Clinical and Experimental Health Sciences

An Evaluation Of The Relationship Between Falls, Osteoporosis And The Parkinson's Disease Rating Scale In Patients With Parkinson's Disease

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Received: 12.05.2022 **Accepted:** 03.06.2024

ABSTRACT

Objective: The purpose of this study is to examine conditions such as balance disorder, risk of falling, fear of falling, vitamin D deficiency and osteoporosis in people with Parkinson's Disease (PD), and their association with the Movement Disorders Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS) sub-components, which are used to follow-up these patients.

Method: The study comprised 38 patients who were followed up for idiopathic PD. All the patients' demographic data, falls efficacy scale, number of falls within the last year, history of fractures, Berg Balance Scale, the MDS-UPDRS sub-components, vitamin D levels, and bone mineral densitometry values were recorded.

Results: There was a positive correlation between the MDS-UPDRS Part I and the number of falls and the history of fractures, and a positive correlation with the Hoehn and Yahr scale, and the MDS-UPDRS Part II, III and total and the Berg Balance Scale, the Falls Efficacy Scale, and the number of falls. Our study found that the bone mineral densitometry values for the femoral neck were lower in women than in men, and there was a positive correlation between the bone mineral densitometry values for the femoral neck and the body mass index. A positive correlation was established between levodopa use and the falls efficacy scale.

Conclusion: Falls, imbalance, osteoporosis are life-threatening conditions in patients with PD. This study established that the MDS-UPDRS, used to follow-up patients, was associated with these conditions. It is believed that this assessment method may also give an idea about these conditions in PD patients who are followed up using this scale.
Keywords: Balance, falls, Parkinson's disease, bone mineral density, vitamin D

1. INTRODUCTION

Parkinson's Disease (PD) is a chronic progressive neurodegenerative disease with motor and non-motor symptoms, characterized by the loss of dopamine-producing neurons in the basal ganglia. The prevalence has been reported as high as 15:1,000 in some populations (1). PD is one of the common neurological diseases that cause recurrent falls, and falls pose a significant problem with these patients (2). Studies show that almost 70% of patients fall at least once a year (3). Falls cause patients to develop various conditions such as fear of falling and fractures, as well as extensive costs to the healthcare system due to fall-related diseases (2). The higher incidence of osteoporosis in patients with PD (4) results in a higher rate of fractures due to these patients' falls. Several studies have been conducted on why osteoporosis is common among these patients. Many factors such as inactivity, loss of muscle strength, reduced body mass index, vitamin D deficiency, and nutrition have been reported to be involved in the increased incidence of osteoporosis (4). Osteoporosis and the increased risk of falls due to various reasons reduce the quality of life of patients with PD, as well as isolating patients due to additional complications. Considering these potential adverse effects, balance disorder, risk of falls and osteoporosis has become extremely important in patients with PD.

DOI: 10.33808/clinexphealthsci.1114826

Assessing changes in the health status of patients and determining the severity of the disease are vital in the follow-up of diseases. There are several scales used to assess the motor and non-motor symptoms of patients with PD. Among these are the "Parkinson's Disease Questionnaire-39" to assess the patients' quality of life, the "Non-motor Symptoms Scale" to assess non-motor symptoms, and the "Clinical Impression of Severity Index" to assess the quality of life and disability (5). Likewise, the Unified Parkinson's Disease Rating Scale is of great importance in the follow-up of these patients because it is a comprehensive and reference scale. It was revised in 2008 due to its limited assessment of non-motor symptoms (6). Despite the difficulty of use in practice as it is time-consuming, a complete version of the scale has been created that assesses the disease in every aspect, determines the course of the disease, and is more homogeneous and comprehensive.

In this study, our objective was to examine the association between the sub-components of the Movement Disorders Society Unified Parkinson's Disease Rating Scale (MDS-UPDRS), one of the important assessment scales for the disease, and balance, falls, the falls efficacy scale, history of fractures, vitamin D levels and bone mineral densitometry (BMD) values, which to the best of our knowledge has never been investigated.

2. METHODS

Thirty-eight patients who presented to the Physical and Rehabilitation Medicine Outpatient Clinic and were diagnosed with PD according to the United Kingdom Parkinson's Disease Society Brain Bank criteria were included in the study. The study included patients followed up between 2017 and 2019. A retrospective analysis was made of the patients' demographic data, using the hospital data recording system. Fall history and tests were carried out by inviting patients to the hospital. The number of falls within the previous one year and the history of fractures confirmed by the hospital were recorded. The history of fractures reported by the patients were confirmed by examining their medical records. The study protocol was approved by the University's Ethics Committee (No:02/2021-3).

2.1. Inclusion Criteria

The inclusion criteria were established as follows: ≥ 40 years of age, having idiopathic PD, being followed up by the Neurology outpatient clinic for PD for at least one year and having a stable disease, a Mini-Mental test score of >24, and a PD (Hoehn and Yahr) stage of ≤3.

2.2. Exclusion Criteria

Patients with renal and hepatic failure, patients with thyroid or parathyroid dysfunction, patients diagnosed with cancer, patients with cognitive impairment, patients receiving osteoporosis or hormone replacement therapy, and patients who had deep brain stimulation surgery for PD were excluded from the study. Patients followed up for secondary parkinsonism were not included in the study. Patients with a history of spinal degeneration (stenosis, myelopathy) that may affect falling and balance, and additional neurological disease that may affect balance were not included in the study.

The study patients' demographic data, body mass index (BMI), medications, duration of disease, stage of disease (Modified Hoehn & Yahr scale), comorbidities, assistive devices, number of falls within the previous one year, history of fractures, the falls efficacy scale scores, vitamin D levels, and bone densitometry data were recorded.

The Berg Balance Scale (BBS), developed by Berg et al. (7), is an instrument to assess balance and to determine the risk of falls in patients, and the Turkish validity and reliability study of the scale was conducted by Şahin et al. in 2008 (8). In the 14-item Berg Balance test, the ability to perform the activity in each item is rated on a 5-point scale (0–4), with 0 indicating "unable to do the task" and 4 "able to complete the task safely and independently". The test shows motor functions, disease stage, daily living capacity, postural stability and the risk of falling in PD patients, and has a total score ranging from 0 to 56. Higher scores indicate greater balance. A score of 0–20 indicates balance disorder, a score of 21–40 an acceptable balance, and a score of 41–56 a good balance. Our study used the values of the Berg Balance test that was administered to the PD patients by the same physician.

The Falls Efficacy Scale (FES) is a questionnaire developed by Tinetti et al. (9) to assess the fear of falling, and the Turkish validity study was conducted by Ulus et al. (10). The Falls Efficacy Scale asks the person how confident he/she feels when reaching into cabinets, preparing a meal, walking around the house, getting in and out of bed, answering the door or phone, getting in and out of chair, getting dressed or undressed, doing light household chores, and doing simple shopping. The person is asked to rate each item from 1 to 10 (1: very confident, 10: not confident at all), and the per item ratings are added, giving a total score ranging from 10 (low fall-related efficacy) to 100 (high fall-related efficacy). It has been proven that the validity of this scale is sensitive to changes in fear (11). Our study used the questionnaire forms of the Falls Efficacy Scale that were assessed individually for the patients by the same physician.

The Unified Parkinson's Disease Rating Scale (UPDRS) was developed by members of the UPDRS Development Committee in 1987 and was revised in 2008 due to its limitations (6). The Turkish validity and reliability study of the scale was conducted by Akbostancı et al. (12). The scale determines patients' mental state, activities of daily living, motor functions and treatment-related complications in four parts. The first three parts of the scale are scored from 0 (none/normal) to 4 (severe). The first part consists of 4 items assessing mentation, behavior and mood, the second part 13 items assessing activities of daily life, and the third part 14 items assessing motor examination. The fourth part

assesses motor complications. Higher scores indicate poorer condition. Our study used the data records determined by the same physician through examination.

The vitamin D levels of all patients were measured by the Beckman Coulter UniCel DxI 600 (Beckman Coulter, CA, USA) immunoassay analyzer using the kits of the same brand. Bone mineral density of all patients was assessed by dual energy x-ray y absorptiometry (DXA). The BMD measurements for the L1–L4, femoral neck, and total femur and the T-scores (Hologic QDR 4500 W, Hologic Inc., Bedford, Massachusetts, USA) acquired within the last one year were evaluated.

The DXA scan acquisition and analysis were performed according to the ISCD recommendation for whole body analysis (13). The vitamin D and BMD levels obtained using these methods were used.

Table 1. *Demographic characteristics of Parkinson's Disease patients*

	Total N: 30	Female N: 19	Male N: 19
Age (years)*	68 ± 7.7	67.87 ± 6.4	68.63 ± 9
Levodopa (n ,%)	28 (73)	13 (68)	15 (78)
Comorbidity (n, %)	30 (78)	15 (78)	15 (78)
Surgery (n, %)	24 (63)	6 (31)	11 (57)
Assistive device (n) Canes Forearm crutches	 7 3	 3 3	 4
Length of follow-up (months)*	56.63 ± 55	73.68 ± 69.4	39.58 ± 27.8
BMI – kg/m²**	28.73 (19.72–38.27)	30.29 (20.57–38.27)	28.73 (19.72–36.05)
H&Y stage (n) Stage 1 Stage 1.5 Stage 2 Stage 2.5 Stage 3	 1 3 16 16 2	 1 1 8 8 1	 2 8 8 1

*BMI: body mass index, H&Y: Hoehn and Yahr, *: mean ± standard deviation, **: median (min–max)*

2.3. Statistical Analysis

Statistical analysis of the study data was conducted using software PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc. The normality of the study data was tested using the Shapiro-Wilk test. The continuous variables were expressed as mean ± standard deviation or median (minimum–maximum) and categorical variables were presented as frequency and percentage. The continuous variables were compared using the Independent Samples t-test or Mann-Whitney U test, while categorical variables were compared using Pearson's Chi-square test or Fisher's Exact Chi-Square test. A p value less than.05 was considered statistically significant for all tests. Pearson's or Spearman's correlation coefficients were used to calculate the degree of association between variables. A 'p' value of <.05 was considered statistically significant. The independent samples t test was used to compare the FES between those who used levodopa and those who did not. The linear multiple regression method was used to examine the relationship between the Berg Balance and Fall Efficacy Scale and the MDS-UPDRS sub-components.

Table 2. *Comparison of the characteristics of Parkinson's Disease patients according to gender*

	Total N: 38	Female N: 19	Male N: 19	p
Berg Balance Scale*	37.45 ± 6.7	37.89 ± 5.8	37.68 ± 7.5	.280
The Falls Efficacy Scale*	58.78 ± 16.0	58.47 ± 16	57.05 ± 16.5	.881
Spine BMD T-score**	-1.2 (-3.6–4.5)	-1.5 (-3.6–0.3)	-1.1 (-3.6–4.5)	.348
Vitamin D (ng/ml)*	20.26 ± 7.3	21.49 ± 8	19.81 ± 6.2	.403
MDS-UPDRS 1**	10 (5–30)	11 (5–25)	10 (7–30)	.769
MDS-UPDRS 2*	14.92 ± 5	14.36 ± 3.6	15.47 ± 5.5	.072
MDS-UPDRS 3*	30.60 ± 12.7	30.42 ± 13.3	30.78 ± 12.5	.975
MDS-UPDRS 4**	0.50 (0.00–8)	2 (0–8)	0 (0–7)	.511
Femoral Neck BMD T-score**	-0.7 (-2.8–2.9)	-1.45 (-2.8–2.9)	-0.6 (-2.1–0.5)	**.032 (p⁺)**

p⁺<0.05, p values of other variables are insignificant
*BMD: bone densitometry, MDS-UPDRS: Movement Disorders Society-Unified Parkinson's Disease Rating Scale, *: mean± standard deviation/ Independent Samples t-test, **: median (min–max)/ Mann-Whitney U test*

3. RESULTS

Of 38 study patients with PD, the mean age was 68 ± 7.7 years and the BMI was 28.73 kg/m². The demographic data of the patients are presented in Table 1.

All patients had osteopenia with a lumbar BMD T-score of –1.2, and had vitamin D deficiency with a vitamin D level of 20.26 ng/ml. Five patients had a history of fractures. Of the five patients with a history of fracture, three were female and two were male. Two of the patients had tibial fractures, one had a hip fracture, one had a T12 compression fracture, and one had a phalangeal fracture.

The mean BBS score was 37.45 ± 6.7, suggesting that the patients had acceptable balance. The patients' stages, according to the Modified Hoehn and Yahr Stage (H&Y) that indicate the PD stage and mean MDS-UPDRS scores, are presented in Tables 1 and 2.

The comparison between female and male genders according to the analyzed parameters is shown in Table 2, and there wasn't significant gender difference in the number of falls (p=.379) and the history of fractures (p=.636). The femoral neck BMD value was significantly lower in female patients than in males (p =.032).

When the relationship between disease stages and osteoporosis parameters was examined, a significant positive correlation was found between femoral neck bone densitometry value and BMI, while there was no significant

association with other parameters; duration of disease follow-up, H&Y stage, and MDS-UPDRS scores.

The patients' BBS score was negatively correlated with H&Y stage, and UPDRS Part II, Part III, and total scores. The falls efficacy scale score was positively correlated with H&Y stage, and MDS-UPDRS Part II score, Part III score, and total scores as shown in Table 3.

The number of falls was positively correlated with H&Y stage, and MDS-UPDRS Part I, II, III, and total scores.

When the relationships among the BBS score, the FES score, and the number of falls were examined, a negative correlation was established between the BBS score and the Falls Efficacy Scale score, and a positive correlation between the Falls Efficacy Scale score and the number of falls. The FES score of the patients using levodopa was found to be significantly higher than the patients not using the drug (p=.034).

When analyzed with the linear multiple regression method, it was seen that MDS-UPDRS Part III score, one of the MDS-UPDRS sub-components, had a high effect on the Berg Balance Scale (p=.03), and the MDS-UPDRS Part II score on the FES (p=.04).

Table 3. *Assessment of characteristics of Parkinson's Disease patients and parameters related to osteoporosis and falls*

	Femoral Neck BMD (g/cm²)	Berg Balance Scale	The Falls Efficacy Scale	Number of Falls
BMI (kg/m²)	r:0,365[1] p⁺	Ø[2]	Ø[2]	Ø[1]
H&Y	Ø[1]	r:-0,614[1] p⁺⁺⁺	r:0,573[2] p ⁺⁺⁺	r:0,351[1] p⁺
MDS-UPDRS I	Ø[1]	Ø[2]	Ø[2]	r:0,426[1] p⁺
MDS-UPDRS II	Ø[2]	r:-0,636[2] p⁺⁺⁺	r:0,568[2] p⁺⁺	r:0,499[2] p⁺⁺
MDS-UPDRS III	Ø[2]	r:-0,694[1] p⁺⁺⁺	r:0,492[2] p⁺⁺	r:0,445[1] p⁺⁺
MDS-UPDRS IV	Ø[1]	Ø[2]	Ø[2]	Ø[1]
MDS-UPDRS Total	Ø[1]	r:-0,553[1] p	r:0,361[2] p⁺	r:0,486[1] p⁺⁺

p< .05, p< .01, p< .001

[1]: Pearson's correlation test, [2]: Spearman's correlation testBMD: bone mineral density, BMI: body mass index, H&Y: The Hoehn and Yahr scale, MDS-UPDRS: Movement Disorders Society-Unified Parkinson's Disease Rating Scale, r:rho, Ø:no correlation

4. DISCUSSION

The mean FES score of the study patients was 58.78 ± 16.01. Considering that the cut-off point is 24 for the Turkish population, the patients had a high level of anxiety (10). This finding suggests that patients have to continue their lives with the fear of falling and the associated problems. Several risk factors have been identified for falls in patients with PD. The examination of medications among the risk factors has revealed that the dose of levodopa and the use of benzodiazepam can be risk factors (14,15) study, there was a positive correlation between the use of levodopa and the falls efficacy scale. This finding may serve as an indicator for informing patients and taking necessary precautions regarding conditions with negative impact on life such as falls in PD patients who are on levodopa.

Studies have been conducted to investigate the risk factors for falls in patients with PD. Previous studies that compared patient characteristics between those who fell and who did not fall reported that the duration of the disease, H&Y, MDS-UPDRS Parts II, III and total might be risk factors (15,16). Our study established a positive correlation between the H&Y stage and the BBS, the FES, and the number of falls in patients who were evaluated similarly, despite the different methodology.

The MDS-UPDRS Part I was positively correlated with the number of falls, suggesting that this assessment scale used to follow-up patients means more than following up the patients' disease criteria. The study by the Parkinson Study Group reported that the UPDRS scoring was used in many studies, and the survey conducted with the experts revealed that the first part of this scale was used at a rate of 60% (17). In fact, the use of this scale may create a chance to benefit from the necessary research, precaution and physical therapy methods in order to prevent falls and fractures before the occurrence of a fall and fracture for patients with an increase in this scale during the follow-up. However, considering that this part of the scale assesses symptoms for conditions such as anxiety, depression, and psychosis, it is believed that the treatment of these conditions may prevent negative situations such as falls and fractures.

There was a negative correlation between MDS-UPDRS Parts II, III and total scores, and the BBS, and a positive correlation between the FES and the number of falls. Similar to our study, the study by Tassorelli (18) et al. established a negative correlation between the MDS-UPDRS total and BBS scores, but did not examine the association with the subscales. The authors found vitamin D levels and the Berg Balance Scale scores to be positively correlated, which was not established in our study. Our study, in turn, determined that the increased Parts II, III and total scores of the patients could be considered as a factor warning physicians about conditions such as falling, risk of falls, and balance disorder.

In our study, the correlation between all MDS-UPDRS parts, bone densitometry and vitamin D levels was examined, revealing no correlation between these parameters. Unlike our study, a study conducted in 2020 established a negative correlation between MDS-UPDRS Parts II, III, H&Y staging and vitamin D levels, femoral neck and spine total bone densitometry values (19).

The mean vitamin D level of the study patients with PD was 20.26 ng/ml, indicating that these patients had vitamin D deficiency. In our study group, the femoral neck BMD value was significantly lower in the female patients. These findings

may suggest that patients with PD are at risk for bone mass loss, with a greater risk in women. A meta-analysis that was conducted in 2013 to evaluate the risk for osteoporosis in patients with PD reported that male patients were at greater risk for osteoporosis compared to female patients in the studies reviewed (20) and that, unlike male patients, female patients had lower hip and spine BMD levels than healthy individuals. Our study also found the femoral neck BMD to be lower in female patients. Studies report lower bone mineral density values in patients with PD than age-matched healthy individuals regardless of gender (21); however, our comparison between both genders revealed that female gender might have an increased risk for hip fracture. Similar to our study, a previous study conducted in Turkey reported higher BMD in men compared to women (22). It should not be forgotten that individuals diagnosed with PD based on these results should be evaluated for vitamin D deficiency and osteoporosis as they are at risk for these diseases, besides the follow-up of neurological diseases.

It has been demonstrated that PD patients with a higher disease severity have a lower body mass index (23), while low BMI is known to be a risk factor for osteoporosis and fractures (24). In fact, a previous study established that female gender, low body weight, and low vitamin D were significantly correlated with hip and spine BMD levels in patients with PD, and were associated with bone loss (25). Our study found a positive correlation between BMI and femoral neck BMD, with lower femoral neck BMD in female patients. Weight loss in patients may be a warning sign for following up both PD and osteoporosis, and the severity of both diseases. Following up the patients for weight loss, and muscle mass loss and recommending appropriate exercise programs to the patient may be one of the important tools in preventing the loss of muscle mass.

The present study shows that patients with PD experience fear of falling, balance disorders, and vitamin D deficiency. It was established that the MDS-UPDRS, which has an important place in the follow-up of PD patients, could guide physicians in predicting conditions such as balance disorders, fear of falling and falls, beyond the severity of the disease. However, the lack of a control group is the major limitation of our study.

5. CONCLUSION

Falls, imbalance, and osteoporosis are life-threatening conditions in patients with PD. This study established that the MDS-UPDRS, used to follow-up patients, was associated with these conditions. In order to prevent these feared situations during the follow-up of patients, it is important to follow up with this scale. It is believed that this assessment method may also give an idea about these conditions in PD patients who are followed up using this scale.

Acknowledgements: *None*
Funding: *The authors received no financial support for the research and/or authorship of this article.*
Conflict of interests: *There is no conflict of interest in the authorship or publication of this article.*
Ethics Committee Approval: *This study was approved by University's Ethics committee of 10.02.2021-2021/03. (Date and number of approval)*
Peer-review: *Externally peer-reviewed.*
Author Contributions:
Research idea: A.K.O.
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Acquisition of data for the study: E.A.D.
Analysis of data for the study: A.K.O.
Interpretation of data for the study: S.C.
Drafting the manuscript: A.K.O.
Revising it critically for important intellectual content: S.S.
Final approval of the version to be published: S.O.C.

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How to cite this article: Keleş Önal A, Özdolap Çoban Ş, Sarıkaya S, Acıman Demirel E, Çekiç S. An Evaluation Of The Relationship Between Falls, Osteoporosis And The Parkinson's Disease Rating Scale In Patients With Parkinson's Disease. Clin Exp Health Sci 2024; 14: 525-530. DOI: 10.33808/clinexphealthsci.1114826