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The effects of a Korean computer-based cognitive rehabilitation program on cognitive function and visual perception ability of patients with acute stroke

Jin-Hyuck Park, OT, MPH[1)*], Ji-Hyuk Park, OT, PhD[1)]

[1)] *Department of Occupational Therapy, College of Health Science, Yonsei University: 1 Yonseidae-gil, Wonju, Gangwon-do 220-710, Republic of Korea*

Abstract. [Purpose] The purpose of this study is to investigate the effects of a Korean computer-based cognitive rehabilitation program (CBCR) on the cognitive function and visual perception ability of patients with acute stroke. [Subjects] The subjects were 30 patients with acute stroke. [Methods] The subjects were randomly assigned to either the experimental group (EG) or the control group (CG). The EG subjects received CBCR with the CoTras program. The CG subjects received conventional cognitive rehabilitation. All subjects participated in a standard rehabilitation program according to a daily inpatient treatment schedule. In addition to standard rehabilitation, the subjects received 20 sessions (5 days a week for 4 weeks) of CBCR or conventional cognitive rehabilitation for 30 min. To compare the two groups, the Lowenstein Occupational Therapy Cognitive Assessment (LOTCA) and Motor-free Visual Perception Test-3 (MVPT-3) were performed. [Results] Both groups showed significant improvement in LOTCA and MVPT-3. Furthermore, there were significant differences in LOTCA and MVPT-3 between the two groups. [Conclusion] CBCR with CoTras may contribute toward the recovery of cognitive function and visual perception in patients with acute stroke.

Key words: Cognitive function, Korean computer-based cognitive rehabilitation program, Visual perception

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INTRODUCTION

Cognitive dysfunction is a common symptom after a stroke[1)]. Cognitive dysfunction is a strong predictor of long-term functional outcomes such as work performance and independent activities of daily living[2)]. Thus, the evaluation and recovery of cognitive function after a stroke is critical for the maintenance of independent living[3)]. The literature generally classifies intervention methods for cognitive rehabilitation into conventional cognitive rehabilitation and computer-based cognitive rehabilitation (CBCR)[4)]. CBCR is a technique that can enhance attention, concentration, implementation skills, and perception-motor skills through various programs[5)]. CBCR provides standardized and structuralized training programs and also allows users to adjust the degree of difficulty to their individual cognitive levels[4)]. In addition, these training programs may shorten the treatment period[6)].

Since the early 1980s, CBCR has been proven to be effective in treating the cognitive impairments of the elderly and of patients with brain injury, dementia, schizophrenia, and stroke[7)]. Recently developed CBCR programs have focused on the activities of daily living such as calculating numbers, remembering names, and shopping activities in addition to conventional approaches focused on training for attention, concentration, and memory improvement[8)]. However, CBCR programs used in Korea are mostly imported from abroad, and many aspects of these programs do not fit the Korean culture.

In 2011, Kim developed a Korean CBCR program called CoTras; however, there is still insufficient evidence for the clinical effectiveness of this program[9)]. Therefore, there is an urgent need to verify whether the efficiency of CoTras is sufficient, by using comprehensive and objective methods.

Accordingly, in this study, we attempted to investigate the effects of the Korean CBCR program CoTras on cognitive function and visual perception ability by conducting a randomized controlled trial.

SUBJECTS AND METHODS

The subjects were recruited from a local rehabilitation hospital. All subjects gave their voluntary consent to participate after receiving a detailed explanation of the purpose and methods of the study. We screened the volunteers by using the following study criteria derived from a previous CBCR study[9)]: (i) history of no more than one stroke; (ii) stroke

*Corresponding author. Jin-Hyuck Park (E-mail: roophy@naver.com)

with an onset duration of < 3 months; (iii) a score of ≤23 on the Korean version of Mini-Mental Status Examination (K-MMSE); (iv) ability to understand instructions; (v) ability to use the controller with the unaffected upper limb; and (vi) without unilateral hemispatial neglect and hemianopsia. All subjects provided written informed consent before study inclusion according to the code of ethics of the World Medical Association (Declaration of Helsinki, version 2004).

We administered two outcome measures. The first is the Lowenstein Occupational Therapy Cognitive Assessment (LOTCA) consisting of 26 sub-tests and can be used to assess six domains (orientation, visual perception, spatial perception, motor praxis, visuomotor organization, and thinking operation). The battery of tests takes 30–40 min to administer. The LOTCA has been standardized, and its reliability and validity in various populations have been investigated since 1989[10]. The second measure is the Motor-free Visual Perception Test-3 (MVPT-3), a tool used to evaluate visual perception abilities without motor function use; this was devised for screening, diagnosis, and research purposes[11].

After the previous testing session, all subjects were randomly assigned to either the control group (CG) or the experimental group (EG) in accordance with a random-numbers table. All outcome measures were administered to the patients at baseline and at the end of treatment (after the 4-week intervention) by the assistant researcher with 5 years' experience in using the measures.

During the sessions, all subjects participated in a standard rehabilitation program according to a daily inpatient treatment schedule. In addition to standard rehabilitation, all subjects received 30-min daily sessions of either the CG or the EG treatment.

Subjects from the EG group performed 20 sessions (5 days a week for 4 weeks) of CBCR with the CoTras program (Netblue Co., Ltd, Korea) made for Koreans. CoTras consists of a diverse training program including visual perception, attention, memory, orientation, and others (categorization, sequencing). A joystick and a large button on the CoTras panel make the training easy for patients who are unfamiliar with computer use. The training allows adjusting to individual patient's abilities at all levels of the program. Training data are automatically stored for accurate analysis, aimed at establishing treatment plans[9]. In this study, EG subjects received the visual perception training consisting of object recognition, object constancy, figure-ground organization, visual discrimination, and visual organization. The therapy for CG subjects was designed to match that for the EG subjects in terms of duration (in minutes). The CG subjects received conventional cognitive rehabilitation with a pencil and paper with emphasis on visual perception ability.

All data analyses were performed by using SPSS version 20.0. The independent t-test was used to compare the difference between group means and changes in values, and the paired t-test was used to test differences in continuous variables within groups. Statistical significance was accepted for values of $p < 0.05$.

RESULTS

After applying the inclusion criteria, 37 subjects were screened for this study, with 7 excluded for the following reasons: (i) insufficient motor function (n = 2) and (ii) inability to understand instructions (n = 5). Consequently, 30 subjects were included and their characteristics are summarized in Table 1.

The LOTCA and MVPT scores at baseline and at the end of treatment are shown in Table 2. After treatment, the LOTCA and MVPT scores, measuring the cognitive function of both groups significantly increased ($p < 0.05$), and there was a statistically significant difference between both groups at the end of treatment ($p < 0.05$).

DISCUSSION

CBCR is increasingly being used in rehabilitation settings recently because of its many advantages[12]. One of the advantages of CBCR is the cost-effectiveness by providing individualized treatments to continuously and repeatedly stimulate impaired cognitive areas[13]. The results of this study showed that CBCR with CoTras may significantly improve cognitive function and visual perception ability of patients with acute stroke, with a statistically significant improvement in LOTCA and MVPT in both groups of subjects. The improvement in LOTCA and MVPT was higher in EG than in CG subjects after 20 sessions, confirming that CBCR contributes to obtaining better results than those of conventional cognitive rehabilitation at the early stage of recovery[7, 8].

Table 1. Subjects' characteristics

		EG (n = 15)	CG (n = 15)
Gender	Male	6	8
	Female	9	7
Age (years)		64.7 (8.9)	65.2 (8.0)
Onset period (months)		1.5 (0.5)	1.8 (0.6)
K-MMSE		20.6 (2.3)	20.5 (2.0)

Data are mean (SD). K-MMSE: Korean version of Mini-Mental Status Examination

Table 2. Patients' LOTCA and MVPT-3 scores before and after the interventions

	LOTCA			MVPT-3		
	Pre	Post	Change	Pre	Post	Change
EG (n = 15)	71.6 (3.1)	86.0 (4.4)	14.4 (2.0)	39.1 (1.9)	42.8 (11.6)	6.6 (0.5)
CG (n = 15)	71.2 (2.8)	76.5 (3.6)	5.3 (2.3)	38.9 (1.8)	41.4 (2.3)	2.5 (1.7)

Data are mean (SD). "Change" refers to the mean change in score

Recently, one of the most widely used CBCR programs in Korea is RehaCom[9]. The effects of CBCR with RehaCom have been proved in several studies[4, 6, 14, 15]. However, in some parts of RehaCom, the stimuli presented on the screen do not fit the culture and situation in Korea; therefore, it is difficult to use in Korean[9]. To solve this problem, Kim developed a CBCB program for Koreans. The effectiveness of CBCR with CoTras for the rehabilitation of patients with cognitive dysfunction has been proved in several studies[9, 16, 17]. Especially, Kim, in 2011, indicated that subjects who received CBCR with CoTras showed improvement in LOTCA and MVPT after treatment, which is consistent with the results of this study.

We conclude that CBCR with CoTras can be used as a therapeutic approach for restoring the cognitive function and visual perception ability of patients with acute stroke. Furthermore, CoTras can be used as an alternative to other CBCR programs aimed at improving cognitive function and visual perception ability.

The focus on the early stage of stroke recovery makes this study useful in clinical practice. Although the sample size is small, the results of this study have potential significance in terms of effectiveness and suggest a potential large clinical use of CoTras.

The long-term effects of CBCR with CoTras were not identified in this study. Therefore, further controlled studies with a larger sample size and longer interventions are needed to clarify the clinical benefits of CoTras as a rehabilitation treatment for cognitive dysfunction in patients with acute stroke.

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