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Analysis of functional profile and mobility in Parkinson's disease: a cross sectional study

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ABSTRACT

Background: Idiopathic Parkinson's disease (PD) is a progressive neurodegenerative disease that has a prevalence of 18–328 per 100,000 in habitants in developing countries, with an estimated 3.3% of the Brazilian elderly population affected by PD throughout life. The classic symptoms include a resting tremor, muscular rigidity, bradykinesia and postural instability, which are all motor symptoms. The mobility of the subjects is compromised early, thus impairing their balance and limiting their ability to perform simple tasks. The restricted movement prevents dissociation between the head and trunk during walking, and freezing occurs as advanced disease reduces the progression of movements during walking. **Objective:** To analyze mobility and functionality profiles in subjects with Parkinson's disease and compare them with healthy subjects. **Method**: A sample was consisted of 10 subjects with PD and 10 healthy elderly subjects. Assessment tools were used to quantify the severity of PD the scale Hoehn and Yah (HY), for mobility were used the Dynamic Parkinson's Gait Scale (DYPAGS) and Modified Parkinson Activity Scale (PAS modified), for functionality were used the Unified Parkinson's Disease Rating Scale (UPDRS) and dual task (DT) performance. **Results:** The subjects with PD showed worse performance in mobility and DT as determined by the modified PAS (p=0.0001) and DYPAGS (p=0.0001). Correlations were found between the UPDRS, the Gait Freezing Questionnaire (FOG), the PAS modified score, left-hand grip strength and the HY values (p<0.05). There were no differences in prehensile muscle strength between PD and healthy subjects. **Conclusions:** Subjects with PD showed decreased mobility and functionality for activities related to ADLs, gait and DT compared to healthy elderly subjects. Disease severity, muscle strength and freezing were correlated with the mobility and DT performance in subjects with PD.

Keywords: Parkinson's Disease; Functionality; Gait.

INTRODUCTION

Idiopathic Parkinson's disease (PD) is a progressive neurodegenerative disease that has a prevalence of 18–328 per 100,000 in habitants in developing countries, with an estimated 3.3% of the Brazilian elderly population affected by PD throughout life[1,2]. The symptoms of PD affect movement. The classic symptoms include a resting tremor, muscular rigidity, bradykinesia and postural instability, which are all motor symptoms[3]. The functional impairments caused by PD include poor postural control, and PD patients are more likely to experience falls, especially those with severe stiffness. As the disease progresses, subjects exhibit deficits in tasks requiring fine motor control and grip strength[4]. Muscle stiffness is responsible for reduced movement of the trunk in PD, which makes it difficult for them to roll over in bed or rise from bed. The mobility of the subjects is compromised early, thus impairing their balance and limiting their ability to perform simple tasks[5]. The restricted movement prevents dissociation between the head and trunk during walking, and freezing occurs as advanced disease reduces the progression of movements during walking[6,7]. The non-motor symptoms of PD also have an impact on quality of life (QoL)[8]. These include cognitive changes that modulate prefrontal functions of the brain related to memory, executive function, visuospatial processing and attention[9,10]. The impairment of cognitive function and executive function in PD limits the ability to divide attention between different actions, hindering performance in a dual task (DT)[11]. When two tasks are performed simultaneously by subjects with PD, there is a competition for limited resources, leading to a decrease in performance in one or both tasks[12]. A study by Stegemöller et al. evaluated the functional mobility of subjects with PD by examining their gait with and without obstacles. Obstacles were found to slow the gait. In response, subjects used more stabilizer muscles and decreased their range of motion to adapt to the motor symptoms related to PD. However, this study did not use a control group of healthy older adults for comparison[13].

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To address the gap in literature and clinical practice, we conducted a study to analyze and correlate the profiles of mobility and functionality in subjects with PD, with healthy elderly subjects studied for comparison. The hypothesis of this study is that subjects with PD have mobility deficits related to gait, balance, DT and reduced functionality compared to healthy subjects.

METHOD

This was an observational quantitative study. It used a cross-sectional design and was conducted at the Human Kinetics Laboratory, at Faculty of Health Sciences Trairi (FACISA), a specialized academic unit at the Federal University of Rio Grande do Norte (UFRN). The sampling process was non-random for convenience. Subjects with PD were recruited from the elderly service and assistance waiting list in a basic health unit in the region. The study was approved by the Research Ethics Committee of the institution (number 901.372). Inclusion criteria for the group with PD were as follows: age between 40 and 85 years, on medication for specific PD (dopaminergic) and presenting a score of 4 or 5 on the Functional Ambulation Scale[14]. Subjects with Parkinsonian syndrome were excluded, as were those with other neurological diseases or dementia. The patients were also excluded if their score on the Mini Mental State Examination (MMSE) fell below 13 for illiterates, 18 for low and middle school, and 26 for high school[15]. For the group of healthy elderly controls, the inclusion criteria were age between 60 and 80 years and able to ambulate independently (score of 4 or 5 on the Functional Ambulation Scale). Subjects of control group were excluded if they had musculoskeletal complaints or reports of orthopedic, rheumatic or neurological disease, or if they had scores on the MMSE below 13 for illiterates, 18 for low and middle school, and 26 for high school.

Measuring Instruments

Subjects who met the inclusion criteria for the study signed an Informed Consent form. Initially, a semistructured form with socio-demographic and clinical data (name, gender, education, age) was completed. Clinical diagnosis, diagnostic time, dominant hand, use of medications (including dopaminergic medication and time), auxiliary device use and lifestyle parameters (alcohol consumption, smoking and physical activity) were also recorded to characterize the sociodemographic profile of the study sample. Then, the subjects were evaluated by using the following instruments. The MMSE was used to assess the cognitive abilities of the subjects. The scores range from 0 to 30 points, with different scores for individuals who are illiterate. A score of 30 indicates complete cognitive function[15]. The Hoehn and Yah staging scale modified (HY - Degree of Disability Scale) were used to indicate the overall status and level of disability in patients with PD. Subjects classified in stages I, II and III have mild to moderate disability, whereas those in stages IV and V have grave disability. A version of the modified HY was used, which includes intermediate stages[16]. The Unified Parkinson's Disease Rating Scale (UPDRS) was developed as a standard method for assessing the progression of PD. It features 42 items, which can be grouped into the following categories: mental activity, behavior and mood, activities of daily living (ADL), motor examination and complications of drug therapy. The scores for each item range from 0 to 4, and higher scores indicate greater impairment[17]. We focused on the daily living and motor examination activities. The Ambulation Functional Category scale was used to rate the degree of independence in the gait. It was divided into six items. Subjects classified at level 0 are unable to walk or require the assistance of at least two people. Subjects classified at level 5 are totally independent. Thus, higher scores indicate a higher degree of gait independence[14]. The Dynamic Parkinson's Gait Scale (DYPAGS) consists of eight dynamic items: walking seven meters ahead, walking three meters back, turning 360° in place in both directions, going over an imaginary obstacle with the right leg and left leg, passing through a 50 cm gap between two chairs, and a DT involving walking while saying names of animals. We observed the beginning, hesitations, changes of direction, step count, increased double support time, and other factors. Each item ranges from 0 to 5 points on the scoring ordinal system with a maximum score of 40 points, reflecting severe gait disorders related to PD. In all items, the inability to move the foot, complete akinesia or a fall were assigned the maximum score. For the DT walk, performance was scored based on the number of correct names for animals[18]. The Trunk Mobility Scale (TMS) is based on static test and dynamic tests for six trunk movements and sitting posture. For dynamic items, the score ranges from 0 to 3 (best to worst). The static test assesses postural alignment, ranging from 0 to 4 points. The 0 position corresponds to sitting erect, and 4 indicates severe postural change. The TMS features 22 points in total[19]. The Gait Freezing Questionnaire (Freezing of Gait – FOG-Q) was also used. It consists of six questions about the episodes of gait freezing: duration, frequency of freezing, and hesitation. These events are impairments of gait and affect functional independence and ADLs. The scores for each item vary from zero to four. Higher scores indicate more severe freezing episodes. The FOG-Q has a total score of 24 points, and higher scores indicate a severely impaired gait[20]. The Modified Parkinson Activity Scale (PAS) consists of 14 items divided into three areas: transfer in the chair, akinesia and mobility in bed. The score ranges from zero to four in each category (except for items 1B and 2B, which range from 0 to 2), and higher scores indicate the best condition of the patient. Lower scores indicate that the subjects will need physical support. There is a total possible score of 56 points[21]. There are only four sub-items that relate to DT, involving the following activities: while holding a plastic cup filled ¾ with water, the subject rises from a chair, walks 3 meters to a piece of cardboard that lies on the floor in the shape of a "U", turns 180° inside the "U", goes back and sits in the chair again. The walk and the 180° rotation are two separate items on the scale, but they are performed simultaneously. The other subsection comprises motor and cognitive tasks, including counting down by 3, beginning with 100, and the subject should perform the same path item mentioned above. To evaluate the muscular strength of the upper limbs, a hand-grip dynamometer was used (Saehan® 100 kg capacity and 1 kg precision). At the time of the test, the subject was seated with their arm along the trunk, the elbow flexed to 90°, and the forearm and wrist in a neutral position. Four measurements were performed on each subject. The first was used for adaptation and knowledge of the equipment, so it was discarded. The following three measures were arithmetically averaged[22]. The dynamometers used for men and women were standardized.

Procedures

The evaluation took place in a single session, preferably in the morning, which is when medication is administered. Sessions lasted for a maximum of 1 h 30 min and were conducted by a trained examiner. To characterize the sociodemographic profile of the subjects, we used a semi-structured assessment. After filling out this form, subjects were sent to the application area with the measuring instruments. A 5-minute rest period was allowed between tests, in case of fatigue or at the request of the participant. The movements and tests were first demonstrated by the examiner. Observations were recorded in the following order: socio-demographic profile, MMSE, UPDRS II and III, HY, FAC, FOG, EMT, DYPAGS and modified PAS. Subjects with PD were evaluated with all measuring instruments. Healthy subjects were evaluated only by the socio-demographic profile form, MMSE, modified PAS and DYPAGS.

Statistical analysis

Data were analyzed using SPSS 20.0 (Statistical Package for Social Sciences, IBM Inc., Chicago, IL, USA) on Windows. The Shapiro-Wilk test was used. Numerical variables were expressed as the mean and standard deviation, and categorical variables as frequency and percentage. We used Student's t-tests for comparisons of variables between groups. We used the Pearson correlation coefficient for association analysis of the measuring instruments. We considered *p* values less than 0.05 to be statistically significant.

RESULTS

The final sample consisted of 10 subjects with PD and 10 healthy elderly subjects. We found a normal distribution of numerical variables for both groups. The demographic and clinical characteristics of the subjects are presented in Table 1. The groups were similar in age and categorical variables. Table 2 shows the frequency distribution of HY classification, which indicates that 50% of the subjects had stage 3:04 PD. Table 3 summarizes the scores of the measuring instruments and compares PD patients and healthy subjects. No statistically significant differences were found for the DYPAGS instruments and modified PAS when assessing mobility in bed, walking, and DT. Table 4 shows the correlation coefficients between the measurement instruments, showing moderate to strong relationships between the instruments evaluated in the PD group.

Table 1. Demographic data of subjects with Parkinson Disease and healthy elderly.

Variables	PD group (n = 10)		Healthy group (n = 10)	
	n (%)	Mean ± SD	n (%)	Mean ± SD
Age (years)	---	64.5 ± 12.7	---	67 ± 3.5
Gender (F/M)	5/5 (50% / 50%)		7/3 (70% / 30%)	
PD Time (years)	---	7.5± 5.2	---	---
Education				
Illiterate	1 (10%)	---	5 (50%)	---
Elementary School	6 (60%)	---	1 (10%)	---
High school	2 (20%)	---	4 (40%)	---
Higher education	1 (10%)	---	---	
Dominant side (R/L)	8/2 (80% / 20%)	---	0/10 (0%/ 100%)	---
Alcohol consumption (Y/N)	0/10 (0%/100%)	---	1/9 (10%/ 90%)	---
Tobacco (Y/N)	0/10 (0%/100%)	---	0/10 (0%/ 100%)	---
At. Physics (Y/N)	2/8 (20% / 80%)	---	10/0 (100%/ 0%)	---
Auxiliary device (Y/N)	5/5 (50%/ 50%)	---	0/ 100 (0%/ 100%)	---

Note: PD= Parkinson Disease; F= female; M= male; R=right; L= left; N= No; Y= Yes;. P-value= 0.554 for comparing the variable age between groups. SD= standard deviation.

Table 2. Stage Distribution disability Hoehn and Yarh.

	Characteristics	PD Group (%)
Stage 0	No sign of disease	20%
Stage 1	Unilateral disease	__
Stage 1,5	Unilateral and axial involvement	__
Stage 2	Bilateral disease without balance deficit	30%
Stage 3	Mild to moderate bilateral disease; some postural instability; ability to live independently	20%
Stage 4	Severe disability, still able to walk and remain upright without help	30%
Stage 5	Confined to bed or wheelchair. Need help	__

Note: PD=Parkinson Disease; n = 10.

Table 3. Measurement instruments of subjects with Parkinson Disease and healthy elderly.

Variables	PD group (n = 10) Mean ± SD	Healthy group (n = 10) Mean ± SD
MEEM	24.1 ± 4.4	24.9 ± 3.6
UPDRS II	17.6 ± 9.7	---
UPDRS III	19.8 ±10.4	---
FOG	11.3 ± 7.8	---
EMT	7.3 ± 3.3	---
DYPAGS	17.6 ± 6.6	4.6 ± 3.5 *
PAS Mod.	39.4 ± 9.9	55.7 ± 0.7 *
PAS	26.8 ± 9.6	---
Hand grip strength R	17.7 ± 6.7	24.6 ± 7.2
Hand grip strength L	18.4 ± 9.01	19.6 ± 5.07

Note: PD=Parkinson Disease; SD = Standard Deviation; MMSE = Mini-Mental State Examination; UPDRS = Unified Assessment Scale for Parkinson's disease, PAS = Parkinson Activity Scale; PAS = Modified Parkinson's Activity Scale Modified; EMT = Trunk Mobility Range; R = right; L = left; FOG = Gait Freezing Range; DYPAGS = Dynamic Gait Parkinson Scale; HY = Hoehn & Yahr. * P-value = 0.0001 = for comparison of measurements between the groups.

Table 4. Correlations between the measurement instruments in subjects with Parkinson Disease.

Variables	HY		FOG		PAS mod.	
	r	p-value	R	p-value	r	p-value
UPDRS II	**0.85**	**0.002**	**0.75**	**0.012**	- 0.55	0.101
UPDRS III	**0.89**	**0.001**	**0.71**	**0.020**	- 0.54	0.108
FOG	**0.80**	**0.005**	---	---	**- 0.82**	**0.004**
PAS mod.	**- 0.74**	**0.014**	**- 0.82**	**0.004**	---	---
HY	---	---	**0.81**	**0.005**	**- 0.74**	**0.014**
DYPAGS	0.31	0.388	0.42	0.226	- 0.13	0.729
MEEM	- 0.22	0.536	- 0.19	0.594	- 0.005	0.989
EMT	0.38	0.285	0.54	0.110	0.35	0.322
Hand grip strength R	0.08	0.833	0.03	0.915	- 0.44	0.233
Hand grip strength L	0.46	0.214	0.38	0.307	**- 0.73**	**0.026**

Note: UPDRS II = Daily Life Activities, UPDRS III = Motor Activity; PAS = Modified Parkinson's Activity Scale Modified; EMT = Trunk Mobility Range; FOG = Gait Freezing Range; DYPAGS = Dynamic Gait Parkinson Scale; HY = Hoehn & Yahr; R = right; L = left; r = Pearson correlation coefficient.

Subjects from both groups had low levels of education, and it was consequently difficult to perform the cognitive dual task, which involved carrying out a subtraction calculation. An subject with PD had difficulty performing a motor task of carrying a glass of water while walking and turning due to a hand tremor. Another subject with PD experienced freezing episodes and festination during the mobility activities and the dual task. Most subjects did not experience freezing episodes on the gait freezing evaluation scale.

DISCUSSION

This study investigated mobility and functionality in subjects with PD and compared the results with those of healthy older adults. The results showed that subjects with PD have difficulty with mobility activities and show low functionality in tasks with greater commitment during transfers, bed mobility, gait and DT relative to healthy elderly controls. In the descriptive analysis of HY, we observed that the sample had a high degree of compromise. This finding was confirmed in the analysis of relationships between ADLs, motor function, mobility, gait, double tasks, freezing and severity of disease, indicating that the stage of PD is a modulator of the symptoms of PD. Matinollia et al. analyzed mobility and balance in PD and noted that advanced age and severity of disease are related to mobility and impaired balance in patients with PD[23]. Munhoz and Tieve rated balance by retropulsion using the UPDRS test and found that age and severity of PD increase the level of difficulty for completion of the task[24]. We also analyzed the relationship between freezing of gait and mobility / performance of DT, and we observed that the low performance of DT and functional activities could be due to gait freezing. Duncan et al. conducted a similar study evaluating gait, postural orientation, balance and DT in patients with gait freezing, and they found that the subjects had difficulty walking and turning 360º and showed worse performance in DT compared to subjects with PD without freezing[25]. Peterson et al. noted that subjects with PD had no freezing episodes during DT walking forward, but experienced episodes during the spin freezing test[26]. In our study, subjects who had the lowest freezing step length were compared with those who did not, especially while performing the DT.

During the comparative analysis between PD and healthy elderly subjects, better performance was observed in mobility, gait and double task for healthy elderly subjects compared to patients with PD through the DYPAGS instruments and the modified PAS. Wild et al. analyzed the DT in subjects with PD and healthy subjects, and they noted that the walk and performance standards differ between groups[27]. The complexity of the task prevented a perfect realization in subjects with PD, who needed more time and reported greater difficulty in DT than the healthy subjects. Teixeira and Alouche analyzed how PD affected performance in DT (cognitive-motor), and they observed that the time taken to perform the DT was higher in the group with PD compared to the control group of healthy subjects[28]. In our study, the control group showed no difficulty in performing DT (motor and cognitive) during walking or mobility in bed, with the exception of those subjects with lower education who had difficulty in the cognitive task.

Muscle strength analysis for the upper limbs correlated with mobility / dual task performance as evaluated by the modified PAS, indicating that the loss of muscle strength in PD decreases mobility and functionality and affects making transfers and performing the dual task. Paul et al. evaluated the sensitivity of mobility and muscle strength in PD, and they observed a strong relationship between the loss of strength and mobility measurements in people with PD, in agreement with the results found in our study[29]. Frazzita et al. studied muscle strength in patients with moderate PD using an isokinetic dynamometer. The results showed that muscle strength in patients with PD had a tendency to be lower compared to healthy subjects, contributing to their weakness. However, in this study, there was no significant difference between the hand-grip values between the control group and the group with PD[30].

CONCLUSIONS

It was possible to conclude that subjects with PD have decreased mobility and functionality for related activities such as ADLs, gait and dual tasks, and that healthy older adults perform better on mobility and dual tasks than those with a clinical diagnosis of PD. There was no difference in prehensile muscle strength between individuals with PD and healthy subjects. Furthermore, we can conclude that the severity of the disease, muscle strength and freezing when walking are correlated with the mobility and performance in the dual task in patients with PD. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

AUTHORS' CONTRIBUTIONS

WLG and LMSM contributed to the intellectual content of this work, according to the ICMJE guidelines in the literature review part, data collection and treatment and writing of the manuscript; ICR contributed to the content according to the ICMJE guidelines, in the part of the critical review, revising the intellectual contents of the manuscript before the final presentation; NMS, GKSD and RCSC contributed to the intellectual content of this work, according to the ICMJE guidelines in the part of the collection and treatment of the data; EWAC, ROC and NMFVL, contributed to the intellectual content of this work, according to the ICMJE guidelines in the Conception and development part, methodological design and critical review.

CONFLICT OF INTEREST

Nothing to declare.

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