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The Effect of Bilateral Asymmetrical Motion Induction Task Training on Hand Activity in Chronic Hemiplegic Patients
-According to the Presence or Absence of Predominant Damage-

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Abstract

Background/Objectives: This study investigates changes in the recovery of upper extremity motor functions according to preferred hand damage after training with a bilateral asymmetrical motion induction task.

Methods/Statistical analysis: In this study, 11 patients with preferred hand hemiplegia and 11 patients with nonpreferred hand hemiplegia, for a total of 22 people, were recruited as subjects.

This study evaluated the manual function test to find out the difference in hand activity before and after the study bilateral task training for a total of 12 weeks.

Findings: As a result of this study, bilateral asymmetrical motion induction task training in both hands showed no significant difference between the two groups in the preferred hand damaged group and nonpreferred hand damaged group in the manual function test. But there was no statistically significant difference between groups for treatment time of preferred hand damaged group and nonpreferred hand damaged group in MFT ($p > .05$)

Improvements/Applications: In conclusion, in the bilateral asymmetrical motion task training, there may be differences in motor recovery according to the degree of participation in movement and learning ability.

***Keywords*:** Hemiplegic, Preferred, Nonpreferred, Bilateral asymmetrical task training, Hand function

1. Introduction

Hand function is critical for leading a high quality of life and performing tasks of active daily living. Hand function is a fundamental factor in work and leisure activities, and both hands are often used simultaneously to solve tasks (Scissors, dressing, cutting food, grooming, toileting, etc.) when performing activities of daily living(ADL).

For most individuals, the preferred hand acts a greater role in mobility, and the nonpreferred hand acts a greater role in stability[1]. Loss of hand function in patients with stroke-induced hemiplegia is a typical symptom and the largest after-effect of the stroke. Paralysis of one hand in patients with hemiplegia causes mental and physical pain and is often accompanied by a loss of motivation and sense of frustration. Paralysis of the upper extremity prevents simultaneous use of both hands in daily life, making it more difficult to perform functional tasks. In particular, in performing functional tasks, damage to the preferred hand is especially important. Harris and End (2006) reported that preferred hand damage is more important for rehabilitation because preferred hands have advantages over nonpreferred hands in task performance accuracy and speed[2]. As a result, the authors suggest that accuracy and speed factors can impact motor learning effects differently for the preferred hand and the nonpreferred hand in upper extremity function.

Currently, many methods for managing upper extremity function after strokes have been reported in the literature. One of these methods is two-handed task training based on a task-oriented approach. The classic two-handed task training approach involves

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bilateral symmetrical movement guided training, which is very different from the therapeutic design for performing training with the paralyzed upper extremity. Most currently reported studies are designed to simultaneously guidance bimanual movement to verify the effect of training on the paralyzed upper extremities[3,4,5]. However, in solving the actual task, both hands perform the task with bilateral asymmetrical movement, not symmetrical movement.
Therefore, it is necessary to verify the difference in the qualitative level of movement of the preferred and nonpreferred upper extremity functions, the frequency of task participation, and the effect of the difference in recovery

2. Research and Methods

2.1. Research *Subjects*

This experiment investigates changes in the recovery of upper extremity motor functions according to the preferred hand damage after training with a bilateral asymmetrical motion induction task, rather than the bilateral symmetrical motion induction tasks conventionally used in training upper extremity function recovery after a stroke.

In this study, 11 patients with preferred hand hemiplegia and 11 patients with nonpreferred hand hemiplegia, for a total of 22 patients, were selected as subjects. Each group assigned a therapist to a patient with mild symptoms (Fugl–Meyer score of 58–66) as a participant in the task training according to the Fugl–Meyer score. The subjects all visited B Rehabilitation Hospital in Seongnam City, and all subjects who were recruited agreed to participate in this study after receiving sufficient explanation[Table 1].

2.2. *Materials*

2.2.1. Manual function test(MFT)

MFT is a instrument for a evaluation that evaluates the overall functional state of upper extremity function and is mainly used in clinical practice. The MFT is divided into 8 items in 3 areas, where the state of recovery of upper extremity function is assessed by upper extremity motor function, grasping, and finger manipulation. Each item score is recorded as 1 point for successful performance, and 0 points when the participant cannot perform the action. A perfect MFT score is 32 points.

2.3. *Methods*

The 22 subjects, including 11 subjects from the preferred hand damaged group (Rt hemiplegia) and 11 from the nonpreferred hand damaged group (Lt hemiplegia), participated in two-handed task training for 30 minutes, thrice a week, for 12 weeks. In this study, after training in 5 types of two-handed tasks for a total of 3 months, subjects were re-evaluated for upper extremity function. After 2 weeks, re-evaluation was conducted for the retention test.

2.3.1. Research procedure

The subjects of this study conducted functional two-handed task training using everyday objects that can perform tasks by engaging both hands in their daily life.

Training for detail task is as follows.

1) Handwashing task: We performed two-handed handwashing task training at the handbasin in activity daily living room. The therapist provided assistance as required.
2) Dressing task: The training task was to change into new clothes in the hospital, and the therapist provided assistance if necessary.
3) Scissors task: Using several sizes of scissors, participants cut a sheet of thick A4-sized drawing paper. The therapist provided assistance as needed.
4) Nonmetal bottle cap removal task: The nonmetal bottle cap opening task was conducted with a bottle opener on a beverage bottle. The therapist provided assistance as needed.
5) Strength training: Two JAMAR® hand dynamometers were used for the two-handed task training, and the therapist provided assistance as needed.

Subjects had 6 minutes to performance each task. All training was performed in under 30 minutes, and the sequence was randomized.

2.4. *Statistical analysis*

In this study, the SPSS/WIN statistical program 18.0 was used for statistical processing, and repeated measures analysis of variance was analyzed to see the amount of change of each variable in time and two groups. A paired t-test was performed to see the difference in effect between pre-and post-treatment within a group, and an independent t-test was analyzed for comparison between groups. All statistical significance levels of the data were set to a = 0.05.

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3. Results

3.1. *Results*

3.1.1. General subject characteristics

The subjects of this study were 22 patients with chronic stroke (14 men and 8 women), including 11 patients with preferred hand damaged (right hemiplegia patients), and 11 nonpreferred hand damaged patients (left hemiplegia patients). The average age of the preferred hand damaged group was 68.64 ± 6.80 years, and the average age of the nonpreferred hand damaged group was 56.64 ± 19.30 years. The preferred hand damaged group averaged 3.45 ± 1.21 years between time of stroke and time of rehabilitation and the nonpreferred hand damaged group averaged 3.18 ± 1.67 years [Table 1].

Table 1. General subject characteristics.

Characteristics		PHDG (n=11)	NPHDG (n=11)
Age (year)		68.64±6.80	54.64±19.30
Duration (years)		3.45±1.21	3.18±1.67
Type	Infarction	7	6
	Hemorrhage	4	5
Paretic side	Right	11	0
	Left	0	11
Gender	Male	7	7
	Female	4	4

PHDG: preferred hand affected group. NPHDG: nonpreferred hand damaged group.

3.1.2. Comparison of manual function test between groups and timing after bilateral task training

After task training 3 times a week for 12 weeks, the MFT score in PHDG increased by 2.45 points from 23.73 points before the study to 26.18 points after the study. Two weeks after all training was completed, the MFT score for the holding test had increased 2.36 points to 26.09 points [Table 2]. The MFT score of NPHDG increased by 1.54 points from 23.55 points before the study to 25.09 points after the study, and reached 24.91 points in the holding test 2 weeks after all training was completed, which was 1.36 points higher than before the study[Table 2].

Table 2. Comparisons of manual function test between groups

Variable	PHDG	NPHDG	t	p
Pre-test	23.73±1.85	23.55±2.30	.205	.461
Post-test	26.18±1.83	25.09±2.55	1.153	.295
Retention test	26.09±1.92	24.91±2.59	1.216	.440

PHDG: preferred hand damaged group; NPHDG: nonpreferred hand damaged group.

This study was no statistically meaningful difference between groups during the treatment session of PHDG and NPHDG in MFT ($F = .786$, $p > .05$), but there were meaningful differences according to treatment duration ($F = 131.377$, $p < .001$). Our results showed statistically significant changes in treatment duration and group interaction ($F = 8.043$, $p < .001$)[Table 3].

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Comparing results between groups over time, both PHDG and NPHDG showed changes before and after the intervention. However, as a result of this study, no significant change could be confirmed in the holding test [Table 4].

Table 3. Comparison of manual function test between group and timing

Source of Variation	SS	df	MS	F	p
Between-subject					
group	11.045	1	11.045	.786	.386
Error	280.909	20	14.045		
Within-subject					
Time	54.939	2	27.470	131.377***	.000***
Time * Group	3.364	2	1.682	8.043***	.001**
Error	8.364	40	.209		

p<.01*p<.001.

Table 4. Comparisons of manual function test within groups

Variable		M±SD	t	p
PHDG	Pre-test	23.73±1.85	-9.925	.000***
	Post-test	26.18±1.83		
	Pre-test	23.73±1.85	-8.480	.000***
	Retention-test	26.09±1.92		
	Post-test	26.18±1.83	1.000	.341
	Retention-test	26.09±1.92		
NPHDG	Pre-test	23.55±2.30	-9.815	.000***
	Post-test	25.09±2.55		
	Pre-test	23.55±2.30	-6.708	.000***
	Retention-test	24.91±2.59		
	Post-test	25.09±2.55	1.491	.167
	Retention-test	24.91±2.59		

***p<.001, PHDG: preferred hand damaged group; NPHDG: nonpreferred hand damaged group.

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3.2. *Discussion*

This study was conducted with 22 patients with hemiplegia due to chronic stroke, and examined potential differences of the learning effects of recovery of upper extremity function in preferred (right) hemiplegic patients and nonpreferred (left) hemiplegic patients after training with both hands for 30 minutes 3 times a week for 12 weeks.

The preferred hand is the hand that one primarily uses to complete tasks in daily life. Even for tasks that utilize bimanual at the same time, the reason for using the preferred hand can be explained by cerebral laterality[6].

Cerebral hemisphere dominance can be considered a result of asymmetric development in the cerebral cortical motor region of the cerebral hemisphere. Approximately 80% of people use the right hand as the preferred hand. In general, when participating a left-handed task, the cortical motor area of the right cerebral hemisphere is activated[7]. However, when the right hand is used functionally, neuronal activity appears in the entire cortical motor area of the left cerebral hemisphere. These findings support the basis for lateralization of the cerebral hemisphere and support that the left cerebral hemisphere performs a role as the dominant cerebral hemisphere in ADL performance.

Harris and Eng (2006) reported that in stroke patients suffering from hand paralysis, individuals with paralysis of the preferred hand controlled by the left cerebral hemisphere experienced less severe motor impairment than individuals suffering from paralysis of the nonpreferred hand[2]. They also found that the right hand showed higher performance accuracy and speed. According to a report by Giuliani et al. (1997), patients with left cerebral hemisphere damage were characteristically impaired in frequency, velocity, and timing factors in both hands[8]. Furthermore, according to a report by Mutha et al. (2010), patients with ideomotor apraxia due to damage to the left parietal lobe demonstrated difficulty in executing or planning spatiotemporal movements when performing purposeful tasks[9]. These patients tend to move each intersegment excessively due to impaired coordination when a simple task was requested, and the direction of movement was largely changed. Patients with right cerebral hemisphere damaged show delays in time and speed of movements when performing tasks, and control impairment at the end of movements[10,11]. Similar critical cases also examined and explored during the research [12-22].

The purpose of this study was to confirm difference in functional movement ability when the preferred hand is used or not used in two-handed task training. Two-hand task training showed significant differences in terms of the recovery of upper extremity function in both groups according to time before and after the treatment period on the MFT test. However, in comparing the preferred hand damaged group and the nonpreferred hand damaged group, statistically significant differences could not be found in this study. Nonetheless, the mean value increased in the preferred hand damaged group in comparison with the nonpreferred hand damaged group, although there was no statistically significant difference after the end of this study. Therefore, in future studies, it is necessary to confirm the difference according to the number of subjects or the intervention method of two-handed task training. The main limitation of this research is difficult to generalize in all hemiplegia patients. Because we have been studied in patients with chronic stroke. In the future, it is considered to supplement the limitations of this research to improve the intervention effect of each recovery stage in patients with acute, subacute, and chronic stroke.

4. Conclusion

The purpose of this researh was to confirm the difference in the effect of motor recovery according to the preferred and nonpreferred upper extremity. As a result of this study showed statistically meaningful changes in the treatment intervention duration and group interaction ($F = 8.043$, $p < .001$). But there was no statistically meantingful difference between groups for intervention duration of PHDG and NPHDG in MFT ($F = .786$, $p > .05$). In conclusion, in the two-handed task training, there may be differences in motor recovery according to the degree of participation in movement and learning ability.

5. References

1. Schaefer, S. Y., Mutha, P. K., Haaland, K. Y., & Sainburg, R. L. (2012). Hemispheric specialization for movement control produces dissociable differences in online corrections after stroke. *Cerebral Cortex, 22*(6), 1407-1419. https://doi.org/10.1093/cercor/bhr237
2. Harris, J. E., & Eng, J. J. (2006). Individuals with the dominant hand affected following stroke demonstrate less impairment than those with the nondominant hand affected. *Neurorehabilitation and Neural Repair. 20,* 380-389. https://doi.org/10.1177/1545968305284528
3. Stinear, J. W., Byblow, W. D. (2004). An interhemispheric asymmetry in motor cortex disinhibition during bimanual movement. *Brain Research, 1002*(1), 81-87. https://doi.org/10.1016/j.brainres.2004.06.062
4. Waller, S. M., & Whitall, J. (2005). Hand dominance and side of stroke affect rehabilitation in chronic stroke. *Clinical Rehabilitation, 19*(5), 544-551. https://doi.org/10.1191/0269215505cr829oa
5. Cauraugh, J. H., & Summers, J. J. (2005). Neural plasticity and bilateral movements: A rehabilitation approach for chronic stroke. *Progress in Neurobiology, 75*(5), 309-320. https://doi.org/10.1016/j.pneurobio.2005.04.001
6. De Gennaro, L., Cristiani, R., Bertini, M., Curcio, G., Ferrara, M., Fratello, F., & Rossini, P. M. (2004). Handedness is mainly associated with an asymmetry of corticospinal excitability and not of transcallosal inhibition. *Clinical Neurophysiology, 115*(6), 1305-1312. https://doi.org/10.1016/j.clinph.2004.01.014
7. Kim, S. G., Ashe, J., Hendrich, K., Ellermann, J. M., Merkle, H., Ugurbil, K., & Georgopoulos, A. P. (1993). Functional magnetic resonance imaging of motor cortex: Hemispheric asymmetry and handedness. *Science, 261*(5121), 615-617.

https://doi.org/10.1126/science.8342027
8. Giuliani, C. A., Purser, J. L., Light, K. E., Genova, P. A. (1997). Impairments in arm control in subjects with left and right hemisphere stroke. *Neurorehabilitation. 9*(1), 71-87. https://doi.org/ 10.3233/NRE-1997-9107
9. Mutha, P. K., Sainburg, R. L., & Haaland, K. Y. (2010). Coordination deficits in ideomotor apraxia during visually targeted reaching reflect impaired visuomotor transformations. *Neuropsychologia, 48*(13), 3855-3867. https://doi.org/10.1016/j.neuropsychologia.2010.09.018
10. Mani, S., Mutha, P. K., Przybyla, A., Haaland, K. Y., Good, D. C., & Sainburg, R. L. (2013). Contralesional motor deficits after unilateral stroke reflect hemisphere-specific control mechanisms. *Brain, 136*(4), 1288-1303. https://doi.org/10.1093/brain/aws283
11. Schaefer, S. Y., Haaland, K. Y., & Sainburg, R. L. (2009). Hemispheric specialization and functional impact of ipsilesional deficits in movement coordination and accuracy. Neuropsychologia, 47(13), 2953-2966. **https://doi.org/10.1016/j.neuropsychologia.2009.06.025**
12. Mishra, S., Mallick, P. K., Tripathy, H. K., Bhoi, A. K., & González-Briones, A. (2020). Performance Evaluation of a Proposed Machine Learning Model for Chronic Disease Datasets Using an Integrated Attribute Evaluator and an Improved Decision Tree Classifier. Applied Sciences, 10(22), 8137.
13. 23. Bhoi, A. K., Sherpa, K. S., & Mallick, P. K. (2014, April). A comparative analysis of neuropathic and healthy EMG signal using PSD. In 2014 International Conference on Communication and Signal Processing (pp. 1375-1379). IEEE.
14. 24. Bhoi, A. K., Sherpa, K. S., Khandelwal, B., & Mallick, P. K. (2019). T Wave Analysis: Potential Marker of Arrhythmia and Ischemia Detection-A Review. In Cognitive Informatics and Soft Computing (pp. 121-130). Springer, Singapore.
15. 25. Mishra, S., Mallick, P. K., Jena, L., & Chae, G. S. (2020). Optimization of Skewed Data Using Sampling-Based Preprocessing Approach. Frontiers in Public Health, 8.
16. 26. Bhoi, A. K., & Sherpa, K. S. (2016). Statistical analysis of QRS-complex to evaluate the QR versus RS interval alteration during ischemia. Journal of Medical Imaging and Health Informatics, 6(1), 210-214.
17. 27. Mishra, S., Tripathy, H. K., Mallick, P. K., Bhoi, A. K., & Barsocchi, P. (2020). EAGA-MLP—An Enhanced and Adaptive Hybrid Classification Model for Diabetes Diagnosis. Sensors, 20(14), 4036.
18. 28. Bhoi, A. K., Mallick, P. K., Liu, C. M., & Balas, V. E (Eds.) (2021). Bio-inspired Neurocomputing, Springer.
19. 29. Oniani, S., Marques, G., Barnovi, S., Pires, I. M., & Bhoi, A. K. (2020). Artificial Intelligence for Internet of Things and Enhanced Medical Systems. In Bio-inspired Neurocomputing (pp. 43-59). Springer, Singapore.
20. 30. Marques, G., Bhoi, A.K., Albuquerque, V.H.C. de, K.S., H. (Eds.) (2021). IoT in Healthcare and Ambient Assisted Living, Springer
21. 31. Marques, G., Miranda, N., Kumar Bhoi, A., Garcia-Zapirain, B., Hamrioui, S., & de la Torre Díez, I. (2020). Internet of Things and Enhanced Living Environments: Measuring and Mapping Air Quality Using Cyber-physical Systems and Mobile Computing Technologies. Sensors, 20(3), 720.
22. 32. Mallick, P. K., Balas, V. E., Bhoi, A. K., & Zobaa, A. F. (Eds.). (2018). Cognitive Informatics and Soft Computing: Proceeding of CISC 2017 (Vol. 768). Springer.