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COMPARISON OF TRUNK CONTROL, MANUAL DEXTERITY, AND REACTION TIME ACCORDING TO DIFFERENT STATUS OF BALANCE IN PEOPLE WITH PARKINSON DISEASE

PARKİNSON HASTALARINDA FARKLI DENGE DURUMLARINA GÖRE GÖVDE KONTROLÜNÜN, EL FONKSİYONUNUN ve EL REAKSİYON ZAMANININ KARŞILAŞTIRILMASI

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Öz

Amaç
Bu çalışmanın amacı Parkinson hastalarında farklı denge durumlarına göre gövde kontrolünün, el fonksiyonlarının ve reaksiyon zamanının karşılaştırılmasıdır.

Gereç ve Yöntem
Çalışmaya 6'sı kadın toplamda 25 Parkinson hastası dahil edildi. Bireyler Berg Denge Ölçeği (BDÖ) kesme puanlarına göre Orta risk grubu (n=11) ve Düşük risk grubu (n=14) olarak ikiye ayrıldı. Gövde kontrolü ve fonksiyonlarını değerlendirmek için statik oturma ve dinamik oturma dengesi, gövde koordinasyonu alt parametrelerinden oluşan Gövde Bozukluk Ölçeği (GBÖ) ile değerlendirildi. El kavrama kuvveti Jamar el dinamometresi ile, el fonksiyonları Purdue Pegboard testi ile el reaksiyon zamanı ise Ruler Drop testi ile bilateral ölçüldü.

Bulgular
Gövde kontrolü için gruplar karşılaştırıldığında gövde bozukluk ölçeği toplam skorunda ve dinamik oturma alt parametresinde düşük risk grubu lehine anlamlı fark vardı ($p=0.030$, $p=0.005$). Ancak statik oturma ve koordinasyon alt parametrelerinde gruplar arası fark yoktu ($p=0.181$, $p=0.558$). Her iki elin el kavrama kuvvetinde, el becerisinde ve reaksiyon zamanında gruplar arası fark görülmedi ($p>0.05$).

Sonuç
Parkinson hastalarında orta riskli denge grubunun dinamik oturma dengesi ve gövde bozukluğu düşük risk grubundan kötü iken, el fonksiyonları ve reaksiyon zamanı benzerdir. Parkinsonlu bireylerde proksimal stabilizasyonda ve dengede kilit rol oynayan gövde ve distal mobilite için el fonksiyonlarının incelendiği daha ileri çalışmalara ihtiyaç vardır.

Anahtar Kelimeler: El kavrama kuvveti, Parkinson hastalığı, Reaksiyon zamanı, Üst ekstremite

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Abstract

Objective
This study aims to compare trunk control, manual dexterity, and reaction time according to different balance states in people with Parkinson's Disease (PwPD).

Material and Method
A total of 25 PwPD, 6 of whom were women, were included in the study. Individuals were divided into the Moderate-risk group (n=11) and the Low-risk group (n=14) according to the Berg Balance Scale (BBS) cut-off scores. To evaluate trunk control and functions, static and dynamic sitting balance were evaluated with the Trunk Impairment Scale (TIS), which consists of trunk coordination sub-parameters. Hand grip strength was measured with the Jamar hand dynamometer, manual dexterity was measured bilaterally with the Purdue Pegboard Test, and hand reaction time was measured bilaterally with the the Ruler Drop Test.

Results
When the groups were compared for trunk control, there was a significant difference in the dynamic sitting subparameter and the total score of the trunk impairment scale in favor of the low-risk group (p=0.030, p=0.005). However, there was no difference between the groups in static sitting and coordination sub-parameters (p=0.181, p=0.558). There was no difference between the groups in the grip strength, dexterity, and reaction time of both hands (p>0.05).

Conclusion
While the dynamic sitting balance and trunk impairment of the moderate-risk balance group was worse than the low-risk group, manual dexterity and reaction time were similar. Further studies are needed to examine manual dexterity for trunk and distal mobility, which play a key role in proximal stabilization and balance in PwPD.

Keywords: Hand grip strength, Parkinson's Disease, Reaction time, Upper extremity

Introduction

Parkinson's Disease is a progressive neurodegenerative disease characterized by the involvement of motor skills. Resting tremors, rigidity, bradykinesia, and gait disturbances are cardinal features of the disease (1). People with Parkinson's Disease (PwPD) often have poor dexterity and reduced grip strength (2). Fine motor deficits seen in PwPD, inability to control grip strength/strength, poor manual dexterity, and difficulties in reaching the amplitude, speed, and coordination required for grasping movement can be listed as motor dysfunction (3). Grip strength, which is closely related to activities of daily living, is an important indicator of motor disorders and quality of life. Excessive grip strength and temporal delays are characteristic of impaired hand functions. As impaired sensorimotor integration and movement disorders progress in PwPD, uncontrolled increase in grip strength, slowing of grasping, dystonia, prolongation of the time to lift objects, and prolongation of the movement phase of manual dexterity can be observed (3, 4).

In the progression of the disease, the symptoms generally progress from distal to proximal, starting from resting tremors in the hand and progressing towards the trunk and in the direction of disrupting the balance (5). The most common disorders in PwPD are loss of ambulation and balance (6). Balance losses and falls are 2 or 3 times more common in PwPD compared to healthy elderly people (7). Balance losses are based on multiple factors in the nature of the disease, such as cognitive impairment starting from postural instability, apathy, anxiety, depression, and non-motor disorders (7, 8). The part that plays an important role in postural instability is the trunk. Trunk control is considered a prerequisite for balance and upper extremity functions. It has been shown that there is a strong relationship between postural control and fine motor functions (9, 10).

For quality movement in the distal, stabilization should be better in the proximal (9). During the upper extremity functions, the body's center of gravity should change with arm movements, and adaptation to the changing gravity center should be provided. Good trunk control is needed in this dynamic process of maintaining balance (11, 12).

Studies examining this link between trunk control, balance, and hand functions are available in the literature (12-15). Among these studies conducted on different populations, studies involving PwPD are very few (9, 11). Investigation of parameters such as grip strength, dexterity, and reaction time including hand functions according to balance status in individuals with Parkinson's Disease will help fill the gap in the literature. In light of all this information, our study was planned to compare trunk control, manual dexterity, and reaction times according to different balance states in PwPD.

Material and Method

The approval for this study was obtained from the Süleyman Demirel University Clinical Research Ethics Committee with the decision number 216 on 16.11.2017. The research is a comparative-cross-sectional study. The sample of the study consisted of PwPD who came to Süleyman Demirel University Neurology Clinic between November 2017 and July 2018. The inclusion criteria for the study were being in the 55-80 age range, being diagnosed with Parkinson's Disease, having a score of 1-3 according to the Hoehn & Yahr Scale, Mini-Mental State examination score being ≥22 in educated subjects (16), and ≥18 in uneducated subjects, not having any orthopedic problems that could interfere with the tests and evaluations, and having good orientation and cooperation. Exclusion criteria were determined as having an orthopedic problem (such as DeQuervain's Tenosynovitis, shoulder pathology, cervical radiculopathy) that could hinder the evaluation, presence of evidence of systemic disease (Rheumatoid Arthritis, Psoriatic Arthritis, Systemic Lupus Erythematosus, or any degenerative or non-degenerative neurological conditions), having more than one complaint of pain in the upper extremity, the presence of a history of surgery on the forearm, presence of signs of psychiatric disease such as dementia that may affect the answers given, any drug and alcohol use that may affect cognitive functions.

Twenty-five PwPD were included in the study. All participants continued their regular drug use. Evaluations were made during the “on” period, which was determined 1-1.5 hours after drug intake. The patients were divided into 2 groups as those with low (n=14) and moderate (n= 11) risk in terms of balance. The sociodemographic information of individuals such as age, gender, and educational status was recorded. To determine the dominant hand, it was questioned which hand the individuals wrote with. The patients' balance was evaluated using Berg Balance Scale (BBS). BBS is a valid and reliable test used to test the ability to maintain balance while performing functional activities (17). Fourteen items assess static sitting and standing balance, as well as daily activities including transfers, turning, and picking up objects from the ground. Scoring is given between 0-4 (4: normal performance and 0: not able to do the movement) according to the person's ability to do what is asked of him/her safely and independently. The total score is 56 points and 0-20 points indicate high risk and 21-40 points show moderate risk (18).

The Trunk Impairment Scale (TIS) was used to assess trunk control and functions. TIS consists of 3 sub-parameters (static sitting balance (0-7 points), dynamic sitting balance (0-10 points), and trunk coordination (0-6 points)). The total score is a minimum of 0 and a maximum of 23 points, and it is accepted that higher scores show better performance. It is a valid and reliable scale in the early stages of PwPD (19). The hand grip strength of individuals was measured with the gold standard Jamar® Hand Dynamometer. The measurement method with high validity and reliability was carried out in the standard position recommended by the American Association of Hand Therapists. Measurements were made in a sitting position, shoulder in adduction and neutral rotation, elbow in 90° flexion, forearm in mid-rotation and supported, and wrist in neutral position. The patients were asked to squeeze the dynamometer as hard as possible, not exceeding 10 seconds. Measurements were made sequentially, starting with the dominant hand, and 3 measurements were made from each hand, and the mean scores were recorded in kilograms (20).

Purdue Pegboard test (Lafayette, MODEL 32020) was used to measure manual dexterity and speed. Before the test was applied, all the materials of the test were introduced to the individuals. Starting from the dominant side of the participants, pins (25), nuts (20), washers (40), and pins (25) were placed in the four compartments at the top of the test board, respectively. Before starting the test period at each step, participants were asked to experiment. One point was given for each nail placed by the individuals within 30 seconds. The test was repeated 3 times bilaterally and the mean value was recorded. The test is a valid and reliable measure of hand functions in PwPD (21).

The Ruler Drop test was used to measure hand reaction time. With the elbow flexed to 90 degrees and the dominant hand in a neutral position, the subjects were asked to catch the ruler upright after the ruler was released from above in the sitting position with the forearm supported on the table. The ruler was left with the lower end between the index and thumb of the person. For the individual to hold the ruler left by the tester, the tips of the thumb and forefinger should be 8-10 cm ahead of the table edge, and the upper parts of the thumb and forefinger should be parallel to each other. The hands of the individuals were fixed during the test and the value read at the top point of the ruler gave the reaction time. The measurement was repeated bilaterally 5 times. The highest and lowest trials were discarded and the mean of the remaining ones was recorded (22).

Statistical Analysis

SPSS 25.0 (IBM SPSS Statistics 25 software (Armonk, NY: IBM Corp.) package program was used for data analysis. Parameters were expressed as mean ± standard deviation and categorical variables were expressed as numbers. The conformity of the data to the normal distribution was examined with the Kolmogorov-Smirnov test. Mann-Whitney test was used for the comparison of differences between groups. The Chi-square test was used to examine the differences between categorical variables. The multiple analysis of variance MANCOVA (covariate: age) was used for the comparison of the study groups in TIS. The significance level was accepted as p<0.05 in all analyses.

Results

The sociodemographic characteristics of individuals and the BBS scores are shown in Table 1. Gender, education level, marital status, and dominant side were similar between the groups (p>0.05). When the disease duration of the individuals was compared, there was no difference between the groups (p=0.687). Individuals in the low-risk group were younger than those in the moderate-risk group (p=0.028). When the groups were compared for trunk control, there was a significant difference in the dynamic sitting subpara-

Table 1 The demographics and basal clinical features of the participants (n = 25)

	Moderate risk group (n=11)	Low risk group (n=14)	z	p
Gender (F/M)	4/7	2/12	1.650	0.350[a]
Age (years) (mean±SD)	70.63±8.50	63.57±7.19	2.199	0.028[b*]
BMI (kg/m^2)	27.51 (3.44)	29.13 (4.75)	1.598	0.115[a]
Education level Primary education (8 years) Secondary Education (8-12 years) Higher Education (12 years<)	 5 3 3	 4 7 3	1.396	0.498[a]
Marital Status Single Married	 1 10	 - 14	1.695	0.440[a]
Onset (years) (mean±SD)	5.27±3.49	6.85±5.64	0.660	0.687[b]
Laterality, R/L	10/1	11/3	0.733	0.604[a]
BBS (Score) (mean±SD)	35.45±5.82	48.57±3.85	4.228	0.000[b*]

*p<0.05; a: Chi-Square Test; b: Mann Whitney U test; F: Female; M: Male; BMI: Body mass index; R: Right; L: Left; SD: Standart deviation; BBS: Berg balance scale

Table 2 Comparison of trunk control by groups

	Moderate risk group (n=11) (mean±SD)	Low risk group (n=14) (mean±SD)	z	p
Total TIS score (range 0-23)	15.90±3.78	18.92±3.40	3.554	0.030*
Static balance (range 0-7)	5.81±1.25	6.42±0.75	1.768	0.181
Dynamic balance (range 0-10)	6.63±2.01	8.57±1.82	5.681	0.005*
Trunk Coordination (range 0-6)	3.45±1.75	3.92±1.81	0.706	0.558

*p<0.05; MANCOVA test; SD: Standart deviation; TIS: Trunk impairment scale

Table 3 Comparison of hand functions by groups

	Moderate risk group (n=11) (mean±SD)	Low risk group (n=14) (mean±SD)	z	p
D-Grip strength (kg)	52.74±21.11	61.75±16.39	0.712	0.477
ND-Grip strength (kg)	48.37±18.80	54.36±17.61	0.493	0.622
D-PPT (score)	3.28±1.01	2.68±1.15	1.177	0.239
ND-PPT (score)	3.83±0.66	3.17±0.99	1.616	0.106
D-RDT (cm)	22.69±4.94	19.31±4.27	1.588	0.112
ND-RDT (cm)	23.81±5.31	22.05±4.98	0.904	0.366

*p<0.05; Mann Whitney U test; SD: Standart deviation; D:Dominant; ND:Non-dominant;
PPT:Purdue Pegboard Test; RDT: Ruler Drop Test

meter and the total score of the TIS in favor of the low-risk group (p=0.005, p=0.030) (Table 2). However, there was no difference between the groups in static sitting and coordination sub-parameters (p=0.181, p=0.558) (Table 2). The comparison of the parameters of hand functions between groups is presented in Table 3. Accordingly, there was no difference between the groups in the grip strength, dexterity, and reaction time of both hands (p>0.05).

Discussion

In this study, which was conducted to compare trunk control, hand functions, and reaction time in PwPD according to different balance states, the main finding was that hand grip strength, dexterity, and hand reaction times were similar between the groups. There was a significant difference between the groups in the dynamic sitting balance sub-parameter of trunk control and the total score of trunk impairment in moderate and low-risk groups.

Postural instability and balance problems are the most common findings in PwPD, and approximately 75% of patients have a history of falling. Patients' ability to control body mass is not sufficient to maintain balance during activities of daily living (23). Since the upper body constitutes two-thirds of the whole body weight, the control of trunk movements is very important in providing postural stability (24). Uncoordinated and uncontrolled trunk movements increase balance loss and falls. In a study evaluating trunk movements in the sitting position in PwPD with and without a history of falling, it was shown that trunk control was affected in PwPD with a fall history, and it was noted that excessive oscillations in the mediolateral direction were higher than in the anteroposterior direction (25). In the study by Cole et al. examining muscle activation for trunk stabilization in PwPD with poor balance during walking, it was found that lumbar multifidus and thoracic erector spinae muscle activation was higher and trunk stabilization was affected more than the group with good balance (26). In our study, the trunk control scores of the group with poor balance were lower, as reported in the literature. The affected trunk control performance that was observed in the clinic was statistically significant in dynamic sitting balance and total score of TIS. While there was no difference in other sub-parameters of trunk control, the only difference in dynamic balance can be explained by the postural strategy that the moderate-risk group could not use to compensate for balance losses. Loss of balance is compensated by corrective movements such as the hip strategy, which requires hip, pelvis, and trunk control. Although not evaluated in the present study, in this strategy, the body is largely responsible for meeting the stresses (27). In the examination of trunk control, we think that dynamic sitting performance is more functional than other sub-parameters and reflects the patient's clinic more. The fact that the BBS is more focused on dynamic balance than static balance measurements and the difference in dynamic sitting balance supports this idea.

It is required that good proximal stabilization for good distal mobility (9). Proximal stabilization requires synergistic control among body segments (such as the trunk, spine, and pelvis). In other words, good trunk control provides good distal functionality (28). A relationship was found between postural control and manual dexterity and hand grip strength, which was evaluated using the BBS, in people over the age of 65 without neurological problems (14). In a study examining the relationship between postural control and manual dexterity in young and old PwPD, it was shown that balance affects manual dexterity in elderly PwPD (9). It has been shown in the literature that hand grip strength in PwPD can predict the severity of the disease. It has also been shown that the better the grip strength, the better the manual dexterity (2). Trunk control was not included in these studies. Dexterity was evaluated with the Nine-Hole Peg Test. In another study, the effects of two different treatment methods effective in trunk control on hand functions and balance were investigated (11). In addition, it was emphasized that the relationship between dexterity and other motor functions such as trunk control should be examined in future studies (9). In our study, which we created in line with these studies, we tried to reveal the differences in trunk control and dexterity in PwPD who have different balance problems. However, contrary to the literature, we did not find a significant difference in hand functions and reaction speed according to different balance conditions. We think that this result occurred because the disease was not advanced and that all aspects of trunk control were not affected yet.

Individuals use hand functions as a compensatory mechanism to prevent falling, and individuals with low hand grip strength cannot prevent falling (29). In these studies, where there is a difference in hand grip strength, there is no pathogenesis of neurological origin. We think that there may be many factors affecting hand grip strength in pathophysiology such as Parkinson's that affects hand functions. Factors such as dystonia, bradykinesia, rigidity, age, gender, and disease duration were considered to be confounding factors, and it was concluded that the relationship between balance and hand grip strength was not as pure as in the elderly population.

When the studies investigating hand function in PwPD were examined, hand function was evaluated with the nine-hole peg test because it was easily accessible in most of the studies (2, 9, 11). The Purdue pegboard test, which we used in our study, was found to be more sensitive than other timed tests measuring hand functions (30).

In falling and loss of balance, the speed of catching objects is as important as the force (31). Considering the diversity of kinetic findings in PwPD, it is inevitable that reaction time is affected (32). The effects of visual control and reaction speed on balance have been shown in young individuals (33). In addition, advanced age involvement, kinetic findings, and loss of balance in PwPD may explain the delays in reaction time. It has been stated that the reaction time varies according to the evoked sensation ratios, the severity of the stimulus, general muscle tone, motivation, fatigue, and emotional state (34). In the same study, it is mentioned that the existence of many factors affecting the reaction time and the change of these factors according to various places and times will change the measurements. In our study, the reason why the reaction times were similar according to the equilibrium state was considered a variable factor. Even if the trunk control performances of individuals with poor balance are the same, we think that grip speed, which is a motor response to falling, should be affected. It has been shown that the decrease in the amplitude of movement (hypokinesia), and the absence of spontaneous movements (akinesia) accompanying bradykinesia in PwPD, is insufficient in the complexity of PwPD, although clinical evaluations are easy (30). Presenting data on this complex structure of hand functions in PwPD with clinical measurements will form the basis for future studies.

Dynamic sitting balance and trunk impairment were affected and hand functions and reaction time were preserved in the moderate-risk group for falls in PwPD. Gross motor skills required for maintaining balance and fine motor skills required for manual dexterity are integral parts of being independent in daily life. For this reason, there is a need for further studies that examine balance and hand functions in more detail in PwPD.

Important limitations of the present study were that hand functions and balance were not evaluated with more technological devices, fall risk assessment was not made, the staging of individuals according to the Modified Hoehn-Yahr Scale was not known, and daily life activity or quality of life assessments of the functionality of individuals were not included.

Conclusion

While the dynamic sitting balance and trunk impairment of the moderate-risk balance group is worse than the low-risk group in PwPD, hand functions and reaction time are similar. Further studies are needed to examine hand functions for trunk and distal mobility, which play key roles in proximal stabilization and balance in PwPD.

Conflict of Interest Statement
The authors have no conflicts of interest to declare.

Ethical Approval
Süleyman Demirel University Faculty of Medicine Clinical Research Ethics Committee approved this study (16.11.2017/No: 216). The study was conducted in line with the principles of the Helsinki Declaration.

Consent to Participate and Publish
Written informed consent to participate and publish was obtained from all individual participants included in the study.

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Availability of Data and Materials
Authors can confirm that all relevant data are included in the article and/or its supplementary information files. Data sharing is not applicable.

Authors Contributions
HY: Conceptualization; Investigation; Methodology; Writing-original draft; Writing-review & editing.

ZB: Conceptualization; Data curation; Formal analysis.

TM: Investigation; Writing-original draft; Visualization
SK: Supervision; Writing-review & editing.

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