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Effects of Motor Freezing on Balance, Activity-Specific Balance Confidence, and Quality of Life in Patients with Parkinson's Disease

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Abstract

Aim: The aim of this study is to evaluate the impact of motor freezing blocks on balance control, activity-specific balance confidence (ABC), and quality of life in patients with idiopathic Parkinson's disease (PD).

Methods: The freezing of gait questionnaire (FOG) was employed to categorize the participants into groups according to the presence (group 1) or absence (group 2) of motor freezing blocks. The balance of the participants was evaluated using the Tinetti Balance and Walking, and the Tandem Stance and Walking test. Activity confidence was assessed using the ABC scale, while quality of life was evaluated using the Parkinson's Disease Questionnaire-8 (PDQ-8).

Results: A total of 74 individuals with PD were included in the study, comprising groups 1 (n = 38) and 2 (n = 36). A comparison of the Tinetti balance and walking score, Tandem stance and step score, ABC-scale, and PDQ-8 scores of group 1 and group 2 revealed a significant difference between the groups ($p<0.05$), with no difference observed in the Tandem gait score ($p=0.615$). A correlation was observed between freezing and other parameters ($p<0.05$), except the tandem walking score ($p=0.994$).

Conclusion: Individuals with PD who experience motor freezing often suffer from more severe balance impairment, decreased self-confidence, and a significantly reduced quality of life.

Keywords: Activity, Balance, Freezing, Parkinson's disease, Quality of life

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Parkinson Hastalığında Motor Donmanın Denge, Aktiviteye Özgü Denge Güveni ve Yaşam Kalitesi Üzerindeki Etkileri

Öz

Amaç: Bu çalışmanın amacı, idiyopatik Parkinson hastalığı (PH) olan hastalarda motor donma bloklarının denge kontrolü, aktiviteye özgü denge güveni (ABC) ve yaşam kalitesi üzerindeki etkisini değerlendirmektir.

Yöntemler: Katılımcıları motor donma bloklarının varlığına (grup 1) veya yokluğuna (grup 2) göre gruplara ayırmak için yürürken donma ölçeği (YDÖ) kullanılmıştır. Katılımcıların dengesi Tinetti Denge ve Yürüme ile Tandem Duruş ve Yürüme testleri kullanılarak değerlendirilmiştir. Aktivite güveni ABC ölçeği kullanılarak, yaşam kalitesi ise Parkinson Hastalığı Anketi-8 (PHA-8) kullanılarak değerlendirilmiştir.

Bulgular: Çalışmaya grup 1 (n = 38) ve grup 2 (n = 36) olmak üzere toplam 74 PH'li birey dahil edilmiştir. Grup 1 ve grup 2'nin Tinetti denge ve yürüme skoru, Tandem duruş ve adım skoru, ABC ölçeği ve PHA-8 skorları karşılaştırıldığında, gruplar arasında anlamlı bir fark olduğu ($p<0.05$), Tandem yürüme skorunda ise bir fark olmadığı görülmüştür ($p=0.615$). Tandem yürüme skoru hariç ($p=0,994$), donma ile diğer parametreler arasında bir korelasyon gözlenmiştir ($p<0,05$).

Sonuç: Motor donma yaşayan PH'li bireyler genellikle daha ciddi denge bozukluğu, özgüvende azalma ve önemli ölçüde düşük yaşam kalitesinden muzdariptir.

Anahtar kelimeler: Aktivite, Denge, Donma, Parkinson hastalığı, Yaşam kalitesi.

INTRODUCTION

Parkinson's disease (PD) is a progressive neurodegenerative disease with an increasing prevalence and complex genetic and molecular features. The disease is characterized by a range of motor and non-motor symptoms[1]. Freezing is a motor symptom characterized by an inability to take steps or excessively small steps when initiating or turning to walk[2]. It is among the most prevalent and morbid gait disorders associated with PD, affecting 26% of individuals with mild PD and 80% of those with severe PD[3]. The phenomenon of freezing is initiated by a number of factors, including initial hesitation, turning, dual tasking, and the act of passing through doorways[4]. In patients with PD who have suffered from freezing, balance tests have also been demonstrated to be impaired, and self-confidence tests have also been shown to be low[5,6]. Individuals who experience frequent losses of balance and falls may experience feelings of insecurity during activities. A number of studies have demonstrated that freezing has a profound and enduring impact on health-related quality of life (HRQoL)[7,8]. As the time of onset of freezing is uncertain and the efficacy of pharmacological, rehabilitative and surgical treatments is limited, it is evident that the QoL will be significantly diminished, particularly in terms of social participation and activities. Furthermore, freezing has been demonstrated to increase the likelihood of a fall[9].

Freezing is a significant challenge for patients and their families, limiting in daily activities, causing a decline in QoL, and an increasing the risk of falls. This study aimed to compare the balance, activity-specific balance confidence, and QoL of patients with PD in the presence and absence of freezing, a highly prevalent and debilitating symptom.

METHOD

Design

This is a cross-sectional study

Setting and Participants

The study included individuals diagnosed with idiopathic PD, aged 50 years and older, with a

Mini-Mental Status Examination (MMSE) score of 24 and above, a Modified Hoehn & Yahr Scale (MHYS) score between 1-3, and who could walk independently on level ground. Individuals with concomitant neurologic disease, uncooperative behavior, significant musculoskeletal disorders, and vascular lower extremity pathology were excluded from the study. The patients with PD who participated in the study were divided into two groups: those who experienced motor freezing blocks were included in Group 1, and those who did not experience motor freezing blocks were included in Group 2 .2 This study was conducted at the Neurology Outpatient Clinic of Nigde Omer Halisdemir University Training and Research Hospital in Turkey. Before the study, all participants were informed in detail about the study, and their written informed consent was obtained.

Data Collection Tools

Motor staging of PD was assessed using the Modified Hoehn & Yahr Scale (MHYS) and the Unified Parkinson's Disease Rating Scale (UPDRS). After collecting demographic data, the Freezing of Gait (FOG)10 scale was used to evaluate the presence of motor freezing. Balance was assessed through the Tinetti Balance and Gait Test11 and the Tandem Stance[12] and Gait Test[13]. The Activity-Specific Balance Confidence Scale (ABC-scale)[14] measured patients' balance confidence. Lastly, quality of life (QoL) was evaluated using the Parkinson's Disease Questionnaire-8 (PDQ-8)[15].

Demographic Data Form

To ascertain the demographic characteristics of the patients, a series of questions were posed regarding age, gender, height, weight, and body mass index (BMI). In addition, the occupations, educational status, and marital status of the patients were obtained. Regarding the medical history of the patients, the duration of the disease, medical history, and medications used were recorded.

Freezing of Gait Scale

The Freezing of Gait Scale, a widely used instrument in the literature, was employed to evaluate freezing. Patients who exhibited a motor freezing period were included in Group 1[10].

Tinetti Balance and Gait Test

Patients' balance was assessed using the 'Tinetti Balance and Gait Test'. The Tinetti Balance and Gait Test provides useful information about an individual's ability to perform a variety of functional tasks comfortably[11]. This test consists of two parts with a total of 16 questions. In the first part there are nine questions assessing balance and in the second part there are seven questions assessing gait. Each section is scored separately and in total. A total score of 18 or below after the Tinetti Balance and Gait Test indicates a high risk of falling; 19–24 points indicate a moderate risk of falling; and scores above 24 indicate a low risk of falling[11,16]. A Turkish validity and reliability study was conducted by Ağırcan in 2009[17].

Tandem Stance Test

A tandem stance test was applied to evaluate static balance. During the test, the individual was asked to position the heel of one foot on the tip of the other foot. Those unable to do this independently were assisted, and their feet were brought to the desired position. While the individual maintained this position without support, the time until the individual's balance was disturbed was recorded with the help of a stopwatch. For individuals who did not exhibit any balance issues, the test was continued until 30 seconds had elapsed[12].

Tandem Gait Test

The Tandem Walking Test was employed to assess dynamic balance. Participants were instructed to walk ten steps at a comfortable pace in a straight line, wearing comfortable shoes, with the heel of one foot touching the toe

of the other foot and the hands on the chest. The elapsed time was recorded. The total number of steps taken by individuals who could not complete ten steps was also recorded[13].

Activity Specific Balance Confidence Scale

The Activity Specific Balance Confidence Scale (ABC-scale) assessed patients' balance confidence during functional activities. The scale was developed by Powell and Myers in 1995[14]. The scale comprises 16 questions about activities of daily living, both within and outside the home. Respondents are asked to rate their confidence in the activity on a scale of 0 to 100% for each question. Low scores indicate a lack of confidence in performing the activity in question. Conversely, high scores indicate a high level of balance and confidence. The Turkish validity and reliability study of the scale was conducted by Ayhan et al[18].

Parkinson's Disease Questionnaire-8

The abbreviated form of the PDQ-39 comprises one question selected from each of the eight domains of the PDQ-39: activities of daily living, physical discomfort, cognition, communication, emotional well-being, mobility, social support and stigma. The scores of the answers to the questions are summed and calculated. An increase in the total score of the questionnaire indicates a worsening quality of life[15]. Turkish validity and reliability study was conducted by Kahraman et al. in 2018[19].

Unified Parkinson's Disease Rating Scale

A motor evaluation of the patients was conducted using the UPDRS scale. This scale was developed to assess motor performance, mental and emotional state, and activities of daily living in patients with PD. It also evaluates motor fluctuations, dyskinesias and autonomic dysfunction. The scale comprises four sections and 42 items. The first part assesses non-motor features of the disease, including thoughts, behaviors and affect. The second part consists of activities of daily living. The third section encompasses a motor examination, while the fourth section addresses complications associated with treatment[20]. Only the motor examination section was performed in the patients included in the study.

Modified Hoehn-Yahr Scale

The Hoehn and Yahr scale, developed by Margaret Hoehn and Melvin Yahr in 1967, is a staging system for PD. The scale comprises eight stages, and it is well established that the severity of symptoms increases as the disease progresses[21]. Individuals with MHYS 1-3 were included in the study. All subjects gave written informed consent in accordance with the Declaration of Helsinki and approval was obtained by the Ethics Committee of Nigde Omer Halisdemir University Non-Interventional Clinical Research (Project No: 2022-106).

Statistical Analysis

A post-hoc power analysis was conducted on data from the study, which included 'Tinetti Gait Test' of 38 individuals with motor freezing and 36 individuals with PD without motor freezing. The analysis was performed with an effect size of $d = 1.342$ and an (α) of 0.05, (1-β) in 99% power. The statistical analysis was conducted using SPSS 26.0 (IBM SPSS Statistics 26 software, Armonk, NY; IBM Corp.). The mean and standard deviation values were calculated for normally distributed continuous variables, while categorical variables were defined by frequency and percentage. The data for groups 1 and 2 were analyzed using the independent sample t-test, one of the parametric methods. The differences between categorical variables were analyzed by chi-square analysis. Pearson correlation analysis was employed to elucidate the relationship between quality of life, activity-specific balance confidence, and motor freezing and balance.

RESULTS

A total of 74 individuals with idiopathic PD were included in this study, comprising 38 individuals with freezing (group 1) and 36 individuals without freezing (group 2). The mean age of group 1 was 72.34±9.49 years, while the mean age of group 2 was 69.94±7.78 years. The gender distribution of group 1 was 12 females (31.6%) and 26 males (68.4%), while group 2 had 11 females (30.6%) and 25 males (69.4%). In group 1, 37 patients reported an average of 3.56±2.57 falls in the previous year, while ten patients in group 2 reported an average of 1.20±0.42 falls in the previous year. Please refer to Table 1 for further demographic and descriptive information.

When the Tinetti balance score, Tinetti gait score, Tinetti total score, Tandem stance score, Tandem gait score, ABC-scale, and PDQ-8 were compared between groups 1 and 2, there was a significant difference between the groups (p = 0.001). When the Tandem gait score (p = 0.615) was compared, there was no difference between the groups (Table 2).

Table I: Demographic and Descriptive Characteristics of the two Groups of PD.

Characteristics	Group 1 (n=38) Means (SD) Min-Max	Group 2 (n=36) Means (SD) Min-Max	p-value
Age (years)	72.34±9.49 54.00-87.00	69.94±7.78 53.00-84.00	0.240
Height (cm)	166.57±8.62 148.00-181.00	164.61±8.88 141.00-180.00	0.337
Weight (kg)	74.50±12.26 45.00-95.00	75.38±13.17 44.00-109.00	0.765
BMI (kg/m²)	26.86±4.36 20.00-37.11	27.97±5.36 15.78-42.22	0.332
MMSE	25.44±1.32 24.00-29.00	25.88±1.54 24.00-29.00	0.191
Duration	4.10±3.61 1.00-15.00	2.94±3.45 1.00-16.00	0.163
UPDRS-motor	34.50±9.26 16.00-55.00	21.94±8.53 10.00-47.00	**0.001***
MHYS	2.15±0.59 1.00-3.00	1.63±0.55 1.00-3.00	**0.001***
Characteristics	**n (%)**	**n (%)**	**p-value**
Sex			
Women	12 (31.6)	11 (30.1)	0.924
Men	26 (68.4)	25 (69.4)	
MHYS			
Stage 1	4 (10.5)	9 (25.0)	
Stage 1.5	1 (2.6)	14 (38.9)	
Stage 2	21 (67.7)	10 (27.8)	**0.001****
Stage 2.5	3 (7.9)	0 (0)	
Stage 3	9 (23.7)	3 (8.3)	
Education level			
İlliterate	3 (7.9)	5 (13.9)	
Primary education	29 (76.3)	23 (63.9)	0.177
High school	2 (5.3)	3 (8.3)	
University	4 (10.5)	5 (13.9)	
Marital status			
Married	25 (65.8)	28 (77.8)	0.253
Single	13 (34.2)	8 (22.2)	
Dominant extremity			
Right	37 (97.4)	36 (100)	0.514
Left	1 (2.6)	0 (0)	
Tremor			
Right	28 (77.8)	25 (71.4)	0.594
Left	8 (22.2.3)	10 (28.6)	
Upper extremity	35 (97.2)	33 (94.3)	0.614
Lower extremity	1 (2.8)	2 (5.7)	
Hearing equipment			
Yes	9 (23.7)	3 (8.3)	0.114
No	29 (76.3)	33 (91.7)	
Glasses			
Yes	16 (42.1)	10 (27.8)	0.230
No	22 (57.9)	26 (72.2)	
Assisstive equipment			
Yes	17 (44.7)	2 (5.6)	**0.001****
No	21 (55.3)	34 (94.4)	

PD: Parkinson's disease, Group 1: people with freezing of Parkinson's disease, Group 2: people without freezing of Parkinson's disease, UPDRS-motor: Unified Parkinson's Disease Rating Scale, MHYS:

*Modified Hoehn-Yahr Scale, MMSE: Mini-mental status examination, n:number, %: percent, SD: standard deviation, cm: centimetre, kg:kilogramme, kg/m2: kilogramme/square metre, t:comparison of means with independent t-test, two-tailed **: Chi-square analysis.*

Table II: Comparisons of the Scores of the Outcome Measures for the two Groups of PD.

Outcome measure	Group 1 (n=38) Median (IQR) Min-Max	Group 2 (n=36) Median (IQR) Min-Max	*z*	p-value	*d*
Tinetti balance score	16.50 (9.00) 5.49-25.00	23.00 (3.75) 16.00-26.00	-4.847	**0.001***	1.342
Tinetti gait score	5.00 (4.00) 0.00-9.00	9.00 (1.75) 4.00-9.00	-4.359	**0.001***	1.112
Tandem stance score	5.54 (22.26) 0.00-30.00	30.00 (19.31) 1.07-30.00	-3.375	**0.001***	0.892
Tandem walking score	13.24 (9.37) 0.00-42.59	12.36 (6.03) 0.00-28.63	-0.503	0.615	0.121
ABC Scale	34.69 (53.12) 0.63-96.88	83.43 (32.50) 13.75-100.00	-4.734	**0.001***	1.281
Outcome measure	**Group 1 (n=38) Mean (SD) Min-max**	**Group 2 (n=36) Means (SD) Min-max**	***t***	**p-value**	***d***
Tinetti total score	22.26±7.81 4.00-34.00	30.91±3.91 22.00-35.00	-5.968	**0.001***	1.400
Step count	6.68±4.15 0.00-10.00	9.30±2.36 0.00-10.00	-3.312	**0.001***	0.776
PDQ-8	46.21±25.82 3.13-96.88	23.26±18.47 0.00-62.50	4.375	**0.001***	1.022

PD: Parkinson's disease, Group 1: people with freezing of Parkinson's disease, Group 2: people without freezing of Parkinson's disease, ABC Scale: Activities Specific Balance Confidence Scale, PDQ-8: Parkinson's disease quality of life-8, min:minimum, max: maximum, t:comparisons of means with independent t-test, two-tailed, z:comparisons of median with Mann Whitney-U test, d:Cohen's effect size.

The relationship between the scale of freezing while walking and other parameters was analysed and detailed in Table 3.

Table III: Associations Between Freezing and Balance, Balance Confidence and Quality of Life.

Variable	FOG		
	(%95, CI)	r	p
Tinetti balance score	-0.74 to -0.46	-0.620"	**0.001***
Tinetti gait score	-0.72 to -0.40	-0.580"	**0.001***
Tandem stance score	-0.61 to -0.23	-0.442"	**0.001***
Tandem walking score	-0.22 to 0.24	0.001"	0.994
ABC Scale	-0.75 to -0.51	-0.651"	**0.001***
Tinetti total score	-0.78 to -0.49	-0.664'	**0.001***
Step count	-0.64 to -0.24	-0.450'	**0.001***
PDQ-8	0.38 to 0.72	0.567'	**0.001***

*FOG: Freezing of gait questionnaire, ABC Scale: Activities Specific Balance Confidence Scale, PDQ-8: Parkinson's disease quality of life-8, CI: confidence intervals, r: correlation coefficient, ': Pearson correlation coefficient, ":Spearman correlation coefficient, *: p<0.05*

DISCUSSION

Seventy-four patients with idiopathic PD were included in the study, with and without motor freezing. All patients underwent a comprehensive balance assessment, including Tinetti balance and gait assessment, tandem stance, and tandem gait. Additionally, balance confidence was determined using the ABC-Scale, and quality of life was assessed using the PDQ-8. It was observed that individuals with PD who experienced freezing exhibited impaired balance, reduced balance-specific activity confidence, and a more negative quality of life. Additionally, a correlation was found between freezing and quality of life, balance, and confidence in activities specific to balance.

In a systematic review and meta-analysis study, Zhao et al (2021) found that the prevalence of freezing blocks in PD ranged between 5-90%, with a prevalence of 38% in the early stage and 65% in the advanced stage[22]. They emphasized that FOG is very common in PD; it is a symptom that should be emphasized in clinical research and special assessment tools should be used in their study[22]. Aktürk et al. (2021) showed that the occurrence of freezing blocks while walking

was associated with bradykinesia, prolonged disease duration and advanced disease stage[23]. Our study applied the FOG questionnaire, a widely used tool in the literature, and the UPDRS assessment to evaluate freezing. We found that individuals diagnosed with PD with freezing had more advanced disease stages and longer disease durations. However, there was no significant difference between the disease durations.

Gait and balance disorders are a significant issue for individuals with PD, leading to falls, immobility and loss of independence. Therefore, it is crucial to recognize motor freezing, gait and balance disorders in individuals with PD at an early stage[3]. Hasegawa et al. (2021) emphasized that individuals who experienced motor freezing fell more than those who did not, there was no difference between their postural oscillations, but the relationship with balance should be examined[24]. Sarıcaoğlu et al. (2021), in their study examining the relationship between non-motor symptoms and balance, stated that non-motor symptoms affect balance[25]. According to the results of this study, motor freezing negatively affected static and dynamic balance.

Motor freezing blocks while walking is an important symptom that increases the risk of falls in patients with PD, thus limiting activities of daily living. Activity-specific balance confidence is an important indicator of functional mobility and independence in elderly individuals. Albay and Tütüncü (2021) found that fear of falling affected the quality of life in individuals with PD and that individuals with a history of falls and balance problems had lower ABC[26]. Castro et al. (2022) reported that falls are frequently observed in PD, but the reasons for this are unknown[27]. They found that balance was more negatively affected in individuals with PD who experienced falls, environmental factors may increase falls, and balance confidence was lower in individuals with PD with frequent falls[27]. According to the results of our study, it is seen that the balance of individuals with PD who experience motor freezing blocks is more affected, falls are more frequent, and ABC is more negatively affected.

In PD, the neural basis of health-related quality of life remains unclear. Nakano et al. (2021) conducted a study to reveal which motor and non-motor symptoms affect health-related quality of life in PD and the neural networks most likely associated with it[28]. They found that fear of falling, activities of daily living, FOG and autonomic dysfunction had significant effects on health-related QoL in PD and that brain networks consisting of the anterior cingulate cortex and temporo-parietal junction, which are responsible for the regulation of emotional behaviours, may affect quality of life in PD[28]. Walton et al. (2015) emphasized that FOG negatively affects health-related quality of life, affects the lives of patients from the early period and triggers loss of independence and fear of movement[8]. This study found that the quality of life of patients who experienced freezing was more negatively affected.

Strengths and Limitations

The assessment methods used in this study are valid and reliable, as accepted by the literature. One of the study's strengths is investigating freezing blocks while walking, which is common in PD but often ignored in clinical evaluation and treatment. This study also examines the impact of this symptom on patients' lives from different aspects. It has been shown that motor freezing blocks have a significant impact on patients' balance, activity confidence and quality of life. However, comprehensive studies including non-motor symptoms can be planned with more objective balance assessment systems.

CONCLUSION

Healthcare teams and caregivers involved in the diagnosis and treatment process in PD must be

aware of the expected emergence of motor and non-motor symptoms as the disease progresses. Holistic treatment approaches must be considered when planning treatment, with appropriate treatment approaches included to address the impact of motor freezing blocks on the disease. In addition to medical treatment, it is crucial to emphasize physiotherapy methods to improve balance and to educate patients and caregivers on how to cope with this symptom.

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Ethics Committee Approval: All subjects gave written informed consent in accordance with the Declaration of Helsinki and approval was obtained by the Ethics Committee of Nigde Omer Halisdemir University Non-Interventional Clinical Research (Project No: 2022-106).

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