Journal of the Formosan Medical Association (2016) 115, 734–743

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.jfma-online.com

ORIGINAL ARTICLE

Home-based virtual reality balance training and conventional balance training in Parkinson's disease: A randomized controlled trial

Wen-Chieh Yang [a], Hsing-Kuo Wang [a], Ruey-Meei Wu [b], Chien-Shun Lo [c], Kwan-Hwa Lin [a,d,*]

[a] *School and Graduate Institute of Physical Therapy, College of Medicine, National Taiwan University, Taipei, Taiwan*
[b] *Department of Neurology, National Taiwan University Hospital, College of Medicine, National Taiwan University, Taipei, Taiwan*
[c] *Department of Multimedia Design, National Formosa University, Huwei Township, Yunlin, Taiwan*
[d] *Department of Physical Therapy, Tzu Chi University, Hualien, Taiwan*

Received 26 August 2014; received in revised form 7 July 2015; accepted 8 July 2015

KEYWORDS
balance training;
Parkinson's disease;
virtual reality

Background/Purpose: Virtual reality has the advantage to provide rich sensory feedbacks for training balance function. This study tested if the home-based virtual reality balance training is more effective than the conventional home balance training in improving balance, walking, and quality of life in patients with Parkinson's disease (PD).
Methods: Twenty-three patients with idiopathic PD were recruited and underwent twelve 50-minute training sessions during the 6-week training period. The experimental group ($n = 11$) was trained with a custom-made virtual reality balance training system, and the control group ($n = 12$) was trained by a licensed physical therapist. Outcomes were measured at Week 0 (pretest), Week 6 (posttest), and Week 8 (follow-up). The primary outcome was the Berg Balance Scale. The secondary outcomes included the Dynamic Gait Index, timed Up-and-Go test, Parkinson's Disease Questionnaire, and the motor score of the Unified Parkinson's Disease Rating Scale.
Results: The experimental and control groups were comparable at pretest. After training, both groups performed better in the Berg Balance Scale, Dynamic Gait Index, timed Up-and-Go test, and Parkinson's Disease Questionnaire at posttest and follow-up than at pretest. However, no significant differences were found between these two groups at posttest and follow-up.

Conflicts of interest: The authors have no conflicts of interest relevant to this article.

* Corresponding author. Department of Physical Therapy, Tzu Chi University, Number 701, Section 3, Jhongyang Road, Hualien City 97004, Taiwan.
E-mail address: khlin@ntu.edu.tw (K.-H. Lin).

http://dx.doi.org/10.1016/j.jfma.2015.07.012

Conclusion: This study did not find any difference between the effects of the home-based virtual reality balance training and conventional home balance training. The two training options were equally effective in improving balance, walking, and quality of life among community-dwelling patients with PD.

Introduction

Patients with Parkinson's disease (PD) demonstrate progressive impairments in balance and walking function.[1] In standing, patients exhibit delayed, reduced postural response to regain stability from balance disturbances. In walking, patients take small, shuffling steps with increased stride-to-stride variability.[2] The impaired balance and walking function increase the patients' fall risk and have a substantial impact on their quality of life.[3]

In the recent decade, virtual reality (VR) has become generally accepted as a therapeutic tool for neurological patients to interact with simulation from the environment via multiple sensory channels.[4,5] VR training can be applied using commercially available devices (e.g., Wii with balance board) or the prototype developed by the researchers,[6] such as Esculier et al[7] using Wii Fit with a balance board for 6 weeks of home-based balance training in patients with PD. Their results indicated that Wii Fit with VR programs could improve the static balance (i.e., one-leg stance), dynamic balance (i.e., center of pressure weight shift), mobility (i.e., timed Up-and-Go test, TUG), and functional abilities (i.e., Community Balance and Mobility scale) of patients with PD. However, they only recruited 11 PD patients and nine healthy controls without randomization. Pompeu et al[8] investigated the effect of 7 weeks of Nintendo Wii-based motor cognitive training versus balance exercise therapy in patients with PD via a randomized controlled trial, with the training taking place at the Brazilian Parkinson Association. The results indicated both groups showed a significant improvement on the Berg Balance Scale (BBS), Unipedal Stance Test (with open and closed eyes), and Montreal Cognitive Assessment after training, and the effects were maintained at follow-up (i.e., 60 days).[8] However, no group effect (Wii vs. exercise) was found. Thus far, it is still unclear how effective home-based VR balance training is compared to conventional balance training.

Hsieh et al[9] reported that patients with PD were impaired on tasks with internal cues but performed normally on tasks with external cues. Furthermore, an external visual cue was commonly used to compensate for impaired kinesthetic feedback and attentional processing to bypass the deficit of internal cueing.[10] It was suggested that VR could provide the visual and/or cognitive cues to facilitate motor learning, retention, and transfer in patients with PD.[11] Thus, the aim of the present study was to examine the effect of our developed prototype VR balance training for patients with PD living at home. The research hypotheses of this study are: (1) VR balance training can improve balance and other related tasks and (2) the VR balance training might be superior to conventional balance training in patients with PD living at home.

Methods

Participants

Community-dwelling patients with idiopathic PD based on the UK Parkinson's Disease Society Brain Bank criteria[12] were recruited from the neurological department of a university-based medical center. The inclusion criteria were (1) age 55–85 years; (2) intact cognitive function (Mini-Mental State Examination score $>$ 24)[13]; (3) Hoehn–Yahr Stages II–III; (4) not engaged in balance or gait training in the past 6 months; (5) no untreated medical conditions (e.g., knee arthritis) that might affect balance and walking function. The exclusion criteria were those with untreated depression or underlying significant visual/auditory impairments. The informed consent form approved by the center's research ethics committee was signed by all participants prior to physical screening.

Procedure

The trial was registered on ClinicalTrials.gov (identifier: NCT01301651) and the CONSORT (Consolidated Standards of Reporting Trials)-type flow diagram is shown in Figure 1. Eligible participants were assigned to the experimental or control group using a dynamic randomization algorithm written in MATLAB (version 7.10.0; The Mathworks Inc., Natick, MA, USA).[14] All participants received twelve 50-minute sessions of balance training, twice per week for 6 weeks. The training of the experimental and control groups was conducted separately by two physical therapists. The pretest (Week 0), posttest (Week 6), and follow-up (Week 8) assessments were conducted by an independent assessor who was blinded to the group allocation. Participants underwent the three assessments during their medication ON period (1 hour after drug intake), and it took 40–60 minutes to complete all measurements.

VR balance training system

As shown in Figure 2, the VR balance training system included a 22-inch all-in-one touchscreen computer (Micro-Star International Co., Ltd., New Taipei City, Taiwan) and a wireless balance board. The VR balance training system was developed by the Cycling and Health Center of Taichung, Taichung, Taiwan. The balance board measured the center of pressure by embedded load cells, and transmitted the signals wirelessly to the computer via Bluetooth. The center of pressure was used for controlling the virtual objects (e.g., a virtual car or human avatar) in the VR software. The sensitivity of the balance board could be set to different