



Original Article

The effect of virtual reality program on the cognitive function and balance of the people with mild cognitive impairment

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Abstract. [Purpose] The purpose of this study was to investigate the effects of a virtual reality (VR) program on cognitive function and balance in the elderly with mild cognitive impairment (MCI) attending G welfare center in Gurye. [Subjects and Methods] Twenty-four patients with MCI were studied. The patients were exposed to the VR program for 30 min per experiment, which was conducted 20 times for four weeks. [Results] The cognitive function and balancing ability of the experimental group, when compared to the control group, showed a statistically significant increase in Visual Span Test (VST), Word Color Test (WCT), and Limit of Stability (LOS), which are the sub-categories of CNT 4.0, after the exposure to the program. In all test categories, the experimental group exhibited statistically significant differences compared to the control group. [Conclusion] Thus, the VR program is an effective intervention for the elderly with MCI.

Key words: Virtual reality program, Cognitive function, Mild cognitive impairment

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INTRODUCTION

The prevalence of geriatric diseases and dementia increases in an aged society, and 80% of elderly people with MCI are diagnosed with dementia within 6 years, while 1–2% of normal elderly people are diagnosed with dementia¹⁾. The cognitive function of the elderly with MCI is lower than that of normal elderly people in language fluency, name recall performance, and attention²⁾. Especially, the elderly with MCI showed symptoms of memory impairment and had difficulty in word recall³⁾. In the elderly patients with cognitive impairment, factors such as age, visual impairment, and reduced mobility were reported to be the cause of falls⁴⁾. However, the basis of the treatment of the elderly with MCI is less solid than that of Alzheimer's patients, urgently necessitating the development of applicable programs for the elderly with MCI⁵⁾. In recent rehabilitation practices, VR programs are used to enable users to simulate real experiences through computer hardware and software⁶⁾. The VR programs can be applied to the elderly with dementia to ameliorate depression and to improve quality of life⁷⁾. The program could also be used to reveal that the reduced path-finding ability of the elderly with mild cognitive impairment is owing to the functional loss of spatiotemporal memory⁸⁾. Despite these ongoing studies on various patients, studies on elderly patients with MCI are very limited. As such, the purpose of this study is to verify the effect of the VR program on cognitive function and balancing ability of seniors with MCI.

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Table 1. Clinical characteristic of the study participants (n=24)

Characteristic	Experimental group	Control group
Gender (male/female)	12 (4/8)	12 (3/9)
Age (yrs)	74.1 ± 6.0*	70.1 ± 5.3*
MMSE-K (score)	22.4 ± 0.7*	22.3 ± 0.7*

*Mean ± SD

Table 2. Comparison of cognitive function and balance in experimental group (n=24)

		Pre treatment (Mean ± SD)	Post treatment (Mean ± SD)
VST (T-score)	Forward	3.8 ± 0.7	3.9 ± 0.7*
	Reverse	2.7 ± 0.7	3.1 ± 0.7*
WCT	Time (sec)	68.9 ± 37.9	54.7 ± 35.7*
	Number of errors (number)	3.0 ± 3.4	2.0 ± 2.7*
Balance	LOS (mm ²)	1,013.7 ± 907.3	1,838.3 ± 1,939.9*

*Significant difference p<0.05

Table 3. Comparison of cognitive function and balance in control group (n=24)

		Pre treatment (Mean ± SD)	Post treatment (Mean ± SD)
VST (T-score)	Forward	3.5 ± 0.7	3.5 ± 0.7
	Reverse	2.6 ± 0.6	2.6 ± 0.6
WCT	Time (sec)	52.0 ± 35.1	52.7 ± 37.1
	Number of errors (number)	1.6 ± 2.8	2.1 ± 3.0
Balance	LOS (mm ²)	1,190.6 ± 664.9	1,267.5 ± 906.5

SUBJECTS AND METHODS

This study was conducted from June 27 to July 22, 2016, and was aimed at selecting 24 elderly patients with MCI attending G welfare center in Gurye. Prior to participation in this study, the objective and method of the study was explained to the patients, and their written consents were obtained. The experimental and control groups were randomized. The study was approved by the ethics committee of the Daegu University Institutional Review Board for Clinical Studies (1040621-201511-HR-01410). In the experimental group VR program for 30 min per experiment, which was conducted 20 times for four weeks and the control group was subject to traditional occupational therapy to examine changes in memory and balance ability. In order to evaluate the memory, VST, a sub-category of CNT 4.0, used the T-score values in the forward and reverse directions, and the WCT test, which can evaluate concentration, used the time and error count in the sections of both letter and color of words. The balancing ability was measured by the LOS value, which is a sub-category of the BIORescue system (France, RM Ingénierie) composed of the decompression platform and RM's motion analysis system. The data obtained were processed using SPSS 18.0. The cognitive function and balance before (control) and after (experimental) the treatment were compared with the paired-samples t-test, while the difference between the cognitive function and balance after the treatment was compared with the independent two-samples t-test. The statistical significance level was set at 0.05.

RESULTS

The participants consists of three males (25%) and nine females (75%) in the control group, and four males (33.4%) and eight females (66.6%) in the experimental group. The average age was 74.16 ± 6.05 years in the experimental group and 70.19 ± 5.38 years in the control group. The MMSE-K was 22.41 ± 0.79 points in the experimental group and 22.33 ± 0.76 points in the control group (Table 1).

Comparing cognitive function and balancing ability before and after the treatment intervention, there were significant differences in VST, WCT, and LOS sections in the experimental group (p<0.05), but not in the control group (p>0.05): (Tables 2, 3).

Table 4. Comparison of cognitive function and balance in two groups after intervention (n=24)

		Experimental group (Mean ± SD)	Control group (Mean ± SD)
VST (T-score)	Forward	0.14 ± 0.10*	0.01 ± 0.55
	Reverse	0.38 ± 0.37*	0.06 ± 0.24
WCT	Time (sec)		-0.72 ± 14.70
	Number of errors (number)	-6.10 ± 6.81*	0.66 ± 0.77
Balance	LOS (mm ²)	-890.08 ± 1072.33*	249.66 ± 598.78

*Significant difference p<0.05

There were significant differences in VST, WCT, and LOS sections between the two groups after the treatment intervention (p<0.05): (Table 4).

DISCUSSION

The virtual reality program allows confirming a self-image and solving the problems presented through the screen, enhancing the motivation and active participation of users through various sensory feedbacks⁹). In this study, the cognitive functions of the experimental group and the control group were compared before and after the treatment intervention, showing significant differences in the experimental group. The result is in good agreement with the previous studies of Kim et al.¹⁰) and Barnes et al.¹¹) who applied VR intervention to elderly patients and patients with cognitive impairment. Thus, our results add evidence that the VR program is one of the effective intervention methods for improving cognitive functions such as memory. In addition, the VR program can increase the motivation by inducing fun and interest through the visual and auditory feedbacks¹²). In line with that, the self-selection of several training programs among others probably stimulated the inner drive of the participants, which led to the positive results in this study.

Compared to the control group, the experimental group showed a significant increase in balancing ability after the treatment intervention. This is in consistent with a previous study in which LOS was significantly increased by applying balance performance with a cognitive task to elderly people Kim.¹³) and a study showing that LOS was significantly different in female seniors who practiced balance performance with a visual cognitive task¹⁴). In this study, it is thought that repeated successes obtained through VR mainly influence the self-efficacy that leads to the increased balancing ability, just as many successes increased the participant's self-efficacy and gave positive results¹⁵). The results of this study, although not significantly different from the previous ones, are highly meaningful in that domestic studies that applied VR programs to MCI patients are insufficient.

Comparing cognitive function and balance between the two groups after the intervention, the VST and LOS scores of the experimental group were significantly increased and the WCT score was decreased with statistical significance compared to the control group. Therefore, it was confirmed that the VR program improves the cognitive function and balancing ability of the elderly with MCI. This is consistent with the study of Cha¹⁶), which reported differences in cognitive functions among normal, MCI, and Alzheimer's groups exposed to a VR program.

The limited number of participants made it difficult to generalize the results of the study. There is a lack of prolonged investigation of continued effect after the intervention of the program, as well as a limited control over the many variables that could affect the participants. Future studies will require both long-term and follow-up studies on MCI patients residing in the community to generalize the current findings.

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