

Effects of Training Using Video Games on the Muscle Strength, Muscle Tone, and Activities of Daily Living of Chronic Stroke Patients

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Abstract. [Purpose] The purpose of this study was to investigate the effects of training using video games played on the Xbox Kinect on the muscle strength, muscle tone, and activities of daily living of post-stroke patients. [Subjects] Fourteen stroke patients were recruited. They were randomly allocated into two groups; the experimental group (n=7) and the control group (n=7). [Methods] The experimental group performed training using video games played on the Xbox Kinect together with conventional occupational therapy for 6 weeks (1 hour/day, 3 days/week), and the control group received conventional occupational therapy only for 6 weeks (30 min/day, 3 days/week). Before and after the intervention, the participants were measured for muscle strength, muscle tone, and performance of activities of daily living. [Results] There were significant differences pre- and post-test in muscle strength of the upper extremities, except the wrist, and performance of activities of daily living in the experimental group. There were no significant differences between the two groups at post-test. [Conclusion] The training using video games played on the Xbox Kinect had a positive effect on the motor function and performance of activities of daily living. This study showed that training using video games played on the Xbox Kinect may be an effective intervention for the rehabilitation of stroke patients.

Key words: Video game, Stroke, Motor function

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INTRODUCTION

The use of technology in rehabilitation has increased rapidly¹⁾. One such technology, virtual reality has been shown to be an effective intervention. In particular, virtual reality using video games played on devices such as the Wii or PlayStation are being used as interventions^{2, 3)}. These video games can provide benefits to patients who have difficulty with activities in the real environment⁴⁾. The video games can furnish interventions to improve motor function, balance, gait, and coordination⁵⁾. Video games were originally designed for recreation rather than rehabilitation of patients. Nevertheless, it is an advanced technology that can be used to encourage functional recovery of individuals with permanent disabilities⁶⁾. In recent studies, virtual reality training using video games has been shown to improve the motor function of the upper extremity of patients with stroke^{3, 7)}. A few studies has also demonstrated that patients showed high levels of motivation when playing in the video games, and that video games can be satisfying for patients in rehabilitation^{8, 9)}. The Xbox Kinect is a device for playing video games that recognizes user's movement using infrared camera sensors. Users can see their posture and movement in the virtual reality environment without a controller, confirmed in real time. Few studies have investigated the

effect of video games played on devices such as the Xbox Kinect in the rehabilitation of post-stroke patients. This study investigated the effects of training using video games played on the Xbox Kinect on muscle strength, muscle tone of the upper extremities, and performance of activities of daily living of chronic stroke patients.

SUBJECTS AND METHODS

In this study, fourteen inpatients recovering stroke rehabilitation were recruited. The inclusion criteria were as follows: >6 months after stroke onset, no problems with auditory or visual functioning, and a Mini-Mental State Examination score of >24¹⁰⁾. Patients with unstable blood pressure or angina, a history of seizure, or who refused to use the video game were excluded. All participants provided their informed consent after receiving a detailed explanation of the study, and all procedures were approved by the Institutional Review Board of Kyungnam University. Table 1 presents the characteristics of the subjects who participated in this study. The participants were randomly allocated to two groups; the experimental group (n=7) and the control group (n=7). The experimental group performed training using video games played on the Xbox Kinect together with conventional occupational therapy for 6 weeks (1 hour/day, 3 days/week), and the control group received conventional occupational therapy only for 6 weeks (30 min/day, 3 days/

Table 1. Subject characteristics

Group	N	Gender (male/female)	Age (years)	Etiology (I/H)	Affected side (R/L)	Disease duration (month)
Experimental group	7	4/3	71.71 (9.14)	4/3	3/4	7.29 (1.38)
Control group	7	5/2	76.43 (5.80)	6/1	2/5	8.29 (3.40)

Values are frequency or mean (SD). Abbreviation: I, Infarction; H, Hemorrhage; R, Right; L, Left

Table 2. Comparison within and between groups

Measures	Experimental group		Control group	
	Pretest	Posttest	Pretest	Posttest
Muscle strength				
Shoulder flexion	4.14 (1.95)	5.57 (2.70)*	3.85 (2.34)	4.57 (2.64)
Shoulder extension	3.85 (2.04)	5.57 (2.37)*	3.86 (2.34)	4.29 (2.75)
Elbow flexion	3.86 (2.27)	6.29 (2.81)*	4.43 (1.90)	5.57 (3.15)
Elbow Extension	3.43 (2.23)	5.71 (2.93)*	4.00 (2.31)	5.14 (3.24)*
Wrist flexion	3.43 (2.51)	4.86 (3.53)	4.00 (2.31)	4.57 (3.21)
Wrist extension	3.14 (2.49)	4.29 (3.25)	3.57 (2.44)	4.29 (3.35)
Muscle tone				
Shoulder	1.71 (0.95)	1.14 (0.38)	1.29 (0.49)	1.29 (0.49)
Elbow	2.14 (1.21)	1.43 (0.79)	1.57 (0.98)	1.14 (0.38)
Wrist	1.71 (0.76)	1.29 (0.49)	1.14 (0.38)	1.14 (0.38)
FIM	62.71 (11.48)	71.42 (15.00)*	56.43 (9.85)	61.24±11.93*

Values are mean (SD). MMT was graded a ten-point ordinal scale from 1 to 10. MAS was graded on a six-point ordinal scale from 0 to 5 with the grade 1+ substituted by grade 2.

* $p < 0.05$ by the Wilcoxon Signed Rank test

week). Before and after the intervention, the participants were measured for muscle strength, muscle tone, and performance of activities of daily living.

The muscle strength was measured using the Manual Muscle Test (MMT). The test-retest reliability coefficients for the MMT range from 0.63 to 0.98⁽¹⁾. Muscle tone was evaluated with the Modified Ashworth Scale (MAS). Kendall's tau correlation between grades in the MAS is reported as 0.847⁽²⁾. The performance of activities of daily living was measured using the Functional Independence Measure (FIM). The inter-rater reliability coefficients for the FIM range from 0.83 to 0.96⁽³⁾.

The Xbox Kinect (Xbox 360, Microsoft, US) was used for training. Xbox Kinect has an infrared camera sensor that recognizes user movements without a controller. For the training, the screen and beam projector were set in a room that was not influenced by external factors. The infrared camera was located in the front of the screen, and the subjects were asked to either sit or stand. The programs used for training, the Kinect sports (Boxing and Bowling) and Kinect adventure (Rally Ball, 20,000 Leaks, and Space Pop), were chosen by the researcher. Two games of each program were selected by the participants according to their interest. Two games were played for 15 min each, for a total of 30 min. The conventional occupational therapy focused on upper extremity function and activities of daily living. That was performed for 30 min.

SPSS 18.0 (IBM Corporation, Armonk, NY, USA) was

used for statistical analysis. The Wilcoxon Signed Rank test and the Mann-Whitney U test were used to compare the differences within and between groups. Null hypotheses of no difference were rejected if p values were less than 0.05.

RESULTS

After the intervention, there were significant improvements in the strength of the shoulder flexor, shoulder extensor, elbow flexor, and elbow extensor muscles, and in the FIM scores for performance of activities of daily living compared to baseline in the experimental group ($p < 0.05$). There were significant differences in the strength of the elbow extensor muscle and the FIM scores for performance of activities of daily living within the control group ($p < 0.05$). However, no significant differences between two groups were found at post-test (Table 2).

DISCUSSION

This study was performed to investigate the effects of training using video games played on the Xbox Kinect on the muscle strength, muscle tone, and performance of activities of daily living of patients with chronic stroke. In the experimental group, the muscle strength of the upper extremities, except the wrist, and performance of activities of daily living significantly improved after intervention compared to the baseline. In the control group, there were

significant improvements in the elbow extensor strength and performance of activities of daily living only. However, no significant differences were found between the groups at post-test.

Muscle weakness and loss of muscle tone are the primary impairments that occur in stroke patients, creating functional limitations on activities using the upper extremities¹⁴. Thus, for functional recovery of the upper extremities, impairments such as muscle weakness and loss of muscle tone should be addressed. The Xbox Kinect is a video game playing device that may be suitable as an intervention for functional recovery. The subjects of this study, who played games on the Xbox Kinect, were required to perform voluntary movements, and it was anticipated that these would improve muscle strength. The results of this study are similar to those of previous studies. Song et al. reported that shoulder muscle strength of stroke patients increased significantly as a result of virtual reality training using video games played on the Wii¹⁵, and that performance of activities of daily living activities improved significantly in the experimental group. This may have resulted from an increase of muscle strength. Yavuzer et al. reported that training using video games played on a Playstation improved functions related to daily living of stroke patients¹⁶, but they observed no significant differences in variables between the experimental and control groups. We think this is a limitation of video games that are not created for rehabilitation. There were no significant differences between and within groups in muscle tone. Marie et al. reported that training using video games played on a Wii decreased the muscle tone of stroke patients, but not significantly¹⁷. Similarly, Yong Joo et al. demonstrated that training using computer-based games was effective at decreasing the spasticity of post-stroke patients, but not significantly¹⁸. They suggested that intervention for rehabilitation of stroke patients should be task oriented¹⁹, and provide visuoauditory feedback²⁰. The Xbox Kinect is a video game device that matches these requirements, and consequently, it may provide significant benefits for muscle strength training of the upper extremity and performance of activities of daily living. Individuals can play the video games using the Xbox Kinect, repetitively and purposefully, and the user can receive feedback immediately, because users can see their posture and movements in the virtual environment in real time. The Xbox Kinect may be suitable as an intervention for the rehabilitation of stroke patients. This study had some limitations. There was a small number of subjects who participated in the study, and we did not investigate their balance or gait ability factors that can influence function. Thus, in future studies, further investigation is required to strengthen the evidence of the training effects derived from using the Xbox Kinect.

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