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The Effect of Action Observation Training Combined with Intrinsic Muscle Stimulation on the Upper Limb of Function in Stroke Patients

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Abstract

Background/Objectives: The aim of this study was to investigate the effect of action observation training combined with intrinsic muscle stimulation intervention on the function of upper extremity in patients with stroke.

Method/Statistical Analysis: Twenty-two stroke patients were prospectively randomized to action observation training with intrinsic muscle stimulation group (N = 11) or action observation (N = 11). The upper limb of motor function and sensory function were evaluated before intervention, and intervention was performed 3 times a week, 40 minutes, 4 weeks, and the same evaluation was performed after intervention. The outcome measure was used by manual function test and sensory test.

Findings: The results of this study showed that there was a significant difference in the test within the group. There was statistically significant difference in manual function test and sensory test in the inter body test.

Improvements/Applications: This study demonstrated that action observation training combined with intrinsic muscle stimulation significantly improves the function of patients with stroke.

Keywords: *Stroke, Upper extremity, Intrinsic muscle stimulation, Action observation, Sensory.*

Introduction

Stroke is a sudden interruption of blood supply to a part of the brain owing to infraction or rupture of the blood vessels. It causes various impairments in physical, cognitive, or emotional functions [1]. Up to 80% of stroke survivors have upper limb dysfunction, and the burden of upper limb injury after stroke is still high. [2]. The recovery of the upper limb function of stroke patients is very difficult, most patients have limitations in functional movements such as reaching, grasping, and ability to activities daily living. Each year after a stroke, upper extremity dysfunction is associated with the quality of life, anxiety, and prejudice of a health-related individual.[3]. Recovering upper limb function is considered to be a very important factor in improving occupation ability and overall physical abilities as well as activities daily living performances[4]. Therefore, many therapists have applied various neurological interventions for the maximal recovery of the upper extremity functions of people with hemiplegia. Including the promotion of alternative movements, aerobic exercise, somatosensory stimulation, action observation training, constraint-induced movement therapy, task-oriented training, bilateral arm training, brain stimulations, mental practice, mirror therapy, virtual reality etc.[5]. Movement and somatosensory awareness can be improved in a variety of ways, including techniques such as sensory

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reeducation, tactile kinesthetic guiding, repetitive sensory practice or desensitization [6]. The intrinsic muscle of a hand is provided stability of the fingers, and the size and amount of muscle in the hand are small, but it generates a strong force equivalent to about 50% of the grasping strength of the hand [7]. Observation training is a method of repeatedly tracing an activity or activity performed by another person, or observing an activity or activity appearing in the image and imitating an observed activity or activity [8]. Action observation therapy facilitates physical training for motor memory formation and is based on mirror neurons, which were first described in monkeys [9]. In previous studies, action observation training using visual information to provide goal-oriented activities and motivational information has a positive effect on upper extremity function of stroke patients. In addition, intrinsic muscle stimulation by providing various sensory information also has a positive effect. However, there has been no research on the combination of motion observation through visual perception and intrinsic muscle stimulation training through somatosensory. The purpose of this study was to investigate the effect of action observation training combined with intrinsic muscle stimulation on the upper limb of function and muscle activity in stroke patients.

Method

1. **Subjects:** In this study, 22 patients who were admitted to B clinic in Gyeonggi province were randomly assigned to two groups. The specific criteria of the subject are as follows: (1) Adults receiving a stroke diagnosis from a rehabilitation doctor, (2) Shoulders and wrists, hand joints and painlessness, (3) Those who have no problem with visual perception, (4)Communication difficulties, (5) Those who have no problem with their visibility (4) Those who have voluntarily participated in this study with the consent

2. **Materials:**

   (a) **Upper limb of motor function:** The Manual Function Test (MFT) was developed for the evaluation and analysis of hand, and upper limb dysfunction. A total of 32 items were examined. Three major areas were assessed for upper extremity function (4 items), gripping (2 items), and finger manipulation (2 items) [10].

   (b) **Upper limb of sensory function:** In this study, sensory evaluation was used for three subjects (2-point discrimination test, proprioception test, stereognosis test) for the affected arm. For each sense, two points were set to exactly match the position and type of the stimulus, one point to match either one of the position or type of the stimulus, and zero points if the position or type of the stimulus were different. [11].

3. **Method:** Twenty-two stroke patients were prospectively randomized to action observation training with intrinsic muscle stimulation group (N = 11) or action observation (N = 11). In the experimental group, 40 min of action observation training with intrinsic muscle stimulation and 40 min of action observation training in the control group were performed. Both groups received general physical therapy and occupational therapy for 30 minutes per day, five days a week, for 4 weeks.

   (a) **Action observation training with intrinsic muscle stimulation on experimental group:** The action observation video presented four daily activities. The video duration for each subtask was 3-4 minutes, and the video duration for one assignment was 12-15 minutes. The video showed that the object was manipulated using one or two hands according to the task, and after the observation, the subjects were asked to imitate the movement [8]. The intrinsic muscle stimulation training was applied in this study was modified and supplemented by referring to the contents suggested by Sue Raine et al [12]. This training wasconsisted of specific activation of lumbricals, specific activation of abductor digiti minimi, and specific activation of thenar eminence. The experimental group was treated for intrinsic muscle stimulation after observing action observation for 15 minutes in table 2.

   (b) **Action observation training on control group:** The control group observed only 30 minutes of action observation without intrinsic muscle stimulation training in [Table 1].

Table 1. Intervention program

Variables	Intrinsic muscle stimulation training	Action observation training
Intervention	specific activation of lumbricals,	Observing the action
	specific activation of abductor digiti minimi	Following the action
	specific activation of thenar eminence	

4. **Statistical Analysis:** The result analysis of collected data was statistically processed using SPSS 18.0 program for Windows. The general characteristics of the study subjects were descriptive statistics and frequency analysis, and the data collected through the study were tested for normality, indicating that all variables were normal distributed. Paired t-tests were performed for pre and post-treatment in the experimental and control groups, and independent t-tests were performed for comparison between the experimental and control groups. All statistical significance was set at 0.05

Result and Discussion

1. **General characteristics of experimental subjects:** The general characteristics of the participants in this study are as follows. According to gender, there were 5 males (45.5%) and 6 females (54.5%) in the action observation training group combined with intrinsic muscle stimulation and there were 5 males (45.5%) and 6 women (54.5%) in the action observation training group without intrinsic muscle stimulation. The causes were 6 patients (54.5%) with cerebral hemorrhage and 5 patients (45.5%) with cerebral hemorrhage in the action observation training group combined with intrinsic muscle stimulation and 6 patients (54.5%) with cerebral hemorrhage, Five cerebral infarctions (45.5%)in the action observation training group without intrinsic muscle stimulation. Paralyzed patients had left hemiplegia (45.5%) and right hemiplegia (54.5%) in the action observation training group combined with intrinsic muscle stimulation and left hemiplegia (45.5%) and right hemiplegia (54.5%) in the action observation training group without intrinsic muscle stimulation.

2. **Comparison of results before and afterintervention of experimental groups:** The MFT of the experimental group showed a significant improvement from 11.69±7.21 points before intervention to 13.69±7.2 points after intervention (p <.05). The 2-point discrimination of the experimental group showed no significant improvement from 0.45±0.52 points before intervention to 0.73±0.47 points after intervention (p >.05).The proprioception of the experimental group showed significant improvement from 0.45±0.52 points before intervention to 0.91±0.54 points after intervention (p <.05).The stereognosis of the experimental group showed no significant improvement from 0.55±0.52 points before intervention to 0.82±0.6 points after intervention in [Table 2] (p >.05).

Table 2. Comparison of results before and after intervention in experimental group (N = 22)

Variables	Pre-test	Post-test	p
Manual function test	11.69±7.21	13.69±7.2	.02*
2 point discrimination	0.45±0.52	0.73±0.47	.08
Proprioception	0.45±0.52	0.91±0.54	.01*
Stereognosis	0.55±0.52	0.82±0.6	.08

The values are mean (standard deviation),*p<0.05 by paired t-test

3. **Comparison of results before and after intervention of control groups:** The MFT of the experimental group showed no significant improvement from 11.69±7.21 points before intervention to 13.69±7.2 points after intervention (p >.05). The 2-point discrimination of the experimental group showed no significant improvement from 0.36±0.5 points before intervention to 0.64±0.67 points after intervention (p >.05).The proprioception of the experimental group showed no significant improvement from 0.64±0.5 points before intervention to 0.73±0.47 points after intervention (p >.05). The stereognosis of the experimental group showed no significant improvement from 0.45±0.52 points before intervention to 0.55±0.52 points after intervention in [Table 3] (p >.05).

Table 3. Comparison of results before and after intervention in control group (N = 22)

Variables	Pre-test	Post-test	p
Manual Function Test	11.62±7.2	12±7.09	.17
2 point Discrimination	0.36±0.50	0.64±0.67	.08
Proprioception	0.64±0.50	0.73±0.47	.34
Stereognosis	0.45±0.52	0.55±0.52	.34

The values are mean (standard deviation)

Discussion

The prognosis for recovering upper extremity dysfunction in stroke patients is poor and only 20% of patients report some upper limb function [13]. As a therapeutic intervention that is widely used in clinical practice to improve upper limb function, it is based on cerebral plasticity. (robot training), task-specific training, virtual reality training, somatosensory training, imagery training, etc. are being applied in various forms[14]. Action observation training is a method of imitating and repeatedly training movement by observing other

people's goal-oriented activities or observing activities appearing in the video [15]. Intrinsic muscle stimulation of hands is a principle that strengthens the ability to modify movement in the physiological aspect based on the theory of motor learning and provides the basis for eliciting the change of functional performance of hand through treatment [7]. Treatment using these tasks is a treatment that causes changes in the nervous system by patients with disabilities performing their tasks on their own [16]. The purpose of this study was to investigate the effect of action observation training combined with intrinsic muscle stimulation on the upper limb of function and muscle activity in stroke patients. In the study of the change in upper limb of motor function before and after intervention experimental group showed statistically significant difference in MFT ($p<.05$) and control group did not show statistically significant difference($p>.05$). In previous studies, lumbricals and interossei, which are intrinsic muscles of the hands, play an important role in generating the shape and holding force of the hands [12]. Action observation training has been shown to be helpful for the upper limb function and activities daily living in stroke patients [17]. The visual stimulus of observing and imitating behavior is thought to influence the pre-shaping of the hand when it reaches the object. Intrinsic muscle stimulation based on direct sensory stimulation within the body is considered to have a positive effect by making the hand easier and more efficient as anticipatory postural adjustments. In the study of the change in upper limb sensory function before and after intervention experimental group showed statistically significant difference in proprioception ($p <.05$) and control group did not show statistically significant difference ($p>.05$). In the study of the change in upper limb sensory function before and after intervention experimental group did not show statistically significant difference in 2-point discrimination ($p>.05$) and control group did not show statistically significant difference ($p>.05$). In the study of the change in upper limb sensory function before and after intervention experimental group did not show statistically significant difference in stereognosis ($p>.05$) and control group did not show statistically significant difference ($p>.05$). Unlike other parts of the body, the human hand and upper limbs have a large number of sensory receptors, which play an important role in processing a lot of information and delivering real-time body information to the central nervous system[18]. In previous research, training was carried out to improve the senses and to improve motor control. Training was conducted to distinguish between object and texture through tactile sensation, to discriminate joint position, and to discriminate the weight of an object. The functional improvement was reported[19]. This suggests that intrinsic muscle stimulation is a factor that improves sensory function of the upper limb as in this study. Action observation also mimics elements of movement, such as proprioception, by imitating it. Observation alone is difficult to influence. The limitation of this study was that the study period of 4 weeks had difficulty in demonstrating the effectiveness of the intervention and the number of subjects was small due to the difficulty in recruiting the subjects meeting the selection criteria. In future studies, it is necessary to specify the upper extremity function and to prove the effect of action observation and intrinsic muscle stimulation on the recovery of upper extremity function.

Conclusion

The aim of this study was to investigate the effect of action observation training combined with intrinsic muscle stimulation intervention on the function of upper extremity in patients with stroke. First, there was a statistically significant difference in manual function test in the action observation training group with intrinsic muscle stimulation ($p<.05$), but there was no statistically significant difference in the action observation training group without intrinsic muscle stimulation ($p>.05$). Second, there was statistically significant difference in sensory function in the action observation training group with intrinsic muscle stimulation after intervention ($p<.05$). There was no statistically significant difference between action observation training group without intrinsic muscle stimulation ($p>.05$).

Ethical Clearance: Not required

Source of Funding: Self

Conflict of Interest: Nil

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