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Original Article

A quantitative assessment of the risk of falls in rheumatoid arthritis patients and determination of the risk factors

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ABSTRACT

Objectives: The aim of this study was to compare the risk of falling in patients with rheumatoid arthritis (RA) to the healthy individuals and to identify the factors affecting the risk of falls.

Patients and methods: Between December 2015 and August 2016, a total of 100 consecutive patients with RA (16 males, 84 females; mean age: 49.5±11.1 years; range, 21 to 65 years) and 50 healthy controls (11 males, 39 females; mean age: 34.3±12.7 years; range, 19 to 63 years) were included in this prospective study. The fall risk was evaluated using the Tetrax Portable Balance System. The Health Assessment Questionnaire Disability Index (HAQ-DI), RA disease activity (Disease Activity Score 28 [DAS28], Clinical Disease Activity Index [CDAI], and Simple Disease Activity Index [SDAI]), and Falls Efficacy Scale International (FES-I) were applied to all participants.

Results: The fall risk scores and the FES-I scores were significantly higher in the patients with RA than the control group ($p<0.001$, $p<0.001$). A positive significant correlation was found between the Tetrax values of the patients and age, and the scores of the HAQ-DI, FES, DAS28, DAS28-C-reactive protein, CDAI and SDAI.

Conclusion: Our study results showed higher fall risk scores in patients with RA than healthy individuals an objective computerized technique, and this higher fall risk appeared to be affected by older age, disease activity, and disability.

Keywords: Disease activity, fall risk, rheumatoid arthritis.

Fall is a major health problem in the elderly population, and the consequences of falls are important public health problems.[1,2] Of all unintentional deaths due to injury in the elderly population, two-thirds are the result of falls.[3,4] Falls present a multifactorial etiology, consisting of complex interactions between intrinsic, behavioral, and environmental risk factors. In the normal population, age and age-related comorbidities are known to be the most important risk factors for falls.[5,6] Rheumatic diseases have also been reported as the second most powerful independent risk factor for fall-related injuries in older females.[7]

Rheumatoid arthritis (RA) is a chronic inflammatory rheumatic disease that mainly affects major and minor joints, although its systemic impact and etiology have not been fully elucidated yet. It is the most frequent inflammatory joint disease worldwide, affecting 1% of the global population.[8,9] The disease usually begins slowly and develops insidiously over time. Clinically, the most common symptoms in RA are joint findings of morning stiffness, limitation of movement, pain and swelling. The joints most commonly involved are the metacarpophalangeal, wrists, and proximal interphalangeal joints.[10]

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Previous studies have reported the incidence of falls within one year in the range of 33 to 54% in patients with RA.[11-17] Approximately 68% of RA patients have a higher risk of falling due to disease-related pain, deformities, decreased muscle density, changes in gait, and decreased functional stability.[15] Hip fractures have been reported to increase three-fold in RA patients as a consequence of falling, which may be due to a reduction in bone mass associated with the disease.[18] Although there is a relatively high incidence and significant outcomes in RA patients, there is still an underestimation of falls, which have not been sufficiently investigated in this group. Most previous studies of the risk of falls in cases with RA have used subjective evaluation tools. In the present study, we aimed to evaluate the risk of falling and to identify the potential risk factors of falls using an objective computerized technique in patients with RA.

PATIENTS AND METHODS

This prospective, cross-sectional study was conducted at Atatürk University Training and Research Hospital, Rheumatology outpatient clinic between December 2015 and August 2016. The study included a total of 100 consecutive patients with RA (16 males, 84 females; mean age: 49.5±11.1 years; range, 21 to 65 years) who were diagnosed according to the 2010 American College of Rheumatology (ACR)/European League Against Rheumatism (EULAR) criteria[19] and 50 healthy controls (11 males, 39 females; mean age: 34.3±12.7 years; range, 19 to 63 years). Exclusion criteria were as follows: a history of malignancy or orthopedic surgery, being bedridden or wheelchair-dependent, pregnancy, and lack of co-operation or intolerance of the fall risk evaluations.

A record was made for each patient on presentation of age, sex, duration of illness, fear of falling, number of falls during the last year, additional diseases (hypertension, hypotension, diabetes, stroke, atrial fibrillation, polyneuropathy, osteoporosis, joint replacement, visual disturbances, use of walking sticks and walkers), drugs used, and body mass index (BMI). A detailed physical examination of each patient and routine tests were performed. To evaluate disease activity, Disease Activity Score 28 (DAS28), Clinical Disease Activity Index (CDAI), and Simple Disease Activity Index (SDAI) were used.[20-22] For the evaluation of functions, the Health Assessment Questionnaire Disability Index (HAQ-DI) was applied.

The Falls Efficacy Scale International (FES-I) was applied to the RA patients to evaluate fall efficacy.[23] This short, self-reported scale is an easily applicable measure of the level of anxiety related to falling during any indoor or outdoor activities, irrespective of whether or not it is a habitual activity. The scale comprises 16 items scored using four-point Likert-type responses (1=not at all concerned to 4=very concerned), to give a total score in the range of 16 to 64 points (from a lack of concern to a high level of concern). The FES-I was originally developed with the help of members of the European Prevention of Falls Network.[23] The validity and reliability study of the scale was carried out by Ulus et al.[24] Fear of falling was recorded by the participants as "Yes" or "No" responses.

The Tetrax Interactive Balance System (Sunlight Medical Ltd., Tel Aviv, Israel) was used to assess the fall risk using a technique similar to that in the device user guide. All data are produced by the integral computer software system of the Tetrax static posturography device. The individual stands on four baseplates, which contain force gauges to transmit wave signals, digitally translating the vertical forces on the plates into the computerized system. Using this system, the participants were given full task instructions before starting the evaluation. They stood on the platform as shown by the foot lines, without speaking or moving. For each participant, measurements were taken in eight different positions using the same strategy, sequence, and directions. Each of the eight positions was held for approximately 40 sec; the first position was eyes open, head vertical, on a hard surface; the second position was eyes closed, head vertical, on a hard surface; the third position was eyes open, head vertical, on a soft surface (sponge beneath the feet); the fourth position was eyes closed, head vertical, on a soft surface; the fifth position was eyes closed, head turned to the right, on a hard surface; the sixth position was eyes closed, head turned to the left, on a hard surface; the seventh position was eyes closed, neck completely extended, on a hard surface; and the eighth position was eyes closed, neck completely flexed, on a hard surface.[25] The scores represented the individual's risk of falling.[26]

Statistical analysis

The study power was calculated using the G*power version 3.1.9.2 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany). When effect size (d) was taken as 1.38, and type-I error as 0.05, the post-hoc power was found to be 99.9% for the fall risk assessment.

TABLE 1
Demographic and clinical characteristics of patient and control groups

	Patient group (n=100)			Control group (n=50)				
	n	%	Mean±SD	n	%	Mean±SD	*p*	*p**
Age (year)			49.5±11.1			34.3±12.7	**<0.001**	
Body mass index (kg/m²)			28.5±6.0			26.5±5.0	**0.030**	0.846
Fall Risk Assessment (0-100)			58.4±28.3			26.0±17.1	**<0.001**	**<0.001**
FES-I			21.7±19.7			11.8±4.3	**<0.001**	0.128
Sex							0.367	
Male	16	16		11	22			
Female	84	84		39	78			
Fall history in the last 12 months							0.194	
Yes	23	23		7	14			
No	77	77		43	86			
Fear of falling							**<0.001**	
Yes	54	54		8	16			
No	46	46		42	84			

SD: Standard deviation; FES-I: Falls Efficacy Scale International; * Age adjusted p-values.

Statistical analysis was performed using the IBM SPSS version 19.0 software (IBM Corp., Armonk, NY, USA). The data were checked for normal distribution using the Kolmogorov-Smirnov test. Continuous variables were expressed in mean ± standard deviation or median (min-max), while categorical variables were expressed in number and frequency. The Mann-Whitney U test was used to analyze data between the groups in terms of BMI, RA duration, Tetrax measurement values, and FES-I values. The Kruskal-Wallis and chi-square tests were applied to evaluate the results. The Spearman correlation analysis was used to evaluate correlations between Tetrax and DAS, DAS28, CDAI, SDAI scores. The Tetrax score was determined through linear regression analysis using variables which were significant in the univariate analysis. In the final model, the forward selection method was used and age was kept in the model as a biological factor. A *p* value of <0.05 was considered statistically significant.

RESULTS

Demographic features of the participants are summarized in Table 1. Fear of falling was found to be 54% in the RA group and 16% in the control group (p<0.001). No fall history within the last 12 months was reported by 77% of the patients and 86% of the controls (p=0.194). However, statistically significantly higher fall risk scores were found in the computerized system for the RA group, compared to the control group (p<0.001). Although higher FES-I scores were determined in the patients with RA than the control group (p<0.001), after the adjustment for age, there was no statistically significant difference between the groups (p>0.05).

The correlations between the fall risk assessment using a computerized system and age, BMI, RA

TABLE 2
Correlations between fall risk assessment and specific factors

	Fall risk assessment	
	r	*p*
Age (year)	0.377	<0.001
Body mass index (kg/m²)	0.143	0.081
RA duration (year)	-0.037	0.712
Rheumatoid factor	0.174	0.084
Anti-CCP	-0.020	0.866
HAQ-DI	0.500	<0.001
FES-I	0.477	<0.001
DAS28	0.472	<0.001
DAS28-CRP	0.532	<0.001
CDAI	0.514	<0.001
SDAI	0.483	<0.001

RA: Rheumatoid arthritis; Anti-CCP: Anti-cyclic citrullinated peptide; HAQ-DI: The Health Assessment Questionnaire Disability Index; FES-I: Falls Efficacy Scale International; DAS28: Disease Activity Score 28; CRP: C reactive protein; CDAI: Clinical Disease Activity Index; SDAI: Simple Disease Activity Index.

TABLE 3
Comparisons of the fall risk assessment for clinical parameters in patients

Clinical parameters	n	Mean±SD	*p**
Additional disease			0.118
Yes	76	61.2±27.9	
No	24	49.5±28.2	
Hypertension			0.720
Yes	30	60.1±26.3	
No	70	57.7±29.3	
Hypotension			-
Yes	5	83.2±16.8	
No	95	57.1±28.2	
Diabetes			0.572
Yes	10	63.8±28.1	
No	90	57.8±28.4	
Stroke			-
Yes	3	73.3±46.2	
No	97	58.0±27.8	
Atrial fibrillation			-
Yes	1	72.0±00	
No	99	58.3±28.4	
Polyneuropathy			0.119
Yes	61	62.3±29.1	
No	39	52.3±26.3	
Osteoporosis			0.213
Yes	22	64.9±29.3	
No	78	56.6±27.9	
Joint replacement			-
Yes	2	62.0±53.7	
No	98	58.4±28.1	
Visual impairment			0.420
Yes	18	63.4±27.1	
No	82	57.3±28.6	
Walking aids			-
Yes	3	94.0±10.4	
No	97	57.3±28.0	
Active involvement			-
Yes	2	78.0±31.1	
No	98	58.0±28.3	
DAS28			**0.001**
Remission	16	44.5±15.2	
Low	20	44.5±27.1	
Moderate	46	62.1±27.1	
High	18	76.8±29.9	
DAS28-CRP			**<0.001**
Remission	21	42.1±17.6	
Low	22	45.4±23.3	
Moderate	45	66.6±28.4	
High	12	80.3±27.4	
CDAI			**<0.001**
Remission	8	40.8±16.7	
Low	42	45.7±23.5	
Moderate	30	68.0±25.5	
High	20	77.9±29.2	
SDAI			**<0.001**
Low	24	42.5±19.5	
Moderate	40	51.7±23.9	
High	36	76.5±28.6	

SD: Standard deviation; DAS28: Disease Activity Score 28; CRP: C reactive protein; CDAI: Clinical Disease Activity Index; SDAI: Simple Disease Activity Index; *p values not reported, when the number of cells were ≤5. Mann-Whitney U test or Kruskal-Wallis test.

duration, RF, CCP, HAQ-DI, FES-I, DAS28, DAS28-C-reactive protein (CRP), CDAI, and SDAI results were evaluated (Table 2). Significant positive correlations were found between the fall risk assessment and age, HAQ-DI, FES-I, DAS28, DAS28-CRP, CDAI, and SDAI results. However, no significant correlation was observed between the fall risk and other parameters. A significant correlation was also seen between the age and fall risk, although disease activity was also found to affect fall risk, when RA patients of the same age were compared with each other.

The comparisons between the fall risk assessments and some clinical parameters are shown in Table 3. Disease activity was categorized as remission, low, moderate, or high disease activity according to the disease activity measurements and fall risk was evaluated in these categories. The risk of falls was found to increase, as disease activity increased ($p=0.001$ for DAS28 and $p<0.001$ for DAS28-CRP, CDAI). The results obtained for SDAI, when disease activity was categorized as low, moderate, or high, were similar ($p<0.001$).

In the linear regression analysis related to the Tetrax score, age was kept in the model as it is a biological factor. As the scales of disease activities were correlated with each other, they could not be added to the model at the same. Only DAS28-CRP was statistically significant, with a one-unit increase in DAS28-CRP increasing the Tetrax score by 12.5 units ($\beta=12.49$ and $p<0.001$).

DISCUSSION

In the present study, we observed that RA patients had a higher risk of falling than the control group, and this higher fall risk seemed to be influenced by disease activity.

Falls create a significant burden on healthcare resources worldwide and may have serious consequences such as loss of confidence, injury, and even death.[27] It has been suggested that rheumatic disease is the second most powerful independent risk factor for major falls.[7] Rheumatoid arthritis may constitute a greater risk for falling due to disease-related pain, deformities, decreased muscle density, changes in gait, and decreased functional stability.[27] There has been shown to be a three-fold increase in hip fractures in RA patients due to falling, which may result from a reduction in bone mass associated with the disease.[18] Therefore, evaluating

the risk of fall is critical, and the factors affecting this risk in rheumatological diseases should be identified. Prevention of falls is important in RA, which is the most frequently seen inflammatory joint disease worldwide, affecting 1% of the global population.[8,9]

Although falls are considered to be very common in RA patients, the reasons for falls have not been clarified yet, and the cause-effect relationships remain a matter of debate. A previous study using clinical evaluations demonstrated that RA patients with at least one fall in the last year were older, had a prolonged RA disease period, increased fear of falling, greater HAQ scores, and lower functional level.[28] Unlike previous studies, an objective computerized technique was used in the current study to evaluate the risk of falls, and a higher fall risk was found in the RA group than the control group, regardless of the patient characteristics other than age. Thus, evaluation of the fall risk with an objective method can be considered a strong aspect of this study.

There is a limited number of data regarding the evaluation of falls and fall-related risk factors in cases with RA. In some previous studies, arthritis has been defined as a risk factor,[11,12,14,15] although the underlying causes of joint problems have not been clearly understood. In the current study, which can be viewed as a pilot study owing to the objective method used, several variables were found to be significantly associated with a higher fall risk in cases with RA. Age was defined as an independent risk factor in this study. In previous studies, age was evaluated as a variable affecting falls in RA patients, although no significant correlation was determined between age and fall frequency.[11,27] However, in the current study, age was seen as a significantly correlated factor to the fall risk similar to studies on healthy older adults, which reported a higher fall risk with increasing age.[5,6] This result can be attributed to the objective method used in this study. However, as the association between age and fall for RA patients remains a controversial issue, further studies are required. Moreover, no relationship between fall risk and disease duration was observed in the current study, which is consistent with the results obtained by Hayashibara et al.[13]

Unlike other studies, the fear of falling was questioned verbally in the current study and it was calculated according to the FES-I. Although 23% of the patients had a history of falling, the fear of falling was quite high in 54%. In a similar study design, Böhler et al.[29] reported that 46.2% of RA patients had a fear of falling. In another study, Akyol et al.[30] found fear of falling in 58% of patients with RA, even in patients without a fall history. The fear of falling may have serious social effects, as patients may start to avoid daily living activities, leading to depression and diminished quality of life.[31] It has also been shown that fear of falling is associated with falls in the future.[32,33] In the current study, factors related to the risk of falling were examined, and only the fear of falling was found to be significant according to the FES-I.

In the present study, the effect of disease activity on falls in RA patients was evaluated using the CDAI, SDAI, DAS28 and DAS28-CRP. A significant correlation was found between the CDAI, SDAI, DAS28 and DAS28-CRP and fall risk assessment. Similarly, fall risk assessment was significantly correlated with the HAQ-DI scores, which assessed the overall health status of patients. In patients with high HAQ-DI scores, care should be taken in terms of falls and necessary precautions should be taken. In another study where the fall risk was assessed with the Tinetti test (TIT), timed up-and-go test (TUG), chair-to-stand test (CRT), tandem gait and tandem posture test, patients with a high disease activity obtained worse results.[29] Although age is the most important factor in falls and fear of falls, disease activity was also found to affect the fall over time.

Furthermore, we examined the association between comorbid diseases and fall risk. The parameters evaluated statistically were the presence of additional disease, hypertension, hypotension, diabetes, stroke, atrial fibrillation, polyneuropathy, osteoporosis, joint replacement, visual impairment, use of walking aids, and active systemic involvement. According to the results, we showed no significant relationship between comorbid diseases and fall risk, which is completely contrast to the result of study showing significant consequences for osteoporosis and an increased risk of falling.[15] It is also well known that RA causes periarticular and generalized osteoporosis,[34,35] and cases with RA are at a greater risk of fractures than the general population.[1,36,37] In these results, bone mineral density was not examined in the patients, and it may be effective to accept patients with low bone mineral density as osteoporosis when questioning the patients. Another factor may be that osteoporosis in the current study was mostly not very advanced and there were often no accompanying fractures. In the future studies, it would be valuable to examine osteoporotic RA patients with a history of fracture for any significant risk.

The data of previous studies investigating the relationship between disease activity and fall incidence are somewhat contradictory, which could be related to the examination time. The objective of the current study was to identify and evaluate the risk of falling rather than the prevalence or incidence of falling. Therefore, in this study, the risk of falling was evaluated at the same time as disease activity, which constitutes a significant superiority over other studies. In addition, most other studies used "self-reported" falls data and, thus, the use of an objective technique in evaluating falls in patients with RA can be considered to increase the importance of this study.

One of the main limitations of the present study is the use of activity assessment forms such as DAS28, CDAI and CDAI, which measure the number of painful and swollen joints in the upper extremity. However, the degree of pain painful and swollen joints of the lower extremity was separately evaluated in many previous studies of falls. Further large-scale, comprehensive studies are needed to confirm these findings.

In conclusion, our study results showed that, with an objective computerized method, higher fall risk scores were obtained in patients with RA. This higher fall risk seemed to be influenced by older age, disease activity, and disability. As there are known to be serious consequences of falls, particularly in this patient population, this risk evaluation and the implementation of preventative strategies should be a part of RA general management.

Ethics Committee Approval: The study protocol was approved by the Atatürk University Faculty of Medicine Clinical Research Ethics Committee (date/no: 03.12.2015/B.30.2.ATA.0.01.00/102). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each participant.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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