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Comparison of Hand Activation using Mirror Therapy on Power Grip

Kim Hwan-Hee[1] and Shim Je-Myung[2*]

[1]Department of Occupational Therapy, Semyung University, 65 Semyungro Jecheon-si Chungcheongbuk-do, KS007, Republic of Korea; heeya6672@hanmail.net
[2]Department of Physical Therapy, College of Health and Science, Kangwon NationalUniversity, 346 Hwangjo-ri Dogye-eup Samcheok-si Kangwon-Do, KS007, Republic of Korea; sjm7897@hanmail.net

Abstract

Objectives: This study is aimed to look into what effect mirror therapy has on the muscle activity of a hand when it is applied to healthy individuals. **Methods/Statistical Analysis**: The participants of the experiment were 22 healthy adults without musculoskeletal disease at upper extremity. For the mirror therapy, a mirror is placed on the center of a table in front of a subject. To check the changing muscle activation between pre-test and post-test the mirror therapy, this study was usedsEMG about MP 36 USA Biopac System. **Findings**: As a first result about comparison of resting and left movement, the muscle activity was shown to have increased in a thenar muscle, a hypothenar muscle, a flexor bundle muscle, an extensor bundle muscle with a significant statistical difference. As a second result about comparison of right movement and both movement, the muscle activity did not show a significant statistical difference in the thenar muscle, hypothenar muscle, flexor bundle muscle, extensor bundle muscle. **Improvements/Applications**: Mirror therapy will benefit the muscle activities of patients whose limbs are paralyzed through the brain activation even though there isn't any movement in the limbs in the future.

Keywords: Adult, Electromyography, Hand Muscle Activation, Mirror Therapy, Power Grip

1. Introduction

Mirror therapy is therapeutic mediation used for visual feedback of the movement of a paralyzed limb through the mirror reflection on the movement of a normal limb[1]. When one arm moves, the movement in the other arm reflected on a mirror induces stimuli in both contra lateral primary motor cortex and ipsilateral primary motor cortex and hence, stimulus control of the primary motor cortex could become a neurological mechanism for brain plasticity[2]. This becomes the therapeutic mediation using visual feedbacks for brain plasticity[3], and while training the visual feedback. Patients become interested in the treatment, which results in maximizing motivation[4]. Moreover, it enhances the brain function as the patients see the visual feedback of the movement on both sides through the reflection on the mirror.

According[5], it would has a positive effect in managing the phantom pain of amputees, and[6] introduced the effectiveness of the mirror therapy on chronic stroke patients in the ROM, movement, speed and accuracy of the upper limbs. Moreover[7], also reported its effect on improving the hand's grip and movement of a chronic stroke patient's paralyzed limb. In addition, it has been applied to complex regional pan syndrome (CRPS), peripheral nerve injuries, motor coordination failures and fractures[8,9].

An Electromyogram (EMG) measures naturally occurring biological signals including several linear characteristics of user motion[10]. The Electromyogram is advice to check the electrical potentials generated by muscle contraction and records these from the outward skin epidermis of the skin using diversity electrod[11]. The EMG sign can display muscle activities of all movement unit potentials using varying insertion depths and lengths of

*Author for correspondence

electrodes[12]. Form of the output, muscle conditions, sex, depending on the age, different values of the respective results, even measured in the same environmental conditions, it is possible to measure the value is different[10]. Therefore, this experiment is to investigate the differences in muscle contraction when performing several movements in the same environment, such as through the EMG.

There have been many academic papers that investigated into recoveries of upper limb function and from various illnesses with the application of mirror therapy. However, the research into what differences and changes occur in the muscle activity of a hand during the mirror therapy. Therefore, this study is aimed to look into what effect mirror therapy has on the muscle activity of a hand when it is applied to healthy individuals.

2. Methods

2.1 Subjects

The participants in the experiment were healthy adults in their twenties without upper extremity musculoskeletal disease, and included 10 males (45.46%) and 12 females (54.54%). The subjects were given an explanation about the experimental procedure and provided written consent indicating voluntary participation in the study. The average age was 22.27±0.4 years, with height 173.25±3.78 cm, and weight 67.25±8.6 kg. All subjects were right-hand dominant. The study obtained prior approval from Kangwon National University. This study followed the principles of the Helsinki Declaration. (Table 1)

2.2 Instrument and Intervention

The experiment was conducted in a quiet therapy room. This study used a mirror box, 35×35cm mirror vertically erected on a desk. The mirror was perpendicularly placed on midsagittal plane from the subjects sitting on the chair as the standard. For alignment of the trunk, it was located 15cm distant from the median line toward the paretic side or the non-dominant side. In order to block the vision of the non-paretic side or the non-dominant side, a triangular prism was selected as the mirror. In order to adjust angles according to patients' sitting height, velcro was used so that attachment and detachment were made possible (Figure 1).

For the mirror therapy, a mirror is placed on the center of a table in front of a subject. The subject was told to remove accessories such as rings and then, to place the subject's dominant hand inside a mirror box and the non-dominant hand facing the mirror. At this time, the subject was told to adjust the image of the non-dominant hand reflected on the mirror to the position of the dominant hand inside the box. First, the subject was seated comfortably and the muscle activity of his dominant hand was measured. Then, the subject was asked to clench a fist with his non-dominant hand and the muscle activity of the dominant hand was again measured. This was repeated after a 20-minute break. An average value was drawn after measuring it for three times.

After an hour-long break, the subjects were told to clench their fists with their dominant hands and the muscle activities on the hands were measured. Then, they were told to make fists with both the dominant and the non-dominant hands and the muscle activities of the hands were measured. This was repeated after a 20-minute break and an average value was drawn after measuring it for three times (Figure 2).

Throughout the experiment, the movement of the dominant hand was blocked from view because of the mirror. However, the dominant hand was made to look as if it was moving by the movement of the non-dominant hand through the mirror.

Table 1. The general characteristics of the subjects

	Participants(n = 22)
Gender(Male/Female) (number)	10/12
Dominant hand(Left/Right) (number)	0/22
Age(years)	22.27±0.40
Height (cm)	173.25±3.78
weight (kg)	67.25±8.60

Figure 1. Mirror box.

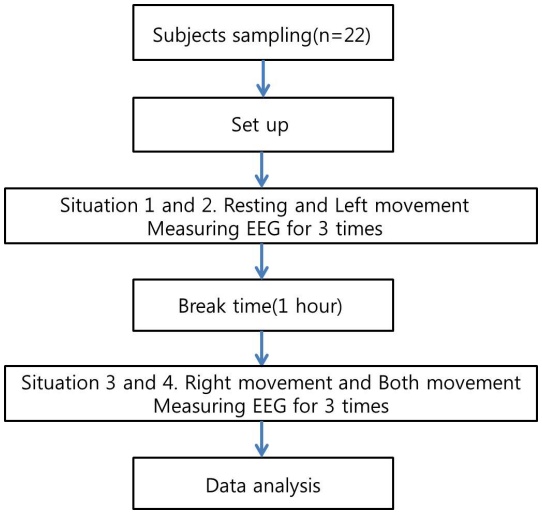

Figure 2. Frame of study.

Changes in muscle activation pre and post therapy using mirror therapy were measured with sEMG about MP 36USA Biopac Systems. The sEMG was used and the analog biological signs were digitized. The digitized signals were filtered and processed on a computer using Acknowledging software 3.7.3. Pre-test measuring the signals, any foreign matter on the electrode attachment points were cleaned using alcohol cotton swabs and three-pole surface electrodes (positive-ground-negative) were attached. The sEMG has generally been used for superficial muscles[13]. The electrodes were attached to the forearm extensor bundle to observe wrist extension, and to the forearm flexor bundle to observe wrist flexion. Electrodes were also attached to the thenar and hypothenar muscles, which are involved in finger movements.

2.3 Data Analysis

The results in this study were analyzed using SPSS/PC 12.0 for Windows and the statistically significance level for all results was set as 0.05. We used frequencies (percentage) and means (standard deviation) for commonly characteristics of the study subjects. The muscle activation values received from a power grip were analyzed using paired sample t-tests.

3. Results

The muscle activities of the dominant hands were shown using the mirror therapy while the subjects were resting (Tables 2). First, the subject's dominant hand was placed inside the mirror box while the non-dominant hand was facing the mirror, and his eyes were made to look at the mirror on the right where the mirror image of the left hand was reflected.

Before the experiment, the muscle activity of the subject's dominant hand was measured. Then, the subject was told to make a fist with the non-dominant hand and the muscle activity of the dominant hand was measured. As a result, the muscle activity was shown to have increased in a thenar muscle, a hypothenar muscle, a flexor bundle muscle, an extensor bundle muscle with a significant statistical difference ($p<.05$).

While the subjects were clenching their fists with their dominant hands, their muscle activities were measured using the mirror therapy (Table 3). Before the experiment,

Table 2. Comparison of muscle activation on hand muscle during using mirror therapy

Muscle	Resting†	Left Movement††	t	p
	Mean±SD	Mean±SD		
Hyper thenar M.	0.0099±0.0074	0.0175±0.0020	−20214	0.038
Hypo thenar M.	0.0046±0.0020	0.0075±0.0022	−8.266	0.000
Flexor bundle	0.0069±0.0064	0.0096±0.0082	−2.375	0.027
Extensor bundle	0.0082±0.0029	0.0105±0.0049	−4.027	0.001

†Resting =The subjects were resting and not movement
††Left Movement = Non-dominant hand was facing the mirror, and his eyes look at the mirror on the right where left hand was reflected and left hand movement

Table 3. Comparison of muscle activation on hand muscle during using mirror therapy

Muscle	Right Movementʃ	Both Movementʃʃ	t	p
	Mean±SD	Mean±SD		
Hyper thenar M.	0.2371±0.1759	0.2574±0.2365	−0.950	0.353
Hypo thenar M.	0.2432±0.2333	0.1927±0.1367	0.927	0.364
Flexor bundle	0.0891±0.1029	0.0958±0.1067	−1.592	0.126
Extensor bundle	0.1328±0.0663	0.1378±0.0598	−0.881	0.388

ʃRight Movement = Non-dominant hand was facing the mirror, and his eyes look at the mirror on the right where left hand was reflected and right hand movement
ʃʃBoth Movement = Non-dominant hand was facing the mirror, and his eyes look at the mirror on the right where left hand was reflected and both hand movement

the muscle activity of the dominant hand while clenching was measured. After then, the muscle activity of the dominant hand was measured while both the dominant and the non-dominant hands were clenched. The result did not show a significant statistical difference in the thenar muscle, hypothenar muscle, flexor bundle muscle, extensor bundle muscle ($p>.05$).

4. Discussion

The mirror therapy is a neurological mechanism for brain plasticity perceiving the movement of a limb on the mirror in the brain through a visual feedback and inducing a normal motor movement while activating the perceived information in the pre motor cortex[6,14,15]. Believed that were observation on the image of a movement could activate the cerebral cortex[16]. This effect has been proven as various brain researches have been done imitating the mirror neuron system[17]. In addition, there is an academic paper claiming the mirror therapy has a remedial value in pain syndromes and sensory re-education after a hand injury[8]. Nonetheless, there seems to be a lack of researches investigating what changes occur in the muscles of a hand while the other hand on the other side of the mirror is moving.

This study has targeted healthy individuals. When the research subjects were told to move their non-dominant hands, which were reflected on the mirror, to the movement of the dominant hand, the muscle activities of the dominant hands, which seemed to move on the mirror reflection, were shown to be increasing although they were blocked from the view seemed to be moving. So during the mirror therapy, the cerebral cortex becomes active and its result is shown in the hand muscles. This result seems to coincide with the result of the various researches mentioned above. When comparing the results of the states when the dominant hands were clenched and when the non-dominant hands were clenched, there seems be no big difference between the results. This is because the movement of the dominant hand activates the brain much more. However, when there was no movement, the mirror reflection of the movement was enough to activate the brain and thus, this effect influenced the hand muscles.

5. Conclusion

This study will be able to be utilized as a neurophysiological basic theory when mirror observation is clinically applied. On the basis of these research findings, it suggests the mirror therapy will benefit the muscle activities of patients whose limbs are paralyzed through the brain activation even though there isn't any movement in the limbs in the future. Future research will be focused on the development of cognitive brain activity in the bio technology.

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