overall function and the foot function: the Health assessment questionnaire, which consists of 20 questions that assess functional status, with scores ranging from 0 to 3 for each question; and the questionnaire on Foot Function Index (FFI), which has 23 items divided into three subscales: pain (nine items), physical functioning (nine items), and limitation (five items). A percentage of the total score was computed. Reduced foot function was indicated by higher FFI scores.

2.2 | Disease activity

Disease activity score (DAS28) was used to assess RA activity by counting the number of swollen, tender joints. Erythrocyte sedimentation rate tests and the VAS score were also recorded. The results were then entered into a mathematical formula to produce a score.

2.3 | Ultrasound examination

On the same day as the clinical examination, an experienced rheumatologist (MGA) with approximately 9 years of experience in musculoskeletal ultrasound scanned both ankles and feet of each patient. The examiner was not given access to the patients’ clinical or laboratory data. The same person scanned all the patients with a Toshiba Xario 200 machine with 13 MHz superficial probe.

According to European League Against Rheumatism guidelines, the following structures were investigated: joints including tibiotalar (TTJ), subtalar (STJ), talonavicular (TNJ), calcaneo-cuboid (CCJ), naviculo-cuneiform (NCJ), cuneiform-metatarsal, cuboid-metatarsal, metatarso-phalangeals (MTP), tendons of tibialis anterior, extensor hallucis longus, extensor digitorum longus, tibialis posterior (TP), flexor digitorum longus, flexor hallucis longus, peroneals, Achilles, as well as retrocalcaneal bursa, and plantar fascia. The ultrasound examination involved initial gray-scale examination, followed by a power Doppler (PD) evaluation. The PD settings were constant (gain just below noise level, 750 Hz pulse repetition frequency, 8-10 MHz Doppler frequency, low wall filter).

Synovitis, tenosynovitis, bursitis, enthesitis, and erosions were all noted as abnormalities. Their interpretation was based on preliminary OMERACT definitions for ultrasound pathology. Enthesitis was diagnosed if there was one of: tendon insertion pathology, bone erosion, enthesophyte, bursitis. Bursitis was defined as a well-defined, localized anechoic or hypoechoic area at the site of an anatomical bursa that could be compressed by the transducer.

2.4 | Statistical analysis

The IBM SPSS software package version 25.0 for Windows was used to analyze the data (IBM, Armonk, NY, USA). Numbers and
percentages were used to describe qualitative data. After testing normality with the Kolmogorov-Smirnov and Shapiro tests, quantitative data were described using the median (minimum and maximum) and interquartile range for non-parametric data and mean, standard deviation for parametric data. The \( \chi^2 \) or Fisher exact test was used to compare qualitative variables, as appropriate. The significance of the obtained results was determined at the 5% level.

Linear regression was used with FFI and VAS as dependent variables. The independent variables used in the regression models were chosen from those that had a significant correlation with the FFI and VAS. To test the reliability of categorical variables with \( \kappa \), reliability analysis was performed using \( \kappa \) agreement.

## RESULTS

The current study included 152 RA patients with a mean age of 43.23 ± 12.5 years, with a higher prevalence of female (84.9%) than male (15.1%), as well as 52 age- and gender-matched healthy controls. The median of disease duration was 1 month. Two hundred ankles were symptomatic, and 104 were asymptomatic. The median duration of ankle pain was 3 months, with a VAS ranging from 0 to 9 and a median of 4. Patients were on methotrexate, leflunomide, hydroxychloroquine, sulfasalazine, and steroids. None of our patients were on biological therapy, and those taking more than 10 mg of steroids per day or taking non-steroidal anti-inflammatory drugs in the last 14 days were excluded. Table 1 displays detailed clinical and laboratory findings.

Clinical examinations were performed to detect tenderness and swelling at different joints of ankle and foot in addition to adjacent soft tissue. Detailed findings of the clinical examinations are shown in Table S1. The patients were classified according to presence or absence of ankle pain. There was a statistically significant difference between both groups regarding ankle and hindfoot pathologies (\( P \leq .001 \)) in addition to NCJ (\( P = .03 \)) and first (\( P \leq .001 \)), second (\( P = .027 \)), fifth (\( P = .028 \)) MTP joints. Details are shown in Table S2.

### 3.1 US scan

To the best of our knowledge this study contains the largest number published until now of structures scanned by US in ankle and foot, including 17 joints, 11 soft tissue structure per foot, for a total of 11424 structures (6936 joint and 4488 soft tissue). Each foot was

| TABLE 1 Demographics and clinical data of patients in the study |
|---------------------------------------------------------------|
| **Demographic data** | **RA patients (n = 152)** | **Healthy controls (n = 52)** |
| Age (years) | 43.23 ± 12.53 | 43.07 ± 0.70 |
| Gender | Female (84.9%) – male (15.1%) | Female (84.6%) – male (15.4%) |
| Disease duration (months) | 1 (1-360) | 1 (1-360) |
| Ankle pain (n = 304) | 200 painful ankles (65.8%) | 200 painful ankles (65.8%) |
| | − 104 non-painful ankles (34.2%) | − 104 non-painful ankles (34.2%) |
| Ankle pain duration (months) | 3 (0-60) | 3 (0-60) |
| VAS (0-10) | 4 (0-9) | 4 (0-9) |
| ESR (mm/h) | 46.5 (5-125) | 46.5 (5-125) |
| CRP (mg/L) | 12 (0-132) | 12 (0-132) |
| DAS28 score | 3.8 (1.2-5.8) | 3.8 (1.2-5.8) |
| RF | 106 (69.7%) | 106 (69.7%) |
| ACPA | 66 (43.4%) | 66 (43.4%) |
| HAQ | 1.8 (0.4-2.65) | 1.8 (0.4-2.65) |
| FFI | 60 (15-92) | 60 (15-92) |
| MTX | 63 (41.4%) | 63 (41.4%) |
| Leflunomide | 53 (34.9%) | 53 (34.9%) |
| Hydroxychloroquine | 66 (43.4%) | 66 (43.4%) |
| Sulfasalazine | 12 (7.9%) | 12 (7.9%) |
| Steroid | 40 (26.3%) | 40 (26.3%) |
| Biologics | 0 (0%) | 0 (0%) |

Note: All parameters are described in median (min-max) except age in mean ± SD.

Abbreviations: ACPA, anti-citrullinated protein antibody; CRP, C-reactive protein; DAS28, disease activity score of 28 joints; ESR, erythrocyte sedimentation rate; FFI, foot function index; HAQ, health assessment questionnaire; MTX, methotrexate; RA, rheumatoid arthritis; RF, rheumatoid factor; VAS, visual analogue scale.
divided into the following sections: ankle (TTJ), hindfoot (STJ, TNJ, CCJ), midfoot (NCJ, cuneiform-metatarsal joint, cuboid-metatarsal joint), and forefoot including the five MTP joints.

Ankle and foot pathologies were significantly more frequent in RA patients than in healthy controls. In RA patients, synovitis was detected in TTJ (39.8%), followed by TNJ (37.2%), STJ (27%), and CCJ (9.2%). The most common soft-tissue pathology was tenosynovitis of TP (45.4%), peroneal tendons (39.1%), Achilles tendon enthesitis (37.8%). Positive PD signal was present in TP (14.1%), peroneal tendons (10.9%), hindfoot (7.6%), forefoot (6.9%), ankle (6.3%), and midfoot (1%).

Table 2 shows the specifics of the ultrasound examination. Figure 1 shows some pathologies of patients in the study.

In terms of ankle pain, there was a statistically significant difference between symptomatic and asymptomatic ankles in hindfoot pathologies ($P = .001$), as well as the NCJ ($P = .03$) and the first, second, and fifth MTP joints ($P = .03$). Regarding relation of both gray-scale and PD findings to VAS scale of ankle pain, we found a significant relationship with stronger link of PD findings to higher VAS scores ($P = .001$).

When compared with disease activity, the findings revealed a significant relationship between TTJ synovitis ($P < .001$), as well as tenosynovitis of TP ($P = .007$), peroneal tendons ($P = .008$), and high disease activity. Hindfoot involvement was associated with moderate disease activity. Retrocalcaneal bursitis was more common in patients in remission. Positive PD signal was significantly related to high disease activity in all ankle and hindfoot structures ($P < .001$).

Patients were divided into two groups based on disease duration; the cut-off for the early RA group was 1 year. The established
RA group (70 patients) had more TTJ synovitis, hindfoot, midfoot, and forefoot pathologies (52.1% vs 29.3%), (50% vs 38.4%), (22.9% vs 12.2%), and (54.3% vs 38.4%). Soft-tissue pathology, on the other hand, was more prevalent in the early disease group (82 patients) in TP (50.6% vs 39.3%) and peroneal tendons (45.7% vs 31.4%), as shown in Table 3.

3.2 | Impact on health

The study attempted to quantify the impact of ankle and foot pathologies on functional disability and foot function by comparing ultrasound pathologies with questionnaire scores. The findings revealed a significant link between foot and ankle pathologies and higher questionnaire scores. Linear regression analysis revealed that ankle, STJ, forefoot synovitis, TP tenosynovitis, and Achilles enthesitis were found to be predictors of foot functional disability. Also, severity of ankle pain was dependent on TTJ, TP, peroneal, and plantar fascia involvement, as shown in Table 4.

3.3 | Clinical examination vs ultrasound

In comparing clinical examination with ultrasound, we found poor agreement between both modalities in the CCJ ($P = .016$) and tibialis anterior tendon, and fair agreement in TTJ, TP, and peroneal tendons ($P < .001$). However, in plantar fascia pathologies, there was moderate agreement ($P < .001$). These results are shown in Table 5.

4 | DISCUSSION

The ankle and foot are prone to numerous pathological conditions that may contribute to their eventual functional impairment. So the identification of the inflamed joint and/or tendon by ultrasound might provide useful information. Only a few studies have focused on this area in RA.

We worked on this knowledge gap in the literature and conducted our study to obtain more information about ankle and foot involvement in RA. In terms of pathology prevalence, the TTJ was the most affected (39.8%), followed by the TNJ (37.2%), the STJ (27%), and the CCJ (9.2%). Our findings were similar to those of Alsuwaidi et al$^{12}$ and Enache et al$^{13}$ but differed from Suzuki et al$^{14}$ who found higher frequencies of TTJ synovitis (76%), STJ synovitis (71%), and TNJ synovitis (59%). The difference could be explained by their small sample size of only 17 RA patients.

Regarding soft-tissue pathology, the most common was TP tenosynovitis (45.4%), followed by peroneal tenosynovitis (39.1%), Achilles enthesitis (37.8%), plantar fasciitis (18.1%), and retrocalcaneal bursitis (16.8%). Our findings were similar to those of Hernández-Díaz et al$^{12}$ and Harman and Tekoğlu,$^{15}$ but less frequent than Alsuwaidi et al,$^{12}$ which could be explained by the different age and disease duration, as our study included younger patients with shorter disease duration.

Another significant finding in our study was the high prevalence of Achilles enthesitis (37.8%). Although it is commonly associated with spondyloarthropathy, some studies like those of Suzuki et al$^{14}$ or Genc et al,$^{14}$ have described it in about 40% of RA. Our results
Table 3: Comparison of ultrasound findings according to disease duration

| Gray-scale ultrasound | Early RA ankles = 164 | Established RA ankles = 140 | Test of significance | P |
|-----------------------|-----------------------|-------------------------------|----------------------|----|
| TTJ                   | 48 (29.3%)            | 73 (52.1%)                    | $\chi^2 = 16.49$    | P < .001* |
| Hindfoot pathology    | 63 (38.4%)            | 70 (50%)                      | $\chi^2 = 4.12$     | P = .042* |
| STJ                   | 39 (23.8%)            | 43 (30.7%)                    | $\chi^2 = 1.84$     | P = .175 |
| TNJ                   | 55 (33.5%)            | 58 (41.4%)                    | $\chi^2 = 2.01$     | P = .156 |
| CCJ                   | 10 (6.1%)             | 18 (12.9%)                    | $\chi^2 = 4.13$     | P = .042* |
| Midfoot pathology     | 20 (12.2%)            | 32 (22.9%)                    | $\chi^2 = 6.01$     | P = .014* |
| Naviculo-cuneiform joint | 20 (12.2%)      | 21 (15%)                      | $\chi^2 = 0.51$     | P = .475 |
| Cuneiform-metatarsal joint | 11 (6.7%) | 15 (10.7%)                   | $\chi^2 = 1.55$     | P = .213 |
| Forefoot pathology    | 63 (38.4%)            | 76 (54.3%)                    | $\chi^2 = 7.67$     | P = .006* |
| MTP-1                 | 46 (28%)              | 51 (36.4%)                    | $\chi^2 = 2.44$     | P = .118 |
| MTP-2                 | 38 (23.2%)            | 41 (29.3%)                    | $\chi^2 = 1.47$     | P = .226 |
| MTP-3                 | 29 (17.7%)            | 35 (25%)                      | $\chi^2 = 2.43$     | P = .119 |
| MTP-4                 | 13 (7.9%)             | 26 (18.6%)                    | $\chi^2 = 7.65$     | P = .006* |
| MTP-5                 | 11 (6.7%)             | 27 (19.3%)                    | $\chi^2 = 10.93$    | P = .001* |
| TA                    | 2 (1.2%)              | 10 (7.1%)                     | $\chi^2 = 6.99$     | P = .008* |
| EHL                   | 0 (0%)                | 3 (2.1%)                      | FET                  | P = .097 |
| EDL                   | 4 (2.4%)              | 2 (1.4%)                      | $\chi^2 = 0.399$    | P = .528 |
| TP                    | 83 (50.6%)            | 55 (39.3%)                    | $\chi^2 = 3.91$     | P = .048* |
| FDL                   | 16 (9.8%)             | 15 (10.7%)                    | $\chi^2 = 0.08$     | P = .783 |
| FHL                   | 5 (3%)                | 7 (5%)                        | $\chi^2 = 0.758$    | P = .384 |
| Peroneal tendons      | 75 (45.7%)            | 44 (31.4%)                    | $\chi^2 = 6.49$     | P = .011* |
| AT                    | 37 (22.6%)            | 59 (42.1%)                    | $\chi^2 = 13.4$     | P < .001* |
| RCB                   | 24 (14.6%)            | 27 (19.3%)                    | $\chi^2 = 1.17$     | P = .279 |
| Achilles enthesitis   | 46 (28%)              | 69 (49.3%)                    | $\chi^2 = 14.48$    | P < .001* |
| Calcaneal erosion     | 8 (4.9%)              | 22 (15.7%)                    | $\chi^2 = 9.97$     | P = .002* |
| PF                    | 27 (16.5%)            | 28 (20%)                      | $\chi^2 = 0.64$     | P = .425 |

Abbreviations: AT, Achilles tendon; CCJ, calcaneocuboid joint; EDL, extensor digitorum longus; EHL, extensor hallucis longus; FDL, flexor digitorum longus; FET, fisher exact test; FHL, flexor hallucis longus; MTP, metatarsophalangeal; PF, plantar fascia; RA, rheumatoid arthritis; RCB, retrocalcaneal bursa; STJ, subtalar joint; TA, tibialis anterior; TNJ, talonavicular joint; TP, tibialis posterior; TTJ, tibiotalar joint; $\chi^2$, chi square test.

* indicates significance P values (where P value < .05).

agree with them, and this should attract the attention to focus on Achilles tendon during follow up of RA.

Heel pain in RA is also considered a neglected area, with more attention paid in cases of spondyloarthropathy. At the heel, important sites must be evaluated: the Achilles tendon, retrocalcaneal bursa, as well as the adjacent cortical surface of the calcaneum. Our findings showed the presence of retrocalcaneal bursitis with positive PD, and this matches with Serban et al., who stated that retrocalcaneal bursa had a significant impact on patients’ symptomatology and quality of life.

Previous research found a low PD frequency in TTJ.\textsuperscript{12,19–21} Our data agree with them, and this could be explained by the low sensitivity of PD in large joints and deep anatomic areas. This highlights the importance of performing a thorough examination of the TTJ, including scanning the medial and lateral aspects to improve PD sensitivity in this complex area.

Regarding ankle pain, our study showed statistically significantly more pathological findings in painful ankles. Our results agree with Suzuki et al.,\textsuperscript{22} and differ from those of Alsuwaidi et al.;\textsuperscript{12} and this could be explained by the different age and disease duration. Soft-tissue pathology was also significantly higher in painful ankles than non-painful ankles. Those findings were similar to those of Enache et al.,\textsuperscript{13} who discovered a link between ankle pain and pathological findings in both the gray-scale and PD.
The association between positive PD findings and ankle pain is still being debated in the literature, with studies supporting the hypothesis that hypervascularization is associated with pain and others finding no correlation. In our study, positive PD appears to be significantly associated with pain in TTJ ($P < .001$), hindfoot ($P < .001$), STJ, TNJ ($P = .028$), forefoot ($P = .039$), TP ($P < .001$), peroneal ($P = .007$), and Achilles enthesitis ($P = .028$).

In RA patients, the prevalence of ankle joint involvement seems to have a tendency to increase with disease duration. We focused on this point by categorizing patients into early and late disease duration groups. The established RA group had more joint affection, while the early RA group had more tendon affection. Our findings are consistent with those of Harman and Tekeöglu, Elsaman et al, Alsuwaidi et al, and Suzuki et al. Our findings contradicted those of Hernández-Díaz who highlighted the superiority of ultrasound.

We also tested rheumatoid factor and anti-citrullinated protein antibody (ACPA) for the patients to denote their relation to pathology. Our findings were consistent with those of Serban et al, Harman and Tekeöglu, and Jeong et al, who found higher prevalence joint pathologies in the first year. This could be explained by a difference in ethnicity or age group.

We tested rheumatoid factor and anti-citrullinated protein antibody (ACPA) for the patients to denote their relation to pathology. Previous studies denoted ACPA sensitivity ranged from 40% to 89%. There is some variation according to ethnicity, age, and disease duration. Our patients showed incidence of ACPA of about 43.4% and this matches previous studies on the same ethnic population.

We tried to explore the impact of foot involvement on health. Our findings revealed a statistically significant link between ankle pathologies and higher Health assessment questionnaire and FFI scores. Our findings were consistent with those of Serban et al, Harman and Tekeöglu, and Jeong et al, who highlighted the association between hindfoot pathologies and functional disability. Our findings differ from those of Petterle et al. This may be explained by their examination of only asymptomatic feet, whereas our sample size included both symptomatic and asymptomatic feet.

Previous studies attempted to identify predictors of disability. In one study, age, disease duration, and disease activity were found to be predictors of hindfoot valgus. STJ, TP, and peroneal tenosynovitis were discovered to be predictors of FFI in another study. We investigated more data, supported by our large sample size, and discovered TTJ, STJ, forefoot synovitis, TP tenosynovitis, and Achilles enthesitis to be predictors of impaired ankle and foot function. TTJ synovitis, TP, peroneal tenosynovitis, and plantar fasciitis were also found to be predictors of ankle pain severity.

Previous research has investigated the agreement between clinical examination and ultrasound. In an earlier study we investigated this point in the shoulder joint and discovered poor concordance between both modalities. Numerous studies, particularly in the hands, have demonstrated the superiority of ultrasound and magnetic resonance imaging (MRI) to clinical examination in the early detection of inflammatory synovial lesions.

Comparing clinical examination to ultrasound at the level of ankle joint, we found poor to fair agreement between both modalities. Our findings were consistent with those of Wakefield et al, who discovered a high concordance of ultrasound with MRI but a low concordance with clinical examination, and Toyota et al, who highlighted the superiority of ultrasound over clinical examination in detecting ankle involvement.

We acknowledge that our study has several limitations, including the lack of a reference standard radiological modality, such as MRI, to confirm the ultrasound findings and the lack of a longitudinal follow up to determine the long-term clinical implications of these ultrasound findings.

In conclusion, the ankle and foot are frequently involved in early RA. The duration of the disease is an important consideration, with more soft-tissue pathologies in the first year and more joint involvement later.

Ankle and foot pathologies have a significant impact on the functional activity and quality of life of RA patients, and this needs to be assessed early and accurately using various modalities. Accurate ankle assessment has a big impact on patient’s quality of life,

### Table 4: Impact of ankle and foot pathologies on functional status in RA

| Variable          | FFI          | VAS          |
|-------------------|--------------|--------------|
|                   | Standardized coefficient | $P$ | 95% CI | Standardized coefficient | $P$ | 95% CI |
| TTJ               | 0.265        | $<.001^*$    | 7.872 | 17.313 | 0.249 | $<.001^*$ | 0.801 | 2.151 |
| STJ               | 0.124        | $.018^*$     | 1.144 | 11.884 | 0.084 | .162    | $-0.220$ | 1.315 |
| TNJ               | 0.062        | .283        | $-2.454$ | 8.380 | 0.049 | .455    | $-0.480$ | 1.069 |
| CCJ               | $-0.009$     | .856        | $-8.612$ | 7.154 | $-0.017$ | .765    | $-1.299$ | 0.956 |
| Midfoot           | 0.036        | .479        | $-3.916$ | 8.328 | 0.109 | .059    | $-0.033$ | 1.717 |
| Forefoot          | 0.124        | $.017^*$     | 1.024 | 10.583 | 0.085 | .154    | $-0.188$ | 1.179 |
| TP                | 0.188        | $<.001^*$    | 3.997 | 13.526 | 0.153 | .010^*  | 0.211  | 1.574 |
| Peroneal          | 0.050        | .317        | $-2.301$ | 7.078 | 0.114 | .047^*  | 0.008  | 1.349 |
| AT enthesitis      | 0.148        | .007^*      | 1.961 | 12.266 | $-0.073$ | .243    | $-1.175$ | 0.298 |
| PF                | 0.066        | .181        | $-1.875$ | 9.883 | 0.114 | .045^*  | 0.021  | 1.702 |

**Abbreviations:** AT, Achilles tendon; CCJ, calcaneocuboid joint; CI, confidence interval; FFI, foot function index; $P$, probability value; PF, plantar fascia; STJ, subtalar joint; TNJ, talonavicular joint; TP, tibialis posterior; TTJ, tibiotalar joint; VAS, visual analogue scale.

Significant results were bolded and marked with * ($where P value < .05$).
physicians need to be aware of ankle pathologies to be able to treat them in an adequate and timely fashion so as to prevent permanent malalignment/irreversible damage to the foot. Ultrasound is a reliable tool that aids in diagnosis, prediction of functional disability, and proper management of ankle pathologies in RA. PD should be included during ultrasound scans to provide more information about disease activity and ankle pain severity. These data should be corroborated further in longitudinal studies.

**AUTHOR CONTRIBUTIONS**

MGA contributed to study design, ultrasound scan, data analysis, interpretation of results, and preparation of manuscript; SF contributed to data analysis, revision of the manuscript, and proofreading; AA and AFE contributed to study design, data analysis, and interpretation of results; and NA contributed to study design, data analysis, interpretation of results, and supervised the work.

**ACKNOWLEDGEMENTS**

The corresponding author would like to express appreciation to the Ministry of Higher Education of Egypt for funding with a scholarship of a joint supervision. We are indebted to Dr. Mathieu Boudier-Revert from the Centre hospitalier de l’Université de Montréal, Canada for the scientific revision and language editing of the paper. Open Access funding enabled and organized by Projekt DEAL.

**CONFLICT OF INTEREST**

None declared.

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**TABLE 5** Agreement between clinical examination and ultrasound in detection of ankle pathologies in RA

| Structure          | κ value | P       | SE   | Strength of agreement |
|--------------------|---------|---------|------|-----------------------|
| TJ synovitis       | 0.366   | <.001*  | 0.051| Fair                  |
| STJ synovitis      | 0.255   | <.001*  | 0.058| Fair                  |
| TNJ synovitis      | 0.299   | <.001*  | 0.048| Fair                  |
| CCJ synovitis      | 0.096   | .016*   | 0.075| Poor                  |
| TA tenosynovitis   | 0.039   | .372    | 0.053| Poor                  |
| TP tenosynovitis   | 0.313   | <.001*  | 0.053| Fair                  |
| Peroneal tenosynovitis | 0.377 | <.001* | 0.055| Fair                  |
| AT enthesitis      | 0.350   | <.001*  | 0.058| Fair                  |
| Plantar fasciitis  | 0.474   | <.001*  | 0.070| Moderate              |

Abbreviations: AT, Achilles tendon; CCJ, calcaneocuboid joint; P, probability value; SE, standard error; STJ, subtalar joint; TA, tibialis anterior; TNJ, talonavicular joint; TP, tibialis posterior; TTJ, tibiotalar joint.

* indicates significance P values (where P value < .05).
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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Abdelzaher MG, Finzel S, Abdelsalam A, Enein AF, Abdelsalam N. Ankle and foot pathologies in early rheumatoid arthritis, what can ultrasound tell us? *Int J Rheum Dis.* 2022;25:1315-1323. doi: 10.1111/1756-185X.14426