Journal of Novel Physiotherapies

Tousignant, et al., J Nov Physiother 2015, 5:1
http://dx.doi.org/10.4172/2165-7025.1000247

Research Article Open Access

Assessment of the Feasibility of the Nintendo Wii Balance Board as an Intervention Method For Balance Rehabilitation with Lower-limb Amputees

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Received : November 11, 2014, **Accepted:** January 21, 2015, **Published:** January 27, 2015

Abstract

Lower-limb amputations have a major impact on balance and functional skills, which can be limited by rehabilitation. The Wii Balance Board (WBB) with its Wii Fit game (WFg) is often used in clinical settings with lower-limb amputees but there is little research concerning its efficacy in improving static and dynamic balance. This study aims to assess the feasibility of using the Nintendo Wii Balance Board (WBB) and Wii Fit game (WFg) for balance rehabilitation with lower-limb amputees. A pre-/post-intervention pilot study design with no control group was used. Participants received 5 WBB and WFg rehabilitation sessions / week for 8 weeks. The length of the training sessions gradually increased from 10 to 30 minutes. Clinical outcomes were measured before (T1) and after (T2) the program and consisted of: 1) walking (L-test), 2) function and balance (Amputee Mobility Predictor [AMPPRO]), 3) satisfaction (Health Care Satisfaction Questionnaire [HCSQ]), 4) motivation (visual analog scale), and 5) quality of life (Trinity Amputation and Prosthesis Experience Scales [TAPES]). All participants (n=3) showed an improvement on all the clinical outcomes, except for the two functional tests, where one participant performed worse at T2 than T1. This pilot study demonstrated the feasibility of using the WBB and its WFg for balance rehabilitation with lower-limb amputees. Further research is needed to determine if this method is at least as effective as conventional interventions.

Keywords: Lower-limb amputation; balance training; wii balance board; rehabilitation

Introduction

Amputations affect a large and increasing number of people in North America. In 2005 the prevalence of amputations in the United States was 1.6 million [1]. The most frequent causes of lower-limb amputations are vascular, traumatic, infectious and neoplastic [2,3]. Amputation has dramatic consequences in terms of functional abilities and quality of life because of its impact on a person's static and dynamic balance [4] as well as confidence in his/her balance abilities [4]. The extent of the functional deficits varies depending on the level of amputation. For example, the energy expended is higher for femoral amputees than tibial amputees for the same walking distance [5]. Femoral amputees also performed worse than their tibial-amputee counterparts on functional mobility tests. As functional abilities of amputees are highly correlated with balance (lower functional levels are correlated with greater balance deficits), they are more prone to falls as well [6].

To improve functional abilities in amputees, balance retraining during the rehabilitation process is crucial [7]. Current clinical practices in the rehabilitation of amputees aim to improve balance and gait. The purpose of rehabilitation interventions is usually to increase the strength of both the healthy and the residual limb, the patient's flexibility, cardiovascular capacities, and balance [8,9]. However, few studies have demonstrated such benefits with different intervention methods, including: (1) soccer training with unilateral transtibial amputees [10]; (2) audiovisual biofeedback and electrical stimulation [11]; and (3) use of the BalanceReTrainer [12]. The latter is an interesting intervention method since it provides feedback on a computer screen and allows the difficulty of the tasks to be gradually increased while addressing the fear of falling [13].

The BalanceReTrainer is similar to the Nintendo Wii Balance Board (WBB), which is well known for its low cost and availability [14]. Even if this gaming console with its Wii Fit game (WFg) is predominantly used in a clinical rehabilitation context [15-17], few studies have been conducted with the WBB that specifically target balance rehabilitation in different populations [18-20]. However, those few have been positive about the benefits of this rehabilitation method in improving balance. For example, a study with acquired brain injury hemiparetic patients demonstrated that the WBB intervention (n=9) significantly improved static balance on the Berg Balance Scale and Anterior Reach Test compared to standard rehabilitation (n=8) [18]. In two other studies, significant improvements in balance were also demonstrated with a community-dwelling older adult population (n=22) [19] and an older adult population presenting balance impairments (n=7) [20] after a 4-week or 3-month WBB intervention, respectively.

The WBB has also have been proven to have a favorable outcome in the retraining of balance abilities after lower-limb amputations [21]. However, there is little research on using the WBB with its WFg as a way to improve static and dynamic balance, specifically in a lower-limb amputee population. Therefore, this study aimed to: (1) assess the feasibility of the WBB for the balance rehabilitation of lower-limb

amputees (i.e. evidence of improvement in the patients' functional mobility, walking and balance); (2) measure the quality of life, satisfaction and motivation of the participants with regard to the intervention.

Materials and Methods

Design

This was a pilot study with pre-/post-intervention measures, where participants were their own controls. Assessments took place before and immediately after the 8-week WBB and WFg intervention program. This study presented short-term effects only because traditional rehabilitation treatment continued after our experimental intervention. Thus, the outcomes had the potential to improve over time, but not necessarily due to our intervention.

Sample

The participants were lower-limb amputees receiving rehabilitation as outpatients at the Centre de réadaptation Estrie (CRE) in Sherbrooke, Quebec. They were recruited through the clinical physiotherapist and occupational therapist assigned to this patient population between April and December 2011. This research project was approved by the research ethics committees of both the Centre for interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR) (# CRIR 560-1110) and Centre de santé et de services sociaux – Institut universitaire de gériatrie de Sherbrooke (CSSS-IUGS) (# 2011-42/Tousignant). The written consent of all participants was obtained.

To be included in the study, participants had to: (1) be referred to the CRE outpatient clinic; (2) have undergone an unilateral lower-limb amputation in the past six months; (3) have received a non-pneumatic lower-limb prosthesis less than one week before recruitment; (4) have a tolerance for standing for at least three minutes; (5) be able to complete the Amputee Mobility Predictor (AMPPRO) test in one evaluation session; and (6) have begun the prosthetic training. The exclusion criteria were having: (1) cognitive deficits according to the Modified Mini-Mental State Examination<65; or (2) uncorrected visual deficit preventing them from perceiving the feedback provided by the WFg.

Intervention: WBB and WFg program

The intervention consisted of a WBB and WFg program given over eight consecutive weeks. In a chronic phase of amputee rehabilitation, an adequate amount of time for rehabilitation is needed to maintain improvement of the function. A period of 8 weeks was judged to be a good window of opportunity to observe changes on outcomes with the intervention. Less intervention time might not have been enough considering the adaptation for patients and therapists to the novel therapy. During this period, participants had five WBB and WFg sessions per week, delivered by the clinical physiotherapist and occupational therapist from the CRE. The length of the training sessions gradually increased as the participants progressed, as judged by the clinicians, from 10 minutes until it reached 30 minutes. To complete the balance intervention, some balance exercises were done without the WBB (e.g. walking, specialized walking tasks and exercises with eyes closed to develop walking abilities and dynamic balance, respectively).

Dependent variables

The AMPPRO is designed to measure amputee patients' functional mobility with a prosthesis [22]. This evaluation tool consists of 21 tasks performed by the participant for a total maximum score of 47; a higher score indicates greater functional mobility. The AMPPRO final score is associated with the Medicare Functional Classification Levels [22]. Walking and balance were evaluated with the L-Test of Functional Mobility (L-Test). This is a timed test consisting of two position changes and four direction changes while the participant walks along a 10-meter L-shaped course [23]. The Trinity Amputation and Prosthesis Experience Scales (TAPES) is a self-administered questionnaire consisting of 37 items evaluating three satisfaction domains: (1) psychosocial adjustment, (2) activity restriction, and (3) satisfaction regarding the prosthesis [24]. Higher scores indicate better quality of life. Satisfaction with health care services was assessed with the validated French version of the Health Care Satisfaction Questionnaire (HCSQ). This self-administered questionnaire consists of 26 items answered on two different four-point Likert scales, and assesses patients' satisfaction with the health care and services received [25]. The total score can be computed as the mean overall satisfaction for the three factors. Higher scores indicate a higher level of satisfaction. This questionnaire showed a good internal consistency of the overall scale (Cronbach $\alpha = 0.92$) and a good convergent validity [25]. Finally, the research team developed a self-administered motivation questionnaire based on an existing questionnaire evaluating motivation at work. This questionnaire consists of 10 items scored by the participant on a four-point Likert scale. The participant also had to score, on a 10-point visual analog scale, his/her level of motivation with regard to the specific balance and general rehabilitation process.

		Participant A	Participant B	Participant C
Age (years)		65	69	57
Gender		Man	Man	Man
Amputation	Level	Trans-tibial	Trans-tibial	Trans-femoral
	Side	Left	Left	Left
	Cause	Diabetes	Diabetes	Diabetes trauma
	Delay between amputation and admission to outpatient clinic (days)	30	105	153

Table 1: Participants characteristics.

Data collection procedures

Members of the research team conducted the different evaluations at two different times during the participants' rehabilitation process. The first evaluation (T1) established the baseline for the functional mobility, walking and balance. It took place two weeks after the beginning of the prosthetic training, or as soon as the clinician physiotherapist judged it was safe to proceed with the evaluation. The second evaluation (T2) took place after the eight-week program, and in addition to the measures taken at T, quality of life, satisfaction and

motivation were evaluated using the adequate questionnaire previously described.

Results

Sample description

The sample consisted of three lower-limb amputees. They all completed the WBB and WFg intervention. Participants' characteristics are detailed in Table 1.

Efficacy of the interventions

Two (participants A and C) of the three participants showed improvement on the two functional tests between T1 and T2 (Figure 1). The other participant (B) had a decrease of 1 point on the AMPPRO test and took an additional 14.3 s to complete the L-test compared to baseline.

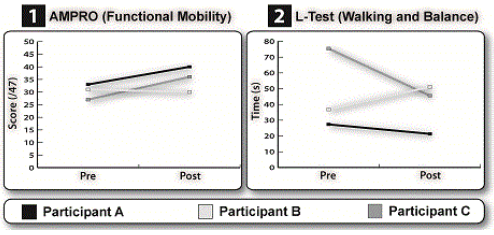

Figure 1: Efficacy of the intervention on functional mobilility and walking and balance

Quality of life

All three participants demonstrated a high perceived quality of life in the three domains measured (psychological adjustment, higher satisfaction regarding the prosthesis and lower activity restriction) with the TAPES at T2 (post-intervention) (Figure 2).

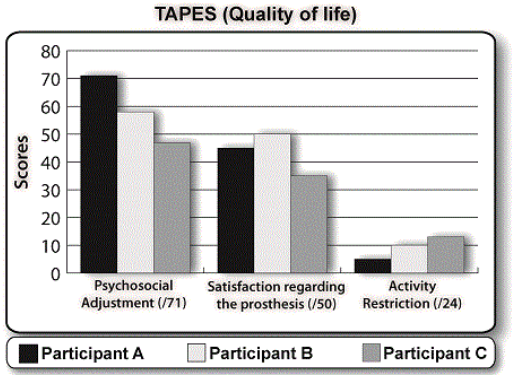

Figure 2: Efficacy of the intervention on quality of life

Health Care Satisfaction Questionnaire

All three participants indicated a high degree of satisfaction with the health care and services received. The scores on the HCSQ were 97%, 100% and 84%, respectively.

Motivation

All three participants showed good motivation concerning their participation in the balance rehabilitation program. This was observed for both the balance rehabilitation questionnaire (40, 39, 38/40, respectively) and the visual analog scale (9.8, 10.0, 7.8/10, respectively).

Discussion

The main objective of this pilot study was to assess the feasibility of the WBB and WFg as an intervention method for static and dynamic balance rehabilitation with a lower-limb amputee population. The potential implementation of this novel intervention approach in clinical settings was assessed by investigating its efficacy by measuring functional abilities pre-/post-intervention and by assessing participants' motivation and satisfaction with the intervention. The results indicate that the WBB could be used in rehabilitation programs for amputees.

Moreover, we established a tendency in the effect of the WBB and WFg on functional abilities. According to the results, the WBB and WFg can be used with lower-limb amputees to improve static and dynamic balance since two of the three participants demonstrated improvements in their functional balance assessed with the AMPPRO and the L-test. Given that the tests were performed only twice, 8 weeks apart, the concept of familiarisation is unlikely to explain the positive results obtained. However, the third participant (B) showed no improvement on either test. This could be due to the fact that he had a right-femoral amputation more than 15 years earlier. This first amputation could have limited his rehabilitation potential following his recent left-tibial amputation. Moreover, this participant's general health was precarious.

Nevertheless, the positive results of participants A and C are encouraging with regard to the use of the WBB and WFg as a complement to conventional interventions to improve balance in a lower-limb amputee population. However, it is not possible to conclude that the WBB and WFg intervention is better than conventional treatments because of the study design, i.e. no control group, small sample size (n=3), and the participants' different personal characteristics. There were disparities in age, comorbidities, and level and cause of amputation, which could potentially influence the participants' progress in rehabilitation.

In terms of satisfaction and motivation with regard to the rehabilitation services received, all the participants were satisfied and motivated by both the WBB and WFg intervention and the overall rehabilitation. Participant A was even more motivated by the WBB and WFg method than by the other aspects of his rehabilitation. As satisfaction is an important indicator of the degree of efficacy [26], our sample's high level of satisfaction predicted a high degree of motivation and treatment compliance.

Concerning the internal and external validity of this study, the main strength of this study was that outcomes were measured with standardized tools specific to lower-limb amputees, which minimized information bias. The assessments were structured to be administered in a predetermined order (the same for all participants) with sufficient

rest periods. Despite the fact that patients were recruited based on the rehabilitation therapists' admissions list, the small sample size may not exclude selection bias. Finally, external validity is poor because of the small sample size of this pilot study.

Further studies are needed with a larger sample size and the addition of a control group receiving only conventional balance interventions in order to assess whether the WBB and WFg intervention is more effective than, or as effective as, conventional interventions.

Conclusion

This pilot study demonstrated the feasibility of the WBB and WFg as an intervention method for balance rehabilitation with lower-limb amputees. Since it was easy for the therapists to include this intervention in their daily practice with amputees, it is an interesting therapeutic approach.

Acknowledgements

We would like to thank all the participants who took part in this study.

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