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Foot deformities in rheumatoid arthritis patients and their effects on foot functions

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Abstract. – OBJECTIVE: Foot problems are common clinical disorders in patients with Rheumatoid Arthritis (RA). The aim of this study was to investigate the frequency and impact of foot and ankle problems in patients with RA.

PATIENTS AND METHODS: A total of 164 feet of 82 RA patients with a diagnosis of one year or more were evaluated. Deformities including HV, CT, SF, PC, PP, MPS, MPV, and HT were examined in all RA patients. The Foot Function Index was used to measure the impact of these deformities on pain, disability, and movement limitations. Radiological changes were measured using the modified Larsen score.

RESULTS: The frequency of deformity in RA patients was found to be 95.1%, with HV deformity being the most common at 84.1%. There was a statistically significant relationship between SF, HV, PP, and PC deformities and disease duration. In our sample of 82 patients, 70 (85.3%) reported past or present foot pain complaints. The most common site of pain was the ankle joint, with 44 (53.7%) patients experiencing ankle pain. A statistically significant increase in the frequency of ankle pain was found as DAS28 scores, body mass index (BMI), and disease duration increased. There was also a correlation between an increase in DAS28 scores and the frequency of forefoot pain. A significant correlation was found between MPV, HV, PP, and PC deformities and high FFI scores. Larsen radiological scores were not correlated with foot-ankle pain or duration of pain.

CONCLUSIONS: These findings suggest that foot deformities are common in RA, and it is important to address them early in the disease course to minimize functional disability and improve quality of life.

Key Words:
Foot deformities, Foot function index, Rheumatoid arthritis.

Introduction

Rheumatoid Arthritis (RA) is a chronic autoimmune disease. It affects 0.3-1.5% of the global population and is 2-3 times more common in women than in men. RA is characterized by symmetrical joint involvement and deformities. The feet are slightly more frequently involved in the acute phase of RA than the hands, with 15.7% and 14.7% involvement, respectively. Foot deformities can occur in up to 85-90% of patients with RA in the long term[1-3]. Metatarsophalangeal (MTP) joints are particularly prone to involvement in the early phase of RA.

The main pathological changes in the rheumatoid foot are caused by synovitis and mechanical stress. Destructive synovitis leads to direct destruction of bone, ligaments, cartilage, and capsule structures. It also leads to joint instability due to periarticular involvement. Proteases and collagenases contribute to damage to the joint and periarticular structures. Weakness of joint capsule and ligament structures leads to deterioration of joint stability. The mechanical stress on these joints after the loss of supporting structures leads to various degrees of deformity and eventually loss of function[4,5].

In this cross-sectional study, our aim was to investigate the frequency of foot and ankle problems in patients with RA. Additionally, we aimed to examine the impact of these problems on foot function and quality of life. Furthermore, we aimed to determine the relationship between these problems with disease activity, disease duration, and radiological scores. The study population consisted of RA patients followed in our outpatient clinic.

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Patients and Methods

A total of 93 consecutive patients with a diagnosis of RA according to the criteria of the American College of Rheumatology (ACR) were included in the study. Of these, 2 patients were not evaluated due to a disease duration of less than 1 year. Additionally, three patients were excluded because they did not give consent. Six patients were excluded from the study due to previous lower extremity surgery, a history of neurological disease, or active arthritis. A total of 164 feet of 82 RA patients with a disease duration of at least 1 year were evaluated. Patients with systemic diseases, neurological abnormalities, active arthritis, or a history of lower extremity surgery that could affect study parameters were excluded. Standing, bilateral anteroposterior, and lateral radiographs were taken for all patients, and Erythrocyte Sedimentation Rate (ESR), C Reactive Protein (CRP), Rheumatoid Factor (RF), Anti- Cyclic citrullinated peptide (Anti-CCP), disease duration, and body mass index (BMI) were recorded.

Anterior, posterior, and lateral radiographs were used to measure the MTP angle between the longitudinal axis connecting the midpoints of the articular surfaces of the 1st metatarsal and the midpoints of the articular surfaces of the 1st proximal interphalangeal joint. Additionally, the intermetatarsal angles between the longitudinal axes of the first and second metatarsals were also measured. A MTP angle greater than 15 degrees and an intermetatarsal angle greater than 9 degrees were considered Hallux Valgus (HV)[6]. In addition, subluxations in the MTP joints were evaluated from anteroposterior foot radiographs. The talo metatarsal angle (angle between the talus and the anterior-background long axis of the first metatarsal) was evaluated in the lateral foot radiographs. This angle shows the alignment of the front of the foot with respect to the back of the foot. Normally, the long axis of the talus and the long axis of the 1st metatarsal should be on the same line. If the convexity of the angle is downward and greater than 4°, it is considered pes planus, and if the convexity of the angle is upward and greater than 4°, it is considered pes cavus (PC)[7]. Plantar flexion in the proximal interphalangeal (PIP) joint and compensatory hyperextension in the MTP and distal interphalangeal (DIP) joints were evaluated as Hammer Toe (HT) deformity. Hyperextension of metatarsophalangeal joints and hyperflexion of PIP and DIP joints were evaluated as Claw Toe (CT) deformity[8,9].

The intermetatarsal angle between the first and second metatarsals (M1/2) and the intermetatarsal angle between the first and fifth metatarsals (M1/5) were measured on the anterior-posterior radiographs. Results with an M1-M2 intermetatarsal angle greater than 10° were considered as Metatarso Primo Varus (MPV). An M1-M5 intermetatarsal angle greater than 35° was considered as Splay Foot (SF)[10]. The modified Larsen grading scale was used to measure radiological changes in the foot radiographs of the patients[11].

The Foot Function Index (FFI) scale was used to assess the functional status of the foot. The FFI consists of 23 items in three subgroups questioning pain (PS), disability (DS), and activity limitation (ALS) in three subcategories[12]. The Health Assessment Questionnaire (HAQ) scores were used to measure the health status of the patients and the Disease Activity Score 28 (DAS 28) was used to measure disease activity[13,14].

To determine the distribution and localization of foot pain, regions were categorized as forefoot, midfoot, hindfoot, and ankle. Photographs showing these anatomical regions of the foot and ankle were shown to the patients, and they were asked to identify and then localize the painful areas on their feet. In addition to the pain described by the patient, two different clinicians examined the foot with palpation and recorded sensitive and painful areas according to different anatomical regions.

Statistical Analysis

The data were analyzed using IBM SPSS Statistics Standard Concurrent User V 26 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as number of units (n), percent (%), mean ± standard deviation (Mean±SD), median (M), minimum (min), and maximum (max). The normal distribution of numerical variables was evaluated using the Shapiro-Wilk test of normality. Comparisons between two groups for numerical variables were made using the *t*-test for independent samples when the data were normally distributed, and the Mann-Whitney U test when the data were not normally distributed. Chi-square tests (Pearson chi-square/Fisher exact test) were used to compare groups with categorical variables. Relationships between numerical variables were evaluated using the Spearman correlation coefficient. A p-value of <0.05 was considered statistically significant.

Ethics committee approval with reference number 199/12 was obtained from the local Ethics

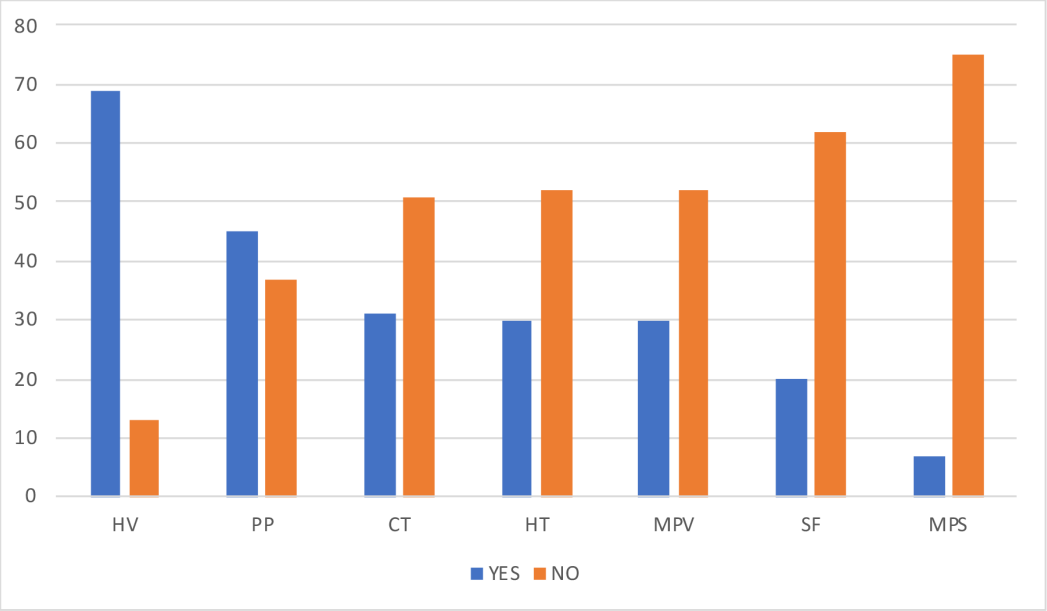

Figure 1. Descriptive Statistics on Deformity Status of Persons. N: 82 patients CT: Claw Toe, ht: hammer toe, SF: Splaying Foot, MPV: Metatarso primo varus, HV: Hallux Valgus, PC: Pes Cavus, PP: Pes Planus, MPS: Metatarsofalengeal subluxation.

Committee for this study. Informed consent according to the Declaration of Helsinki was obtained from all individual participants included in the study.

Results

A total of 82 patients were included in the study, with 72 (87.8%) females and 10 (12.2%) males. The mean age of the patients was 49 years. The mean BMI was 30.02±4.68 kg/m^2, and the mean disease duration was 10 years. Out of the participants, 63 (76.8%) were RF positive and 57 (69.5%) were Anti-CCP positive. The mean ESR was 35.59±13.74, the mean CRP level was 1.03±1.03, the mean HAQ score was 65±0.35 points, and the mean DAS 28 score was 4.22±1.25 (Table I).

When the patients were examined for deformities, 78 (95.1%) had foot deformities and 4 (4.9%) did not. The most common deformity was HV, present in 69 (84.1%) patients. This was followed by Pes Planus in 45 (54.9%) patients. The least common deformity was PC, which was present in 7 (8.5%) patients. The distribution of the various deformities is shown in Figure 1.

In our sample of 82 patients, 70 (85.3%) reported past or present foot pain complaints. The most common site of pain was the ankle joint, with 44 (53.7%) patients experiencing ankle pain. Forefoot pain was reported by 33 (40.2%) patients, midfoot pain by 13 (15.9%) patients, and hindfoot pain by 15 (18.3%) patients. The distribution of foot pain by region is shown in Table II. We found a statistically significant increase in ankle pain positivity as both BMI and disease duration increased (p<0.05).

In addition, we examined the relationship between pain and DAS 28. We found that the DAS 28 scores of patients with ankle pain and forefoot pain were statistically high (p<0.05). There was no statistically significant difference between hindfoot, midfoot, and forefoot pain and the BMI or disease duration. We also found that the relationship between disease duration and the development of SF, MPV, HV, and PP deformities was statistically significant (p<0.05). Furthermore, the Larsen scores of patients with MPV and HV deformities were statistically significantly higher than those of patients without deformities (p<0.05)

The Foot Function Index was examined in the right and left feet. The mean FFI Disability score was found to be 52.07±15.21 points. The mean FFI Activity score was 14.73±6.11 points. The mean FFI Pain score was 55.29±13.5 points, and the mean FFI Total score was 53.09±14.79 points. The descriptive statistics of the patients' FFI scores are shown in Table III.

When the correlations of foot deformities with FFI were examined, a statistically signifi-

Table I. Descriptive statistics of subject.

	Statistics
Age, (Years)	
Mean ±SD	48.83±8.83
M (min-max)	49 (27-65)
Sex, n (%)	
Female	72 (87.8)
Male	10 (12.2)
Body mass index, (kg/m^2)	
Mean ±SD	30.02±4.68
M (min-max)	29.88 (19.03-41.03)
Disease Duration	
Mean ±SD	10.32±5.29
M (min-max)	10 (1-24)
Romatoid factor, n (%)	
Negative	19 (23.2)
Positive	63 (76.8)
Anti CCP, n (%)	
Negative	25 (30.5)
Positive	57 (69.5)
Erythrocyte sedimentation rate	
Mean ±SD	35.59±13.74
M (min-max)	33 (16-78)
C Reactive Protein	
Mean ±SD	1.03±1.03
M (min-max)	0.6 (0.1-4.9)
Health assessment questionnaire	
Mean ±SD	0.65±0.35
M (min-max)	0.6 (0.1-1.6)
DAS 28 Score	
Mean ±SD	4.22±1.25
M (min-max)	4.55 (2.2-6.2)
Larsen Score	
Mean ±SD	9.26±7.39
M (min-max)	7 (0-43)

cant correlation was found between HV and PP deformities and all subgroups and total FFI scores. However, although the relationship between MPV deformity and FFI pain, disability, and total scores was statistically significantly higher, the difference between FFI activity scores was not statistically significant. Although there was a statistically significant difference between PC deformity and the FFI disability subgroup, the difference between other FFI subgroups and the FFI total score was not statistically significant. No statistically significant correlation was found between other existing deformities and FFI scores. Data on correlations of foot deformities with FFI (subgroup scores and total scores) are shown in Table IV.

Discussion

In this study, we evaluated common foot deformities, foot-ankle pains, and their effects on radiological scores, quality of life, and foot functional index in patients with RA. Foot deformities are a common clinical disorder that can result in functional disability and reduce the quality of life of patients with RA. The majority of patients with RA experience foot deformities that result in foot or ankle pain at some time during their illness.

In different studies[4,15-18] evaluating foot involvement in RA, foot involvement has been reported at rates ranging from 59-100% in patients. Our study found that foot deformities were present in 78 (95.1%) patients and foot/ankle pain in 69 (84.1%) patients. This is consistent with previous research[19,20] on the prevalence of foot involvement in RA. Such as, Bal et al[19] found that foot involvement was present in 96% of their sample of 78 RA patients. Thould and Simon[20] reported that 95% of their sample of 105 patients with RA showed positive radiological changes in the foot. Our findings are similar to these previous studies[19,20], indicating that foot involvement is a common feature of RA.

Table II. Frequency and distribution of foot pain based on examination and foot complaints in patients with rheumatoid arthritis.

	Statistics
Visual analog scale	
Mean ±SD	4.51±1.26
M (min-max)	4.55 (1.8-6.9)
Pain duration	
Mean ±SD	10.16±5.94
M (min-max)	9 (1-24)
Ankle pain, n (%)	
No	38 (46.3)
Yes	44 (53.7)
Forefoot pain, n (%)	
No	49 (59.8)
Yes	33 (40.2)
Midfoot pain, n (%)	
No	69 (84.1)
Yes	13 (15.9)
Hindfoot pain, n (%)	
No	67 (81.7)
Yes	15 (18.3)

Table III. Descriptive statistics of patients' foot function ındex scores.

Foot function index	**Disability**	
	Mean ±SD	52.07±15.21
	M (min-max)	51 (17-82)
	Activity	
	Mean ±SD	14.73±6.11
	M (min-max)	14 (6-31)
	Total	
	Mean ±SD	53.09±14.79
	M (min-max)	50.87 (21.3-84.35)
	Pain	
	Mean ±SD	55.29±13.5
	M (min-max)	55 (26-84)

At least one or more-foot deformities were present in 78 (95.1%) of our 82 RA patients. The most common deformity was HV with 84.1% (69) patients. This was followed by PP in 54.9% (45) patients. The least common deformity we detected in our patients was PC deformity with 8.5% (7). The PP deformity, which was the second most common in our study, was reported by Bal et al[19] to be the most common deformity with 80.7%. In the same study, they found HV deformity, which we detected as the most common in our study, to be in the third rank with 64.1%. Similarly, Baysal et al[21] also found PP and HV deformities in RA patients in the first (60%) and second (50%) ranks, respectively.

It is known that RA is a chronic and progressive disease. Therefore, it can be expected that the number of deformities will increase as the disease duration increases. In our study, we found a statistically significant relationship between disease duration and the development of SF, MPV, HV, and PP deformities. Furthermore, the Larsen scores of patients with MPV and HV deformities were statistically significantly higher than those of patients without deformities (p<0.05). Our result was predictable, as RA is known to affect the ankle, intertarsal joints, metatarsophalangeal, and intertarsal joints. Studies[17,19,22,23] reported in the literature showed that the frequency of different foot deformities increases with the duration of

Table IV. Correlations of foot deformities with FFI (subgroup scores and total scores).

		FFI Pain	FFI Disability	FFI Activity	FFI Total
Claw Toe	**Y**	56.4±14.17	53.5±15.67	15.17±6.41	54.38±15.42
	N	52.27±11.23[a]	48.18±13.44[a]	13.55±5.14[a]	49.57±12.56[a]
Hammer Toe	**Y**	57.56±13.07	53.78±15.9	15.61±7.18	55.19±15.32
	N	54.66±13.65[a]	51.59±15.11[a]	14.48±5.81[a]	52.49±14.7[a]
SF	Y	59.17±12.33	56.72±14.31	17.11±6.59	57.83±14.07
	N	54.2±13.7[a]	50.77±15.31[a]	14.06±5.85[a]	51.75±14.82[a]
MPV	Y	60.64±11.75	58.14±13.26	16.18±5.9	58.68±13.13
	N	52.52±13.61[*]	48.93±15.32[*]	13.98±6.14[a]	50.19±14.87[*]
		***p*=0.015**	***p*=0.011**		***p*=0.021**
HV	**Y**	58.82±12.36	56.1±13.86	15.88±5.8	56.87±13.58
	N	50.06±13.6 *	46.09±15.35[*]	13.03±6.25[*]	47.47±14.91*
		***p*=0.007**	***p*=0.005**	***p*=0.011**	***p*=0.007**
PC	**Y**	63±19.08	62.33±22.86	19.33±9.37	62.9±21.68
	N	54.68±12.94[a]	51.26±14.35[*]	14.37±5.71[a]	52.31±14.02[a]
			***p*=0.047**		
PP	**Y**	62.88±10.01	60.29±11.57	17.44±5.72	61.13±11.58
	N	47.71±12.28[*]	43.85±14.01[*]	12.02±5.27[*]	45.04±13.27[*]
		p=0.00	***p*=0.000**	***p*=0.000**	***p*=0.000**
MFS	**Y**	54.29±16	52.18±18.18	15.12±7.27	52.86±17.69
	N	55.55±12.9[b]	52.05±14.5[a]	14.63±5.83[a]	53.14±14.09[b]

[a]: $p > 0.05$ Deformity Yes >No, [b]: $p > 0.05$ Deformity No>Yes, [*]: $p<0.05$, SF: Splaying Foot, MPV: Metatarso primo varus, HV: Hallux Valgus, PC: Pes Cavus, PP: Pes Planus, MFS: Metatarsofalengeal subluxation.

RA. Even Johnson[17] stated that nearly 100% of patients with RA will develop foot problems within a 10-year period. This suggests that longer disease duration and the presence of certain foot deformities may be associated with higher Larsen scores.

Foot pain is a common clinical complaint in RA. In studies[5,16,24-26] evaluating foot-ankle pain in RA, involvement has been reported in 56-100% of patients. In our study, we found the frequency of foot-ankle pain to be 85.3% in RA patients, consistent with previous data. We determined the most common involvement to be ankle (%53,7) and forefoot (%40,2), followed by hindfoot (%18,3) and midfoot (%15,9) pain, respectively. Our findings were consistent with the results present in literature. In some previous studies[24,27], the frequency of foot involvement by gender was reported as 91-94% in women and 50-81% in men. In our patients, these rates were 88.8% in women and 40% in men. The most common involvement was ankle and forefoot in men and ankle in women. However, due to the small size of our study group and the overwhelming majority of patients (72) being female, gender differences were not sufficient to conclude.

In our study, it was found that the frequency of ankle pain increased as the BMI increased, or the duration of the disease increased. This suggests that a higher body mass index and longer disease duration may be associated with an increased likelihood of experiencing ankle pain. It was thought that BMI was associated with excessive mechanical load and disease duration was associated with the prolonged joint damage process. Borman et al[24] also found that ankle involvement increased as the duration of the disease and BMI increased. The fact that mean disease duration (10.32+-5.29) and the mean foot pain duration (10.16+-5.94) were very close to each other suggests that the involvement of the foot joints started in the early period of the disease. Similarly, Turner et al[28] in their study examined the effect of foot functions in RA patients with a duration of less than 2 years. They showed that the involvement of foot functions started in the early stages. Meanwhile, Larsen radiological scores were not correlated with foot-ankle pain or duration of pain ($p>0.05$).

Although there are studies[29] showing the effect of general symptoms of RA patients on their functional status, studies investigating the effect of foot deformities are limited. Therefore, we applied the FFI, which consists of pain, disability, and activity limitation subscales, to focus on the effect of foot functions in our study. In our study, the mean FFI Disability score was 52.07±15.21 points. The mean FFI Activity score was 14.73±6.11 points. The mean FFI Pain score was 55.29±13.5 points, and the mean FFI Total score was 53.09±14.79 points. When the correlations of foot deformities with FFI were examined, a statistically significant correlation was found. This correlation was between HV and PP deformities and all subgroups and total FFI scores. It is possible that these deformities may cause more functional limitations and pain, leading to lower FFI scores. MPV deformity also affects all FFI subgroups and total scores except the activity subgroup. The lack of a statistically significant relationship between MPV deformity and FFI activity scores may be due to the small sample size or other factors that were not measured in this study. Foot deformities in RA can develop together in the forefoot, midfoot, and hindfoot, which have anatomical connections with each other. For example, a pes planus foot with a hindfoot deformity remains in pronation throughout the entire gait cycle. Biomechanically, long-term loading of the prone foot facilitates the development of forefoot deformities such as hallux valgus. In our study, there was a positive correlation between pes planus and hallux valgus, which were found to be associated with all subgroups of FFI. Baysal et al[21] similarly found a positive correlation between HV and PP deformities in their 60-patient studies in which they investigated foot deformities in RA. Bouysset et al[22] also found a correlation between pes planus and posterior foot pathologies in patients with RA. They suggested that early diagnosis and treatments should be targeted before posterior foot pathologies occur. This is because pes planus becomes irreversible when posterior foot pathologies reach a clinically detectable level. Foot deformities can affect each other as well as other joints of the lower extremities. In the literature, there are studies[21,22] on various important pathologies caused by foot deformities in the hip and knee joints. Further research is needed to confirm these findings and to explore the mechanisms underlying these relationships.

There was no correlation between HAQ scores and DAS 28 scores in terms of deformity development in our study. This suggests that deformity development does not significantly affect HAQ scores or DAS 28 scores. Borman et al[24] also did not find a relationship between HAQ score or DAS 28 and deformities in their study, similar to the result we found. The fact that the foot joints are not used in the calculation of DAS 28 may also be a reason for this result we found.

Conclusions

Foot deformities and foot-ankle pain are common in RA patients. They may have a negative impact on foot function and quality of life. Therefore, when evaluating RA patients, it is important to pay attention to the feet and to consider radiographic imaging when necessary. Regular clinical and radiological evaluations can improve outcomes by allowing early diagnosis and treatment. Some deformities, especially HV and PP, may adversely affect the patient's foot function. In order to minimize the functional disability of patients and enhance their quality of life, it is important to plan treatments for foot deformities in the early stages of the disease. Future research is needed to confirm these findings and to explore the mechanisms underlying these relationships. Future studies should also consider other factors that may impact foot function and quality of life in RA patients, such as pain, fatigue, and functional limitations.

Conflict of Interest
The Authors declare that they have no conflict of interests.

Ethics Approval
Ethics Committee approval was released from Istanbul Training and Research Hospital and was conducted in accordance with the principles of the Declaration of Helsinki. Number 199/12.

Informed Consent
Patients have provided informed consent for publication.

Availability of Data and Materials
Data and materials are available and can be sent up on request.

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Authors' Contributions
Conceptualization, expression and writing, preparation of original expenditure: İbrahim Halil Erdem, Muharrem Kanar; Data collection, book: İbrahim Halil Erdem, Muharrem Kanar; Writing, reviewing and editing and supervision: İbrahim Halil Erdem, Muharrem Kanar; All authors have read and accepted the published version of the article.

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