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Original Article

Effect of virtual reality dance exercise on the balance, activities of daily living, and depressive disorder status of Parkinson's disease patients

Nam-Yong Lee, MSc[1)], Dong-Kyu Lee, MSc[2)*], Hyun-Seung Song, MSc[1)]

[1)] *Department of Physical Therapy, Graduate School of Physical Therapy, Daejeon University, Republic of Korea*
[2)] *Department of Physical Therapy, Yeol-Lin Hospital: 570-15 Songchung-dong, Gwangsan-gu, Gwangju 504-704, Republic of Korea*

Abstract. [Purpose] In this study, we examined the effects of virtual reality dance exercise on the balance, activities of daily living and depressive disorder status of Parkinson's disease patients. [Subjects] Twenty patients were assigned either the experimental group (n = 10) or the control group (n = 10). All participants received 30 minutes of neurodevelopment treatment and 15 minutes of functional electrical stimulation 5 times per week for 6 weeks. The experimental group additionally performed 30 minutes of dance exercise. Balance, activities of daily living, and depressive disorder status were assessed before and after the 6-week treatment period using the Berg balance scale, the Modified Barthel Index, and the Beck Depression Inventory. The paired t-test was used to detect differences before and after treatment, and the independent t-test was used to detect differences between the treatment groups. [Results] The values for balance, activities of daily living, and depressive disorder status significantly differed between before and after treatment in the experimental group, and significantly differed between the experimental group and control group. [Conclusion] Virtual reality dance exercise has a positive effect on balance, activities of daily living, and depressive disorder status of Parkinson's disease patients.
Key words: Virtual reality, Parkinson's disease, Balance

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INTRODUCTION

Parkinson's disease (PD) is caused by dopamine deficiency, which negatively affects cerebral basal ganglia function[1)]. The progressive chronic neurodegeneration of the brain associated with PD impairs balance and motor ability. These chronic, negative effects on motor function are accompanied by memory defects and a decreased ability to understand[1, 2)]. In addition, emotional stability deteriorates, which results in difficulty with activities of daily living (ADL) and an increasing feeling of despair and depression; which causes a decline in the quality of life of a patient[2, 3)]. The treatment of PD with medication prescribed by doctors replenishes the deficient dopamine level preventing or delaying nerve cell destruction, thus delaying the progress of the disease[4)]. However, in cases receiving long-term treatment, disease acceleration, motor disturbance, cognitive impairment, or autonomic nerve malfunction may develop[5)].

Exercise protects and promotes regeneration of damaged nerves, and enhances balance, physical state, and independency, thereby facilitating ADL. With an appropriate exercise intensity, dopamine levels can be increased and motor disturbances can be improved[6, 7)]. Therefore, treatment needs to integrate prescription medicines and exercise therapy.

Exercises in virtual reality provide visual, auditory, and tactile feedback, and the exercise intensity can be modified by adjusting the difficulty of interactions and intensity[8, 9)]. There are no limitations in terms of time or place, thus enabling continuous active exercise[8)]. Virtual reality dance exercise has been reported to have a positive effect on cerebral palsy, dementia, and the recovery of physical function of stroke patients[9–12)]. However, there are insufficient studies of the effects of virtual reality dance exercise on PD patients.

In this study, we aimed to examine the effect of virtual reality dance exercise on balance, ADL, and depressive disorder status of PD patients.

SUBJECTS AND METHODS

Twenty participants with PD were randomly assigned to either the experimental group (5 males, 5 females) or the control group (5 males, 5 females). Patients were able to understand the study requirements and to communicate sufficiently, and could ambulate independently. All participants

*Corresponding author. Dong-Kyu Lee (E-mail: ldkpt@hanmail.net)

were informed about the objectives and method of the study and agreed to participate. The study protocol was approved by the Institutional Review Board of Nambu University and was conducted in accordance with the ethical principles of the Declaration of Helsinki. The general characteristics of the participants are listed in Table 1. The age (mean±SD) of the experimental group was 68.4±2.9 years, height was 165.1±9.1 cm, and weight was 63.8±10.2 kg. The age of the control group was 70.1±3.3 years, height was 165.2±8.4 cm, and weight was 63.7±10.1 kg.

All participants received 30 minutes of neurodevelopment treatment (NDT) and 15 minutes of functional electrical stimulation (FES) 5 times per week for 6 weeks. The experimental group participated in an additional 30 minutes of dance exercise. The virtual reality dance exercise used the K-Pop Dance Festival (Nintendo Inc., Japan) game for the Wii (Nintendo Inc., Japan) video game system. Songs liked by patients were selected from the various categories of K-Pop music included in the software. A strap was used to fix the remote control to the hands, and the patients tried to mimic the characters on the TV monitor. When subjects properly mimicked the movement, they felt vibrations from the remote control and heard the word "perfect" broadcast by the TV speaker.

Balance was assessed using the Berg balance scale (BBS). The BBS consists of 14 items and can be divided into balance for sitting, standing, and position changes. The score given ranges from 0 to 4 points, with a highest possible score of 56 points, and higher scores indicate better balance. ADL was assessed using the Modified Barthel index (MBI). The MBI consists of 10 items: 5 points for personal hygiene, 5 points for taking a bath, 10 points for eating, 10 points for using the toilet, 10 points for ascending stairs, 10 point for putting on clothes, 10 points for defecation, 10 points for urination, 15 points for walking, and 15 points for using the bed, with a highest possible score of 100 points. A score of 0–24 points indicates complete dependence; 25–48, maximum dependence; 50–74, partial dependence; 75–90, slight dependence; 91–99, minimum dependence; and 100, complete independence. The presence and severity of depressive disorder was assessed using the Beck depression inventory (BDI). The BDI consists of 21 items covering emotional and physiological symptoms. The score ranges from 0 to 3 points, with a highest possible total of 63 points. A score of 0–9 points indicates no depression; 10–15, light depression; 16–23, heavy depression; and 24–63, severe depression. The balance scores, ADL score, and depressive disorder status were recorded before and after the 6 weeks of treatment.

Data were analyzed using SPPS 12.0 for Windows. Descriptive statistics were used to describe the general characteristics of the participants. The paired t-test was used to compare pre- and post-treatment variables, and the independent t-test was used to compare the treatment groups. The significance level for all tests was $\alpha=0.05$.

Table 1. General characteristics of each group

	EG (n=10)	CG (n=10)
Gender (male/female)	5/5	5/5
Age (years)	68.4±2.9[a]	70.1±3.3
Height (cm)	165.1±9.1	165.2±8.4
Weight (kg)	63.8±10.2	63.7±10.1

[a]Mean±SD, EG: Experimental Group, CG: Control Group

RESULTS

The changes in balance are shown in Table 2. After 6 weeks of treatment, balance had significantly improved in the experimental group (46.0±1.3 to 48.1±3.0; $p<0.05$), while the control group showed no significant improvement (45.0±1.3 to 45.4±1.5; $p>0.05$). Compared to the control group, balance of the experimental group was significantly enhanced ($p<0.05$). Changes in ADL are shown in Table 2. After treatment, ADL had significantly improved in the experimental group (87.9±1.4 to 91.1±3.0; $p<0.05$), while ADL of the control group showed no significant improvement (87.4±1.7 to 88.2±1.8; $p>0.05$). Compared to the control group, ADL of the experimental group were significantly enhanced ($p<0.05$). The changes in depressive disorder status are shown in Table 2. After treatment, the depressive disorder status significantly improved in the experimental group (20.4±0.9 to 18.2±2.0; $p<0.05$), while the depressive disorder status of the control group showed no significant improvement (21.2±1.3 to 20.6±1.5; $p>0.05$). Compared to the control group, the depressive disorder status of the experimental group was significantly improved ($p<0.05$).

Table 2. Comparison of BBS, MBI, and BDI values between the experimental and control groups

	Group	Pre	Post	D-value
BBS	EG	46.0±1.3[a]	48.1±3.0*	2.1±2.3*
	CG	45.0±1.3	45.4±1.5	0.4±0.8
MBI	EG	87.9±1.4	91.1±3.0*	3.2±3.0*
	CG	87.4±1.7	88.2±1.8	0.8±1.6
BDI	EG	20.4±0.9	18.2±2.0*	−2.2±1.9*
	CG	21.2±1.3	20.6±1.5	−0.6±0.8

[a]Mean±SD, *$p<0.05$, EG: Experimental Group, CG: Control Group, D-value: Difference-value, BBS: Berg Balance Scale, MBI: Modified Barthel Index, BDI: Beck Depression Inventory

DISCUSSION

This study aimed to examine the effect of virtual reality dance exercise on the balance, ADL, and depressive disorder status of PD patients. Within-group comparisons demonstrated that balance improved significantly in the experimental group. The group comparison showed balance of the experimental group significantly improved relative to the control group. The present results corroborate those of Esculier et al.[13], Yen et al.[14] and Suarez et al.[15] who showed that virtual reality dance exercise enhanced the balance ability of PD patients. Virtual reality exercise provides visual and auditory feedback while watching the motion of the game character, thus improving balance through integration of feedback from the scala vestibule and proprioceptors. Hence, this method can enhance the balance of PD patients[8, 9, 13].

Virtual reality exercise provides active learning and motivation to patients through an experiential environment[16]. Yavuzer et al.[17] showed that virtual reality dance exercise significantly enhances functional independence, and Zhang et al.[18] showed that it resulted in a significant enhancement of ADL. The present study also found there was a significant enhancement of ADL of PD patients following their performance of virtual reality dance exercise. Dance exercise helps to maintain and increase the range and approach of a patient's movement; it also helps with switching the direction of movement, when performing two simultaneous but separate movements in conjunction with music. Moreover, it provides various unpredictable movement patterns, thus helping PD patients who have impaired ADL[19–21].

A depressive disorder may be caused by the disease itself or may be a side effect of the treatment medication itself. Depressive disorder delays the recovery of physical function and makes it more difficult to perform ADL. Lee et al.[22] and Kim and Lee[23] demonstrated that virtual reality exercise reduces the presence and severity of depressive disorders. The present study corroborates these previous findings since it showed a beneficial effect of virtual reality exercise on the depressive disorder status of PD patients. K-Pop virtual reality dance exercise was performed by the subjects of this study. K-Pop dance utilizes repetitive lyrics and melodies and consists of simple brisk rhythms and beats. Because these features can be used as a targeted treatment and because virtual reality exercise can elicit voluntary participation, the K-Pop virtual reality dance exercise may help improve the depressive disorder status of PD patients[23, 24].

A limitation of this study was that it was conducted with only 20 PD patients, thus making it difficult to generalize the result to all patients with the disease. Further research with a larger cohort is needed. Another limitation of this study is a lack of specific history regarding the treatments the patients received prior to their participation. There is a need for additional research on the effect of various exercise programs other than virtual reality dance exercise.

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