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Effects of Computer-aided Cognitive Rehabilitation Training and Balance Exercise on Cognitive and Visual Perception Ability of the Elderly

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Abstract. [Purpose] This study examined the effects of computer-aided cognitive rehabilitation (CACR) training and balance exercise on elderly individuals' cognitive and visual perception. [Subjects] Thirty healthy subjects aged between 65 and 80 participated in this study. They were randomly and equally assigned to either a CACR training group (TG) or a balance exercise group (BEG). [Methods] Subjects' cognitive functions and visual perception were measured using the Korean mini-mental state examination (MMSE-K) and the motor-free visual perception test (MVPT-3), respectively. For intervention methods, the TG received interval vision training using the RehaCom program, a Cognitive Rehabilitation Computer Program derived the Vienna Test System, and vision composition training with attention training programs for 30 minutes, 3 times per week, for 6 weeks. The BEG training consisting of warm-up exercises, main exercises, and cool-down exercises, for 50 minutes, 3 times per week, for 6 weeks. [Results] Both the TG and the BEG saw their MMSE-K and MVPT-3 scores significantly increase after the interventions, but the two groups showed no significant differences. [Conclusion] Given that the effects of CACR training were similar to those of the balance exercise training, we consider CACR training is a viable treatment method for preventing the decrease of cognitive function among the elderly.
Key words: CACR, MMSE-K, MVPT

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INTRODUCTION

Exercise can improve cardiovascular function and increase blood flow in the brain, thereby preventing cognitive function deficiency caused by aging and resulting frontal lobe degeneration[1)]. Research has shown that exercise also increases brain-derived neurotrophic factors, which inhibit the destruction of normal brain cells and aid in the generation of new brain cells[2)]. Many studies have also reported a correlation between balance ability and cognitive function and visual perception[3, 4)]. The literature generally classifies intervention methods for cognitive rehabilitation into traditional treatment methods and computer-aided cognitive rehabilitation (CACR) techniques. The latter focuses on similar psychiatric processes and involves computer training that enhances attention, concentration, implementation skills, and perception-motor skills, through various programs[5)]. CACR training provides standardized and structuralized training tasks and also allows users to adjust the degree of difficulty to their individual cognitive levels. CACR training addresses different domains such as visual reaction, visual scanning, attention, information-processing speed, memory, and problem-solving ability. It can provide flexibility for treatments, make adjustments, shorten treatment periods, objectively measure performance ability, and provides immediate feedback to patients[6)]. Recently developed CACR programs have focused on activities of daily living such as driving, calculating numbers, remembering names and faces, and performing certain tasks in addition to conventional approaches focused on training of attention, visual exploration, and memory[7)]. Korean studies have focused on computerized cognitive rehabilitation programs since 2000, and researchers have performed diverse relevant research[8, 9)]. However, the field lacks comparative studies of programs involving practical exercises and CACR training for the elderly without much movement.

Accordingly, this study attempted to evaluate and compare the effects of CACR training and balance exercise on cognitive functions and visual perceptions of the elderly.

SUBJECTS AND METHODS

The subjects of this study were 30 healthy individuals between 65 and 80 years of age residing in G city in Korea. All subjects gave their voluntary consent to participation after receiving a detailed explanation of the purposes and methods of the study. Subjects were randomly and equally allocated to either a training group (TG) (7 males, 8 females)

and a balance exercise group (BEG) (7 males, 8 females). The TG's average age, height, and weight were 72.8 ± 3.8 years old, 160.3 ± 7.3 cm, and 59.6 ± 8.9 kg, respectively. The BEG's average age, height, and weight were 74.7 ± 3.7 years old, 159.5 ± 9.0 cm, and 58.3 ± 8.6 kg, respectively. Their characteristics according to gender were analyzed the using chi-square test, and their traits according to age, height, and weight were analyzed using the independent t-test. The analyses showed that the groups did not statistically significantly differ from each other ($p>0.05$), and they were considered homogenous. The study excluded possible subjects who had a MMSE-K score of 24 points or lower; lesions in the central or peripheral nervous system; orthopedic problems including fracture; any cardiopulmonary disease; severe vision defect due to ophthalmic diseases such as cataract or glaucoma; or who took opiates, alcohol, and those antibiotics such as streptomycin that might have affected cognitive rehabilitation and balance training. The CACR tool, RehaCom (HASOMED, Germany) consists of diverse training programs such as attention training, memory training, executive-function training, visual-field training, visuo-motor ability training, and occupational training. A joy stick and a large button on the RehaCom panel make the training easy for patients unfamiliar with computer use. The training allows adjustments to individual patients' abilities at all levels of the program. Training data are automatically stored for accurate analysis of data aimed at establishing treatment plans.

In this study, the subjects participating in the CACR program performed the interval vision training program (SAKA), with 28 stages of difficulty, and a vision-composition training program (KONS), with 18 stages of difficulty in attention-training programs of 15 minutes each, 3 times per week, for a total of 6 weeks. The BEG group performed movements from a balance evaluation method[10] modified to suit older individuals, consisting of warm-up exercises, main exercises, and cool-down exercises for 50 minutes, 3 times per week, for a total of 6 weeks. Folstein et al. introduced the mini-mental state examination (MMSE), a widely popular cognitive function evaluation tool, in 1975. As a standardized tool, it has high validity and reliability. The MMSE-K, a Korean version of the MMSE was developed in 1989, and serves as a dementia screening test for cognitive impairment and dementia[11]. A score of 19 or less, 20 to 23, or 24 or more out of 30 points means a testee has dementia, is suspected of dementia, or falls within a normal range, respectively. The subjects of the present study scored 24 or more points. The test was conducted prior to the intervention, three weeks into the intervention, and after six weeks, at the end of after the intervention. The participants' visual perception was measured using the motor-free visual perception test (MVPT-3), a tool used to evaluate visual-perception capabilities without motor function use which was devised for screening, diagnosis, and research purposes[12]. The MVPT-3 has 8 sub-domains: visual discrimination, form constancy, visual short-term memory 1, visual closure 1, spatial orientation, figure ground, visual closure 2, and visual short-term memory 2. The experimental results were statistically analyzed using SPSS 12.0 KO (SPSS, Chicago, IL, USA). The mean and standard deviation values of the results from variables were calculated. The independent t-test was used to analyze differences between the different training methods and the paired t-test was used compare differences resulting from each of the training methods after the intervention. Statistical significance was accepted for values of $p<0.05$.

Table 1. Comparison of MMSE-K and MVPT scores of each group

content	group	pre-test	post-test	t-value
MMSE-K	TG	26.5 ± 2.5	29.5 ± 0 .7	–5.204*
	BEG	27.5 ± 1.9	29.3 ± 1.5	–6.687*
MVPT	TG	39.8 ± 5.8	49.6 ± 6.9	–2.46*
	BEG	38.3 ± 7.1	44.3 ± 8.0	–4.253*

(unit: score). *:$p<0.05$, MMSE-K: Mini-Mental state examination, MVPT: Motor-Free visual perception test, TG: Training Group, BEG: Balance Exercise Group

RESULTS

The MMSE-K scores measuring cognitive function of both the TG and the BEG significantly increased ($p<0.05$), but showed no statistically significant difference between the two groups at the end of the intervention ($p<0.05$) (Table 1). Likewise, MVPT scores measuring visual perception significantly improved ($p<0.05$), but showed no statistically significant difference between the two groups at the end of the intervention ($p<0.05$) (Table 1).

DISCUSSION

Elderly individual's cognitive information-processing speed declines due to a reduction in the number of brain cells, weakened motor neurons, and decreased activity[13]. In particular, reduced balance ability resulting from aging is correlated with cognitive function and visual perception, and balance improvement exercises attempt to enhance this ability[3, 4]. However, majority of the elderly lead inactive lives, and, much research has examined this[14, 15]. One such study observed that some effects of CACR on elderly people lasted for over five months and proposed that CACR programs be used in diverse ways[16]. A previous study reported that a CACR program for elderly subjects' result, the number of subjects' of visual searches in tasks related to computer use increased, and their reading and phone-use capabilities improved[17]. In the present study, scores of MMSE-K, MVPT-3, and the visual perception tests, significantly improved both the CACR training group and the balance exercise, group, and there were no statistically significant differences between the two groups related to the different intervention methods. We consider this lack of difference is due to the effects of the balance exercise on subjects' cognitive functions and visual perception. Previous research has shown that elderly subjects with good balance ability had high MMSE-K scores[18], and good balance ability also had significant influence on memory and

problem-solving, and information-processing capabilities[19]. Another study conducted a four weeks of CACR training for brain-damaged patients with cognitive impairment reported that the experimental group's short-term language memory, short-term visual memory, auditory and visual attention, and concentration improved significantly relative to the control group[8]. This significant result is similar to that of the present study. Accordingly, the present study's result, that a CACR program has similar effects to that of balance exercise training, may inspire new approaches to prevention programs for the elderly with cognitive impairment resulting from aging, and therapeutic approaches for cognitive impairment prevention programs for elderly individuals with nervous and musculoskeletal system impairments constraining their physical activity.

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