ORIGINAL ARTICLE

The role of rehabilitation with virtual reality in functional ability and quality of life of individuals with Parkinson's disease

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ABSTRACT

Parkinson's disease (PD) is a progressive neurodegenerative disorder of dopaminergic neurons that can cause some mobility limitations, which in turn, can negatively impact quality of life (QOL) of individuals with PD. Virtual reality (VR) has been used to treat these patients. **Objective:** Evaluate the functional capacity and QOL of individuals with PD using VR with X-Box Kinect®. **Methods:** 20 individuals classified as stages 1-3, aged 50-80 years were selected. They were randomly divided into two groups (control and experimental) with ten patients in each. The control group (CG) was treated with conventional therapy for five weeks, with two 60-minute sessions per week, whereas the experimental group (EG) had they sessions split in half: conventional physical therapy and virtual rehabilitation (VR). Subjects were evaluated before and after the treatment with the following scales: Unified Parkinson's Disease Rating Scale – (UPDRS) and Parkinson's Disease Questionnaire (PDQ-39). **Result:** We found a reduction in scores for all domains of UPDRS and PDQ-39 in both groups, but only in the EG this finding was significant. **Conclusion:** VR combined with physiotherapy is an efficient method, what may influence the clinical aspect and improve QOL of individuals with PD.

Keywords: Parkinson Disease, Physical Therapy Modalities, Virtual Reality Exposure Therapy, Quality of Life

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INTRODUCTION

Due to the aging of the world population, it is estimated that by 2020 more than 40 million people may develop motor disorders due to Parkinson's disease (PD).[1] The prevalence of this disease increases progressively with age,[2] and the highest incidence rate is found among men aged 60 to 79 years.[3] However, the disease can also be observed in younger patients aged between 30 and 50 years.[4]

PD is characterized by the decrease of dopamine due to the progressive degeneration of the dopaminergic neurons located in the substantia nigra of the midbrain. As a consequence, dopamine fails to modulate the motor loop, leading to the appearance of the cardinal signs of the disease, such as resting tremor, muscular rigidity, bradykinesia and postural instability.[5,6,7]

With the progression of the disease, non-motor symptoms such as anxiety, depression and sleep disorders may arise.[8] The association of motor and non-motor symptoms often leads to loss of independence, fear of falls and inactivity, what may result in social isolation and increased risk of osteoporosis or cardiovascular diseases.[9]

Consequently, these individuals may present mobility, communication, and motor limitations for activities of daily living, that are probably associated with worst general perception of quality of life (QoL). The concept of QoL is multidimensional and comprises the individual's perception of their physical, functional, mental, and social well-being.[10] Therefore, the main objectives of physical rehabilitation is to promote the improvement of QoL perception, to maintain independent functional abilities, and to improve physical health and well-being.[11]

The QoL of patients with neurological sequelae can be improved with physical exercises.[12] Therefore, physiotherapy can serve as an important and supportive alternative to pharmacological treatment, and indeed it is one of the most commonly used conventional therapies in PD. Motor control can be improved and maintained with physiotherapy, which can also delay motor control problems.[13,14]

Currently, activities for rehabilitation with virtual reality (VR) have been used as treatment of patients with motor and neurological disorders. VR is a real time applied technique, in which the patient interacts with a three-dimensional environment of a computational system. This modality requires the use of the user's senses, such as sight, sound and touch.[15] The knowledge of this tool allows the user to be integrated in a virtual environment for the training of movements and tasks. The system allows interaction and feedback on the patient's performance in real time, what stimulates motor system and cognition.[16]

Therefore, it is important to research strategies that promote the physical and mental well-being of individuals with PD, since the progressive nature of the disease is linked to the appearance of various physical limitations and consequent decline in the perception of QoL.

OBJECTIVE

The objective of this study was to evaluate the functional capacity and QoL of patients with PD after RV-associated physiotherapy with X-Box Kinect®.

METHODS

Study design

This is a randomized double-blind clinical trial that was conducted according to the Consort guideline.

Setting and study period

This study was carried out at the *Associação de Parkinson de Pernambuco (ASP/PE)*, Brazil, from February to April 2014.

Sample and Eligibility

A convenience sample was composed of participants from ASP-PE who were recruited after verbal invitation. Patients of both sexes, between 50 and 74 years of age, classified according to the original version of Hoehn and Yahr (HY) scale[17] as stages HY1, HY2 and HY3 were included in the study.

We excluded from the study those who had difficulties to understand the questionnaire or who refused to respond it, patients who underwent physical therapy or who presented other associated neurological, orthopedic or cardiological limiting pathology.

Ethics

All the volunteers were clarified about the research objectives and methodology and signed the Informed Consent Form (ICF). The research began after the approval of the Research Ethics Committee of the *Centro Universitário Maurício de Nassau - Recife / PE* (CAAE: 18732713.0.0000.5193) and the Clinical Trials registry (NCT02786433). The research was approved by the Ethics Committee in accordance with the Declaration of Helsinki.

Intervention and Outcomes

The individuals included in the study were randomly distributed through a simple draw and formed two groups (control and experimental) with equal numbers of subjects.

The control group (CG) had as a treatment a program of exercises with conventional physiotherapy (CF), according the adapted care protocol based on Silva's study.[18] The protocol was divided into 3 phases (1, stretching; 2, strengthening with help of shin stick, elastic band, and overball; and 3, gait and balance training). The treatment of the experimental group (EG) applied VR combined with CF.

To ensure blinding, evaluations, treatment and reevaluations were performed by different trained researchers. After the initial evaluations, the treatment was started. It lasted five weeks, two sessions each week, totaling in ten treatment sessions. Subsequently, the subjects were submitted to reevaluation.

The data collection was carried out when the patients were under the effect of medication (*on*) by the Unified Parkinson's Disease Rating Scale - UPDRS and the Parkinson's Disease Questionnaire - 39 (PDQ -39).

The UPDRS assesses the progression of the disease. It is composed of 42 items, divided into four parts: mental activity, behavior and mood; activities of daily living (ADL); motor assessment; and complications of drug therapy. For this study, the following items were evaluated: ADL and motor assessment (*on*). The score in each item ranges from 0 to 4, the highest scores indicates a greater commitment, and the lowest scores indicates normality.[19,20]

The PDQ-39 is a specific, easy-to-understand and self-administered questionnaire that assesses the perception of QoL in PD patients. It is composed of 39 items divided into eight domains: mobility; activities of daily living; emotional well-being; PD social difficulties; social support; cognition;

communication and physical discomfort. The score varies from 0 (no problem) to 100 (maximum level of problem), that is, lowest scores indicate better perception of the quality of life.[19,21]

The patients of the CG always performed CF with the same physiotherapist. The stretching exercises were done actively and lasted 15 seconds each, and the strengthening exercises were active-resisted with three sets of 10 repetitions with a 60 second interval in-between.

The patients of the EG performed CF associated with VR that applied Microsoft X-Box Kinect® console and lasted 30 minutes each. For monitoring of the clinical conditions, vital signs such as blood pressure and heart rate were measured before and after each game session.

During the practice of VR, the patients assigned to the experimental group performed both Kinect Adventures® and Kinect Dance® games that required the patients to have antero-posterior and lateral-lateral movements, jumps and squats to get rid of obstacles in the game, what stimulate reactions of straightening and protection, motor coordination, range of motion of the upper and lower limbs, and activation of the cardiorespiratory system. Before performing the game Kinect Dance® it was assured if the patients could perform the movements of the dance in a satisfactorily.

Statistical analysis

The data were pooled in Microsoft Excel spreadsheets and the results were presented descriptively as measure of central tendency and dispersion. For the intergroup comparison of the UPDRS and PDQ-39 scores before and after the therapeutic intervention, the Mann-Whitney U test was used, whereas the Wilcoxon test was used for the intragroup comparison. As a level of statistical significance, p <0.05 was considered. The data was with the statistical pack BiosEstat 5.0.

RESULTS

Thirty individuals were recruited initially, although 10 were excluded because they did not meet the eligibility criteria. The sample consisted of 20 individuals with clinical diagnosis of idiopathic PD, randomly assigned to two groups (control and experimental) of 10 patients each (Figure 1).

The sample consisted of 20 individuals, 16 men and 4 women, with mean age of 63 (7) years. The CG (n=10, 9 men) was composed of two patients HY 1, six HY 2 and two HY 3. The mean age of the CG was 62 (8) years. The EG (n=10, 7 men) comprised two HY 1 patients and eight HY 2 patients. The mean age of the EG was 63 (7) years.

There was no statistically significant difference between the groups in relation to the disease stage (p=0.54) and age (p=0.74), nor in the other outcome variables before the intervention: total UPDRS (p=0.32) and PDQ-39 (p=0.93).

The UPDRS scores showed a decline in the AVD, motor and total UPDRS sections in both groups, i.e an improvement in these parameters. However, this difference was only statistically significant in the EG (Table 1).

In the intergroup comparison of UPDRS, statistical significance was not found before the intervention (ADL: p=0.1534; motor assessment: p=0.0905; and total UPDRS: p=0.0595), showing that in all analyzed parameters the groups were homogeneous. The means of the scores obtained by the studied groups at the different moments are shown in Figure 2.

In the EG all PDQ-39 domain scores showed a significant decline after the therapeutic intervention: mobility (p=0.007), ADL (p=0,002), emotional well-being (p=0.005), PD social difficulties (p=0.027), cognition (p=0.005), communication (p=0.007), physical discomfort (p=0.007), and total score (p=0.005). In the CG this reduction was only statistically significant in the following domains: PD social difficulties (p = 0.034), cognition (p = 0.046) and total score (p = 0.019).

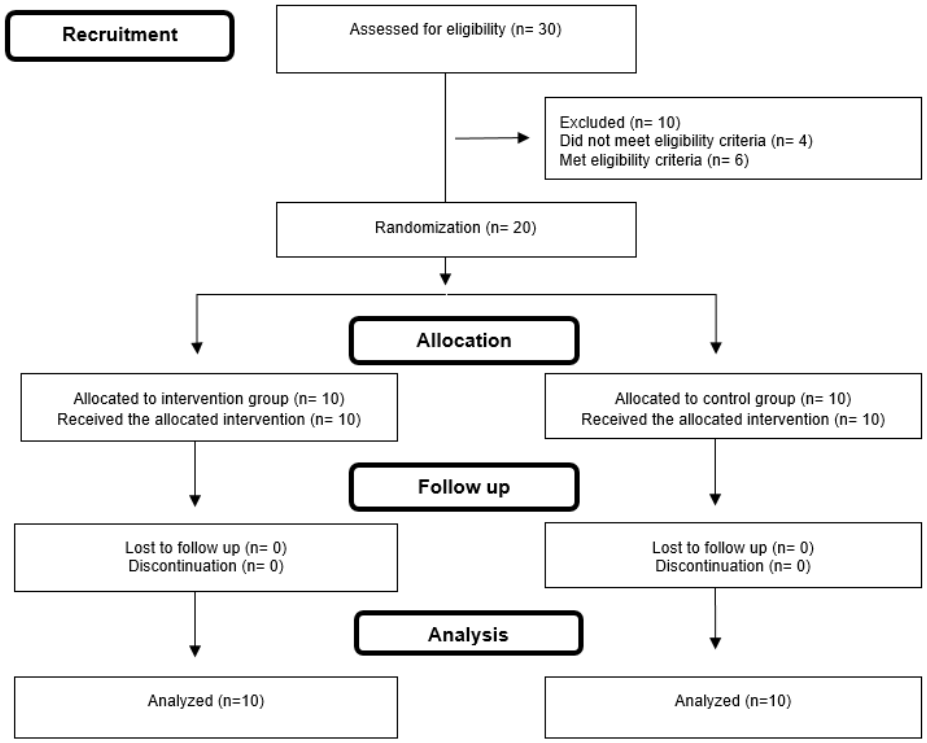


Figure 1. Consort flow.

Table 1. Comparison between the means of the UPDRS domains before and after the therapeutic intervention

	ADL		Motor assessment		Total UPDRS	
	CG	EG	CG	EG	CG	EG
Before	10 (3)	12 (3)	20 (5)	24 (8)	30 (8)	36 (10)
After	9 (3)	7 (3)	17 (5)	15 (5)	27 (7)	22 (7)
P value	0.1534	0.0015*	0.1211	0.0074*	0.3279	0.0009*

* Wilcoxon statistical test, significance p< 0.05 (intragroup comparison); ADL: Activities of daily life; UPDRS: Unified Parkinson's Disease Rating Scale; CG: Control group; EG: Experimental group; mean (standard deviation).

In the intergroup comparison of the PDQ-39 domains, there was a statistically significant difference after the intervention in the following domains: emotional well-being, PD social difficulties and physical discomfort (Table 2).

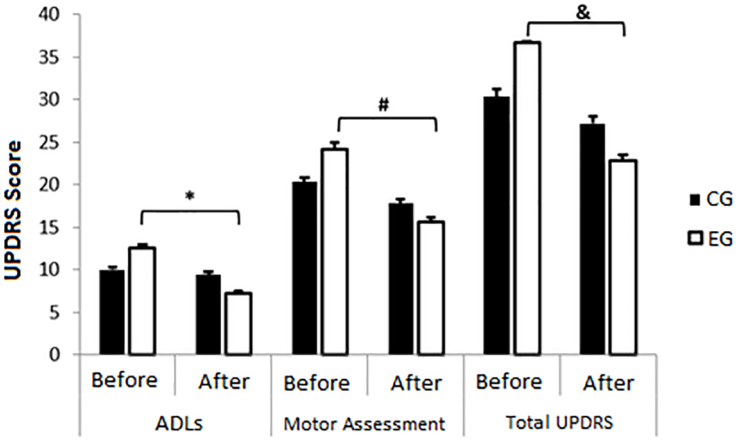
In the intergroup comparison of the PDQ-39 total score, there was a significant difference between CG and EG after the therapeutic intervention (Figure 3).

DISCUSSION

Virtual rehabilitation is an innovative and promising strategy for the treatment of patients with motor disorders involving gait, balance and postural corrections.[15] In the present study, a statistically significant decrease was found in the UPDRS scores of the experimental group when compared to the control group.

The analysis of the UPDRS domain of motor assessment includes items such as tremor, muscle stiffness, posture and gait, and all these items were significantly improved in subjects who underwent VR therapy. Gonçalves and collaborators[22] had already observed a reduction in motor impairment, especially in stiffness and flexibility of the lower limbs evaluated by the UPDRS (motor assessment) of 15 individuals with PD after 14 sessions of VR using the Nintendo Wii console.

Oppositely, Yang et al.[23] did not find significant improvements in the motor assessment of UPDRS of ten individuals with PD who used a balance training protocol with the use of VR. This study also shows that a group of ten individuals with PD who received physical rehabilitation supervised by a physiotherapist without VR did not obtain significant improvements in the UPDRS motor assessment, what agrees with the findings of the CG in the present study.



* ADLs; # Motor Assessment; & total UPDRS; Mann-Whitney U test, significance p< 0.05 (intergroup comparison). UPDRS: Unified Parkinson's Disease Rating Scale; CG, control group; EG, experimental group.

Figure 2. CG and EG mean scores (Standard deviation) of UPDRS domains before and after intervention.

Table 2. Intergroup comparison between PDQ-39 domains after therapeutic intervention

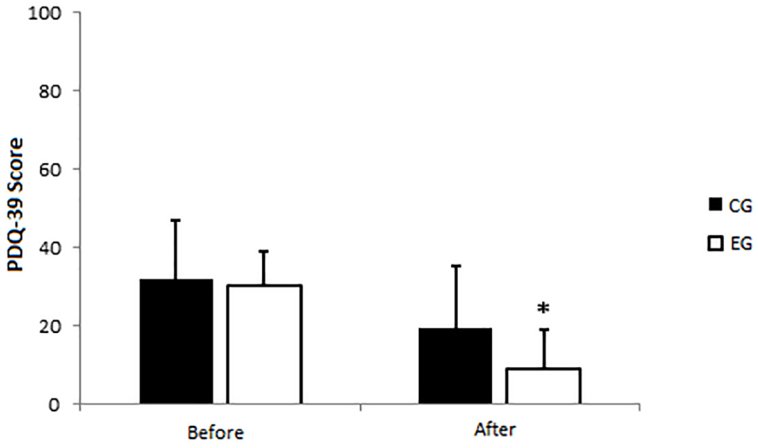
DOMAINS	CG	EG	P value
Mobility	17 (16)	6 (6)	0.185
AVD	21 (16)	10 (8)	0.112
Emotional well-being	24 (20)	12 (23)	0.031*
PD social difficulties	21 (27)	5 (14)	0.049*
Social support	5 (16)	7 (21)	0.969
Cognition	20 (18)	14 (8)	0.762
Communication	22 (17)	10 (11)	0.121
Physical discomfort	29 (16)	12 (12)	0.021*

* Mann-Whitney U statistical test, significance p< 0,05 (intergroup comparison); PDQ-39: Parkinson Disease Questionnaire-39; ADL, Activities of Daily Life; CG: Control group; EG: Experimental group; mean (standard deviatioin).

Functions such as walking, hygiene, dressing, changing bed position and incidence of falls were evaluated in the ADL section of the UPDRS, in which significant improvements were found in the EG. In a randomized trial[24] with 32 subjects with PD were allocated to balance training groups with and without VR, significant improvements in ADL were observed in both groups. Per protocol, subjects were submitted to 1 hour of intervention that included: stretching, active exercises in diagonal patterns, and training of static, dynamic and standing gait. Wii Fit games were chosen for balance training for the VR group and similar exercises were performed by the subjects of the control group of this study, who did not use VR.

Motor limitations related to activities of daily living, mobility and communication have a negative impact on the perception of quality of life[10], which can lead to isolation and little participation in social life of individuals with PD.[25] After the intervention of the EG, a significant improvement was seen in all domains of the PDQ-39: mobility, ADL, emotional well-being, PD social difficulties, cognition, communication, physical discomfort and in the total score. Santana et al.[26] showed that the ADL, social support, communication and physical discomfort domains did not show significant improvements after 20 sessions of non-immersive VR of 14 individuals with PD. These divergent results found by these authors can be justified because there is no association of VR with conventional physiotherapy, and with the choice of games, that in their case was Your Shape - Fitness Evolved, Kinect Adventures and Kinect Sports.

In the experimental study by Herz et al.[27] 20 patients with PD (HY2) undertook an exercise protocol based on VR composed of sports games (tennis, bowling and boxing) for 12 sessions. Analyzing the PDQ-39 results of this study, significant improvements were observed in ADL, emotional well-being, communication, physical discomfort and in the total score. Our results showed significant improvements in emotional well-being, PD social difficulties, physical discomfort and in the total score between both groups. Liao et al.[28] also found significant improvements in PDQ-39 in the virtual reality group as well as in the six-week traditional exercises group, 30 days after the interventions. Also, there was no difference in the control group that only received advices regarding prevention of falls.



* Statistically significant at Mann-Whitney U test, significance p< 0,05 (intergroup comparison). PDQ-39: Parkinson Disease Questionnaire-39; CG: Control group; EG: Experimental group.

Figure 3. Mean ± standard deviation of the PDQ-39 total score of CG and EG before and after the intervention.

Therefore, the present study evidenced relevant findings. However, the small number of subjects in each group may be associated with type II error. Another limitation is the clinical heterogeneity among the patients with PD, a common difficulty encountered in these samples. In addition, the variable quality of life assessed by PDQ-39 is a self-reported variable and other factors can be involved, combined with the clinical intervention.

CONCLUSION

Virtual Reality is an innovative method that has been used in the treatment of motor disorders. It is an interesting alternative because it involves playful and dynamic aspects, for increasing the motivation of the patient during the interventions. When combined with conventional physiotherapy, it can promote gains in functional capacity and quality of life of individuals with PD, showing that exercise not only increases physical fitness, but also positively influences the interaction of the subject with the environment during their activities of daily living. Further studies are suggested with the use of VR in larger samples and with long term.

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