DOI Number: 10.37506/v20/i1/2020/mlu/194594

Effects of Cognitive Exercise Therapy on Tactile Sensations of the Hands and Activities of Daily Living in Stroke Patients

Jong-Hoon Moon[1], Jin-Hwa Jung[2], Hwi-Young Cho[3]

[1]Professor, Department of Occupational Therapy, Kyungdong University, [2]Professor, Department of Occupational Therapy, Semyung University, [3]Professor, Department of Physical Therapy, Gachon University, Republic of Korea

Abstract

Background/Objectives: The aim of present study was to evaluate the effects of cognitive exercise therapy (CET) on tactile sensations of the hands and activities of daily living in stroke patients.

Method/Statistical Analysis: A total of 14 stroke patients with impaired hand sensations were participated and were randomly assigned to the CET group or the traditional occupational therapy (TOT) group. Patients in the CET group performed cognitive tasks using their spatial and tactile senses, whereas those in the TOT group received traditional occupational therapy. The intervention periods of the two groups were 30 min per day, five-times per week for four weeks. All participations were assessed before and after intervention with light touch sensation using the Mono-Filament, two-point discrimination sensation using the Disk-Criminator (static and dynamic tactile sensations), and the modified Barthel index (MBI) for activities of daily living ability.

Findings: The CET group appeared significant improvements in static and dynamic two-point discrimination, and the MBI before and after the intervention. Also, the TOT group showed a significant improvement in MBI after intervention. At post-test, the CET group showed significant improvements in two-point discrimination and light touch compared to the TOT group.

Improvements/Applications: These findings suggest that CET can induce improvement of the tactile sensations of the hands in stroke patients. Thus, we suggest that CET can be used for tactile-sensory rehabilitation of patients with stroke in clinic.

Keywords: *Cognitive exercise therapy, Hand, Activities of daily living, Stroke, Tactile sensation.*

Introduction

Stroke is the most common central nervous system disorder in the Republic of Korea as well as the world, and it causes neurological problems in the sensory, motor, mental, perceptual, and speech functions[1]. More than 85% of patients with stroke experience hemiplegia, and over 69% have upper extremity motor function impairment[2]. Post-stroke dysfunctions of the upper extremities cause significant problems with functional movement in performing the independent activities of the daily life, such as feeding and self-care[3]. The incidence of decreased sensory function after stroke is up to 65%[4]. As patients with stroke with sensory deficits show limitations in movement and performance of functional tasks, treatments for motor and sensory functions of the upper extremities are important in rehabilitation[5].

In the past, using simple objects such as cups, cones,

Corresponding Author:
Hwi-Young Cho
Professor, Department of Physical Therapy, Gachon University, Republic of Korea
e-mail: hwiyoung@gachon.ac.kr

and a pegboard, therapeutic exercise was performed to enhance motor and sensory functions. Recently, however, more diverse therapeutic intervention method have been used to improve the upper limb function of stroke patients in clinics. According to previous researches, the treatment of constraint-induced movement therapy (CIMT)[6], virtual reality[7], and robot-assisted therapy have a positive effect in the upper extremity functions in stroke patients[8]. However, constraint-induced movement therapy requires 5 hours of intense training per day[6], while virtual reality and robot-assisted therapy are expensive and have space constraints[7-8]. Therefore, these limitations make it difficult to conduct the interventions in the clinics, and an effective intervention that overcome these limitations is required.

Cognitive exercise therapy (CET) was designed by Carlo Perfetti in Italy at 1979. It is closely associated with the reorganization of the central nervous system and is a remedial approach based on learning theory[9]. In other words, the treatment is based on learning theory and restores body damage through cognitive processes (perception, attention, memory, judgment, and language). This cognitive process can induce a change in the brain neuronal plasticity[10]. Thus, CET has been used for a disorders with emotional and/or psychiatric problems in the clinic and the researches.

CET has been actively studied in the Republic of Korea but mostly in case studies and not through sufficient experimental research. Recently, Lee et al.[11] examined the effect of CET and task-oriented training on the upper limb functions in stroke patients, and reported a larger improvement in the upper extremity functions with CET compared to that with task-oriented training. However, this study as well as other studies did not identify the effect of CET on sensory functions especially the hands, in stroke patients.

The aim of this study investigated the effects of CET on tactile sensations of the hands and activities of daily living(ADL) in patients with stroke.

Method

Present study was performed on 14 individuals with chronic stroke who were admitted in a rehabilitation unit located in Seoul, Korea. The inclusion criteria were: 1) clinically diagnosed stroke; 2) more than 6 months of stroke onset; 3) a manual muscle testing (MMT) sensitivity of 6.65 mm (monofilament) or less; and 5) a Mini-Mental State Examination (MMSE) score of 24 or more. The exclusion criteria were: 1) visual spatial neglect or visual impairment; and 2) severe spasticity. The subjects participating in the study provided written informed consent. The study was approved by the Gachon University Institutional Review Board (approval number: 1044396-201708-HR-137-01). Also, present study is in accordance with the Declaration of Helsinki.

Sensory tests were performed to evaluate the tactile sensations in the hands of the subjects, and the modified Barthel index (MBI) was used to assess an activities of daily living. All outcome tests were performed under blinded condition by one occupational therapist with minimum 3 years of clinical experience. To conduct accurate measurements, the measurer was trained and checked on the measurement method used in this study one week before the test.

We used the Semmes-Weinstein monofilament (Baseline, USA) to measure the minimum threshold at which the subject felt light touch of the hand[12]. This monofilament consists of different diameters and degree of stiffness. Stimulus was applied to the hands with the perpendicular to skin until the filament was slightly bent. The threshold was measured by repeating the stimulation of the index finger of the paretic hand thrice, until the filament bent at the site for 1.5 seconds[13].

To measure the two-point discrimination sense, the Dellon 2-Pint Disk-Criminator (Baseline, USA) was used[14]. Static and dynamic tests were performed. The dynamic test provided stimulation to the proximal part of the distal side of the index finger of the paretic hand, and the static test was performed by taking a point[15].

MBI was used to assess the level of the activities of daily living for stroke patients or other patients with neurological problems. This method has 10 categories, and was measured as 0 at complete dependence and 100 at independence of activities of daily living. The intra-rater reliability of the MBI is r = .89 and the inter-rater reliability is r = .95[16].

The 14 subjects were randomly assigned to the CET group or traditional occupational therapy (TOT) group after they met the inclusion criteria. Tests were performed in both groups for 30 min/day, 5 times a week, for 4 weeks.

Patients in the CET group performed cognitive tasks using their spatial sense and tactile sense based on the protocol used in a previous study[11]. In the cognitive tasks using spatial senses, an occupational therapist covered the subject's eye and subsequently moved the subject's arm passively along the circle drawn on the task board. The size of the circle was identified. The subjects verbally expressed their feelings toward recognizing the differences. Cognitive tasks using tactile senses were performed by the subjects using their hands. Subsequently, an occupational therapist pressed various sponges of varying hardness on the subject's hands. Subjects were masked and made aware of the hardness of the sponge. Further, subjects identified the hardness of the sponge being pressed on their hands. Subjects were asked to express their feelings verbally while recognizing differences in the sense of pressure. Occupational therapist performed therapeutic intervention without knowing which group the subject belong to. Patients in the TOT group performed a passive or an active range of motion exercises of the upper extremity, using an incline board, stacking cone, ring, pegboard, and putty for improvement in their fine motor and upper extremity functions after stroke.

The Statistical Package of the Social Sciences (SPSS) version 23.0 was used for the statistical analyses. The Wilcoxon signed-rank test was performed to compare the dependent variables within each group before and after intervention. The Mann–Whitney U test used to compare differences in the dependent variables between the groups. A p-value < .05 was considered statistically significant.

Result and Discussion

1. **General Characteristics:** The general characteristics did not differ between the groups (p>.05) [Table 1]. Also, there were no significant differences between the groups in light touch, static or dynamic two-point discrimination, and MBI before intervention (p>.05) [Table 2].

Table 1. General characteristics

	CET group (n = 7)	TOTgroup (n = 7)	p
Age (Year), mean±SD	57.57±5.83	59.43±8.72	.665
Gender, n(%)			.593
Male	3 (42.9)	4 (57.1)	
Female	4 (57.1)	3 (42.9)	
Stroke type, n(%)			.577
Ischemic stroke	4 (57.1)	5 (71.4)	
Hemorrhagic stroke	3 (42.9)	2 (28.6)	
Paretic side, n(%)			.593
Right	4 (57.1)	3 (42.9)	
Left	3 (42.9)	4 (57.1)	
Onset duration (months), mean±SD	9.14±1.77	10.71±1.80	.120
K-MMSE, mean±SD	27.43±1.27	26.14±1.86	.150

Footnotes. CET: cognitive exercise therapy, TOT: traditional occupational therapy, K-MMSE = Korean Mini-Mental State Examination, SD: standard deviation.

Table 2. Comparison of tactile sensory and activities of daily living before intervention

	CET group (n = 7)	TOT group (n = 7)	p
	Mean±SD	**Mean±SD**	
LT (g)	3.50±0.57	3.66±0.62	.646
TPDs (g)	10.43±3.15	10.00±2.83	.747
TPDd (g)	11.29±3.04	11.00±2.31	.897
MBI (score)	85.71±5.50	86.57±5.86	.699

Footnotes. CET: cognitive exercise therapy, TOT:traditional occupational therapy, LT: light touch, TPDs: two point discrimination (static), TPDd: two point discrimination (dynamic), MBI: modified Barthel index, SD: standard deviation.

2. **Comparison of tactile sensations and activities of daily living:** The CET group showed significant improvements in static and dynamic two-point discriminations and MBI before and after intervention (p<.05), but no significant improvement in light touch (p>.05). The TOT group showed significant improvement in MBI before and after intervention (p<.05), but no significant improvement in light touch or static or dynamic two-point discrimination (p>.05) [Table 3].

3. **Change score for tactile sensory and activities of daily living between two groups:** After intervention, the CET group had a significantly greater improvement in light touch and dynamic two-point discrimination than the TOT group based on the change in scores (p<.05). Static two-point discrimination and MBI showed no significant differences between the groups (p<.05) [Table 4].

Discussion

Previous CET studies were conducted mainly in the Republic of Korea. To date, the research on CET or its effect on sensory functions was not insufficient. In addition, since most previous studies were conducted as the case studies or not as the randomized controlled trial (RCT), there are limitations that make it difficult to clearly demonstrate the effects of CET.

Results of this study showed that the CET group had significantly improved static and dynamic two-point discrimination sensation and MBI before and after intervention, while the TOT group showed significant improvement only in MBI. After intervention, the CET group had significantly greater improvement in light touch and dynamic two-point discrimination than the TOT group.

The CET group showed significant improvement in light touch and dynamic two-point discrimination of hands than the TOT group. In Van de Winckel et al.'s functional magnetic resonance imaging study, cognitive tasks using spatial and tactile senses applied in CET activated the premotor cortex areas closely associated with hand functions[10]. This result supports the improvement in sensory functions of the hand in this study. The recovery of upper extremity and hand functions is the slowest recovery after stroke, and control of hand movement must include grasp and prehensile activity for the activities of daily living[17]. Lee et al. found that CET had a greater effect on the improvement of upper extremity function compared to TOT[11]. However, our study did not assess upper extremity or hand function.

Table 3. Comparison of tactile sensations and activities of daily living

	CET Group (n = 7)			TOT Group (n = 7)		
	Pre	Post	p	Pre	Post	p
	Mean±SD	Mean±SD		Mean±SD	Mean±SD	
LT (g)	3.50±0.57	3.23±0.45	.059	3.66±0.62	3.66±0.62	1.000
TPDs (g)	10.43±3.15	9.43±2.44	.038*	10.00±2.83	9.71±2.50	.157
TPDd (g)	11.29±3.04	10.57±2.76	.025*	11.00±2.31	10.86±2.04	.317
MBI (score)	85.71±5.50	87.71±5.25	.014*	86.57±5.86	88.86±5.96	.027*

Footnotes. *p<0.05, CET: cognitive exercise therapy, TOT:traditional occupational therapy, LT: light touch, TPDs: two point discrimination (static), TPDd: two point discrimination (dynamic), MBI: modified Barthel index, SD: standard deviation.

Table 4. Change score for tactile sensory and activities of daily living between two groups

	CET Group (n = 7)	TOT Group (n = 7)	p
	Change Score	Change Score	
	Mean±SD	Mean±SD	
LT (g)	-0.27±0.28	0.0±0.0	.024*
TPDs (g)	-1.00±0.82	-0.29±0.49	.080
TPDd (g)	-0.71±0.49	-0.14±0.38	.037*
MBI (score)	2.00±0.58	2.29±1.50	.632

Footnotes. *p<0.05 CET: cognitive exercise therapy, TOT:traditional occupational therapy, LT: light touch, TPDs: two point discrimination (static), TPDd: two point discrimination (dynamic), MBI: modified Barthel index, SD: standard deviation.

There was no significant difference between the two groups. The interpretation of these results can be explained in three ways. First, there is a possibility that the results are not clear because the sample size is small. Second, there is a possibility that CET will not be effective in improvement of activities of daily living. Third, we measured the evaluation of activities of daily living using MBI. The subcategories of MBI have more evaluation items for the lower extremity functions, such as gait, than for the upper extremity functions. Therefore, there is a possibility that it was difficult to confirm the improvement of the upper extremity functions.

The limitations of this study are as follows. First, the sample size was small. Therefore, it may be difficult to generalize the findings to population with stroke. Second, we performed only a relatively short period of intervention with four weeks of treatment. Third, we did not confirm the sustained effect of treatment. Finally, we did not evaluate proprioception or motions of the hands. In order to verify the effect of CET, one should check whether there is an improvement in motion or proprioception.

Conclusion

In conclusion, these findings suggest that CET can induce improvements in the tactile sensations of the hands in patients with stroke better than TOT. However, further studies with more subjects. In addition, it is necessary to study whether it is effective in improving the upper limb functions as well as sensory functions. In further studies, more patients should be included for long-term effects, and randomized controlled trial is required.

Ethical Clearance: Not required

Source of Funding: This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2017R1C1B5075810).

Conflict of Interest: Nil

References

1. Dromerick A, Reding M. Medical and neurological complications during inpatient stroke rehabilitation. Stroke. 1994 Feb;25(2):358-61.
2. Bonita R, Solomon N, Broad JB. Prevalence of stroke and stroke-related disability. Estimates from the Auckland stroke studies. Stroke. 1997 Oct;28(10):1898-902.
3. Green J, Forster A, Young J. A test-retest reliability study of the Barthel Index, the Rivermead Mobility Index, the Nottingham Extended Activities of Daily Living Scale and the Frenchay Activities Index in stroke patients. Disabil Rehabil. 2001 Oct 15;23(15):670-6.
4. Carey LM, Matyas TA, Oke LE. Sensory loss in stroke patients: effective training of tactile and proprioceptive discrimination. Arch Phys Med Rehabil. 1993 Jun;74(6):602-11.
5. Mercier L, Audet T, Hebert R, Rochette A, Dubois MF. Impact of motor, cognitive, and perceptual disorders on ability to perform activities of daily living after stroke. Stroke. 2001 Nov;32(11):2602-8.
6. DeBow SB, Davies ML, Clarke HL, Colbourne F. Constraint-induced movement therapy and rehabilitation exercises lessen motor deficits and volume of brain injury after striatal hemorrhagic stroke in rats. Stroke. 2003 Apr; 34(4):1021-6. DOI:10.1161/01.STR.0000063374.89732.9F
7. Henderson A, Korner-Bitensky N, Levin, M. Virtual reality in stroke rehabilitation: a systematic review of its effectiveness for upper limb motor recovery. Top Stroke Rehabil. 2007 Mar-Apr;14(2):52-61. DOI:10.1310/tsr1402-52.
8. Kwakkel G., Kollen BJ, Krebs HI.: Effects of robot-assisted therapy on upper limb recovery after stroke: a systematic review. Neurorehabil Neural Repair. 2008 Mar-Apr;22(2):111-21. DOI:10.1177/1545968307305457
9. Perfetti C. Condotte terapeutiche per la reeducazione motoria dell' emiplegico. Milano, Italy: Ghedimedia. 2007.
10. Van de Winckel A1, Sunaert S, Wenderoth N, Peeters R, Van Hecke P, Feys H, et al. Passive somatosensory discrimination tasks in healthy volunteers: differential networks involved in familiar versus unfamiliar shape and length discrimination. Neuroimage. 2005 Jun;26(2):441-53. DOI:10.1016/j.neuroimage.2005.01.058
11. Lee S, Bae S, Jeon D, Kim, KY. The effects of cognitive exercise therapy on chronic stroke patients' upper limb functions, activities of daily living and quality of life. J Phys Ther Sci. 2015 Sep;27(9):2787-91. DOI:10.1589/jpts.27.2787.
12. Bell-Krotoski J, Tomancik E. The repeatability of testing with Semmes-Weinstein monofilaments. J Hand Surg Am. 1987 Jan;12(1):155-61.
13. Radomski MV, Latham CA. Occupational therapy for physical dysfunction. Lippincott Williams & Wilkins. 2008.
14. Dellon AL, Mackinnon SE, Crosby PM. Reliability of two-point discrimination measurements. J Hand Surg Am. 1987 Sep;12(5):693-6.
15. Novak CB. Evaluation of hand sensibility: a review. J Hand Ther. 2001 Oct-Dec;14(4):266-72.
16. Granger CV, Albrecht GL, Hamilton BB: Outcome of comprehensive medical rehabilitation: Measurement by PULSES profile and the Barthel Index. Arch Phys Med Rehabil. 1979 Apr;60(4):145-54.
17. Fritz J, Shamma S, Elhilali M, Klein D. Rapid task-related plasticity of spectrotemporal receptive fields in primary auditory cortex. Nat Neurosci. 2003 Nov; 6(11):1216-23. DOI:10.1038/nn1141