Case Report
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Virtual Reality Rehabilitation in a Case with Spinocerebellar Ataxia

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Abstract

Spinocereballar ataxias that are characterized by loss of balance and coordination as well as gait disturbances have a late-onset but progressive pattern. The goals of rehabilitation with patients with ataxia are the improvement of the balance and postural control, restoration of upper and lower extremity functions, achievement of improved functional walking, and improved independency in performing the daily activities of life. Virtual reality rehabilitation is a new neurorehabilitation technique that may be an alternative to the conventional rehabilitation. We aimed to present the effects of virtual reality rehabilitation on balance, gait, and functional independency of the patient with spinocerebellar ataxia.
Keywords: Virtual reality, rehabilitation, spinocerebellar ataxia

Introduction

Ataxia is an imbalance that affects the extremities while affected individuals walk, and it includes speech and coordination disorders. Cerebellar disorders, spinal cord disorders, peripheral sensory loss, or a combination of these three conditions can result in ataxia. Under functional disorders of these structures, diseases such as genetic, inflammatory, degenerative, vascular, infectious, metabolic, endocrine, or neoplastic can be found (1). Spinocerebellar ataxias are a clinically heterogeneous group of diseases with late onset. Several genetic mechanisms for spinocerebellar ataxia with autosomal dominant transmission, such as CAG repeat increases, point mutations, and SCA 6 channel disorders, have been proposed (2, 3).

Virtual reality rehabilitation (VRR) is an important alternative healing technique in neuromuscular recovery. The purpose of this study is to ensure the acquisition of neuromuscular skills with motivation-enhancing effects by ensuring maximum patient participation through biofeedback (4). Technological and popular gaming systems, such as Nintendo Wii, Dance Revolution, Sony EyeToy, and Kinect Xbox, can be used for VRR. Among these, the advantage of Kinect Xbox is that the user does not need to wear or hold a sensor with their extremities. We applied VRR using the Xbox Kinect (Microsoft© WA, the USA) system. This rehabilitation program is a computer-based system, and users perform the application by following the movements of virtual objects. VRR has been used for rehabilitation purposes to supplement conventional therapy such as Parkinson's disease, cerebral palsy, stroke, and multiple sclerosis therapy in various neurological disorders (4-8). In addition, VRR has been implemented for balance training in old people, even though they have no neuromuscular diseases (9).

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In this study, we present the case of a patient showing the effects of VRR administered alone in a patient with spinocerebellar ataxia on walking, balance, and functional independence.

Case Report

A 55-year-old male presented with complaints that started with a speech disorder 8 years ago. Complaints progressed with symptoms such as slow movements, difficulty in walking, and imbalance. The patient was admitted to the neurology clinic of our hospital with these complaints. A diagnosis of autosomal dominant spinocerebellar ataxia was made based on the results of radiological and electrophysiological examinations as well as after obtaining the family history. Because of the aggravation of symptoms over the last year, the patient presented to our polyclinic and was hospitalized for rehabilitation.

In the last year, the patient's complaints of walking disorder and imbalance increased. Because of this, he had a difficulty in performing activities of daily living. Although muscle strength in the proximal upper and lower extremities was 4/5 on neurological examination, other muscle strengths, deep tendon reflexes, and sensory examination results were normal. The patient was walking with an increased step length or with a staggering gait and short steps. On cerebellar examination, dysmetria and dysdiadochokinesis were detected and the Romberg test was positive.

Figure 1. The patient is playing bowling

Figure 2. The patient is playing football

After being assessed, the patient was considered suitable for VRR program. Detailed information about the VRR program was provided to the patient, and the implementation of the VRR program was proposed instead of the conventional rehabilitation program. The patient agreed, and written informed consent was provided.

VRR program implementation: An Xbox Kinect system was connected to a television with a 47-inch LCD screen. When the patient moved in front of the television, his movements were simulated by the Kinect sensor. Three trial sessions were applied to the patient to introduce the system and provide orientation. The rehabilitation program was administered in an isolated and quiet room of sufficient size under the supervision of a physiotherapist.

Sports games that have therapeutic effectiveness on balance, coordination, and motor activities were selected. The patient played a bowling game and then games of darts, tennis, and football (Figure 1, 2). The patient completed the VRR pro-

Figure 3. The dynamic balance test is being performed with the Kinesthetic Ability Trainer 4000 device

gram in a total of 30 sessions spread over 5 days a week with at least 1 h every day.

In the first 2 weeks, while playing football, he suffered loss of balance three times. However, he did not experience any drop attacks throughout the entire rehabilitation program. The patient expressed that he felt more capable and in balance after playing games.

Before the rehabilitation program, the patient needed a person's supervision to avoid falling and loss of balance and coordination while he walked on the flat ground [functional ambulation scale, Phase 3]; however, he needed physical assistance only in activities such as climbing stairs and slopes after the rehabilitation program (Phase 4).

To evaluate the walking distance, a 6-minute walk test (6 MWT) was performed. The walking distance was 225 m before the rehabilitation program, and it increased to 290 meters after the program.

On the Berg Balance Scale (BBS), which was used to evaluate static balance, the patient scored 38 (moderate risk of falling) before the rehabilitation program; the score increased to 42 (low level of risk of falling) after the program.

The Kinesthetic Ability Trainer 4000 (Med-Fit Systems, Inc.543, East Alvarado St Fallbrook, CA 9202) was used for the evaluation of dynamic balance. Dynamic testing in this device was done by the patient following a cursor on the screen, using the base he stepped on (Figure 3). The overall dynamic balance score of the patient was 2009 before the rehabilitation; it fell to 1599 after the rehabilitation (according to the original manual of Kinesthetic Ability Trainer 4000, a dynamic equilibrium score in the range of 750–950 is considered as excellent, 1500–2000 as good, and 2000–2500 as not good). The Kinesthetic Ability Trainer 4000 device was only used for testing purposes prior to the start of the VRR program and after the completion of the rehabilitation program; it was not used for balance training.

The functional independence measure (FIM) was used to assess the impact of the VRR program on the patient's independence in daily basic physical and cognitive activities. The motor FIM was 70 points before the rehabilitation program, and it increased to 80 points at the end of rehabilitation.

Discussion

In the present report, we describe the case of a patient with spinocerebellar ataxia who showed an improvement in the level of walking and static and dynamic balance as well as functional independence after being enrolled into the VRR program. To our knowledge, no other study has shown the effects of the VRR program in an adult patient with spinocerebellar ataxia; hence, this case report may be useful as a guide. We provided an improvement in the patient's functional ambulation scale, walking distance, balance capacity, and independence measurement. VRR-based training is thought to develop capacity in motor muscles and ensure the targeted movement of the extremities in ataxia as well as improve the dynamic balance and coordination of the entire body (9, 10). Additionally, the VRR program offers a safe, a motivating, and an entertaining environment (11). Considering these features, we chose the VRR program for our patient.

We separately evaluated the static and dynamic balance in our patient and tested the static balance with BBS and the dynamic balance with the Kinesthetic Ability Trainer device. Günendi et al. (12) demonstrated the reliability of quantitative static and dynamic balance tests and the correlation with other clinical balance tests applied in the Kinesthetic Ability Trainer device in our country. Gutiérrez et al. (8) stated that the VRR program provided a more significant improvement in postural and balance control than the conventional physiotherapy program in patients with multiple sclerosis. In this study, although dynamic posturography was used in postural analysis, BBS and the Tinetti scale were used for balance evaluation. Moreover, it was shown in a study that intensive coordination training including the VRR program increased motor performance and balance in children having ataxia with progressive cerebellar degeneration (10). At the end of the VRR program, our patient also showed an increase in balance. We observed an increase in balance with the methods where both static and dynamic balances were individually evaluated.

The VRR program was also shown to improve the function and distance of walking in patients with stroke in previous studies; in particular, games such as tennis, bowling, and golf were found to more effectively improve upper extremity functions (13). It was reported that at least a 54-m increase should considered as a clinically significant change in 6-MWT, which is used to evaluate walking (14). We also demonstrated that a clinically significant increase in 6-MWT was provided through the VRR program.

In comparison to a conventional rehabilitation program, Turoll et al. (15) reported significant improvements in FIM of stroke patients with a VRR program supplementary to the conventional rehabilitation program. We also demonstrated a increase in the motor part of FIM in our patient at the end of the rehabilitation.

Conclusion

Xbox Kinect is a low-cost system with commercially available different computer-based games, and it allows choosing games specific to the patient. Our primary goal, in this case, was to provide postural control with the selected games for the VRR program; our secondary goal was to improve functions of the upper and lower extremities. Although we showed improvements in our patient, randomized controlled studies with more subjects, which also involve comparison with the conventional rehabilitation program, are needed in the future.

Informed Consent: Written informed consent was obtained from patient who participated in this case.

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