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Original Article

Effect of mirror use on lower extremity muscle strength of patients with chronic stroke

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Abstract. [Purpose] This study examines the effect on muscle strength of lower extremity muscle strength exercise while using a mirror on the non-paretic side in patients with chronic stroke. [Subjects and Methods] Subjects were randomly assigned to a non-mirror lower extremity exercise group (n=10), a mirror lower extremity exercise group (n=10), or a mirror lower extremity muscle strength exercise group (n=10). Subjects were asked to do the exercise assigned to their group (5 sets 30 times a day, 5 times weekly for 4 weeks) with general physical therapy in the hospital. Muscle strength in the knee extensor and flexor of paretic and non-paretic side were measured using electrical muscle testing device before and after the intervention. [Results] Muscle strength significantly increased within each group after intervention. No significant differences were found among the three groups. [Conclusion] This study showed that the lower extremity muscle strength exercise of the non-paretic side using a mirror has a positive effect on muscle strength in patient with chronic stroke.

Key words: Chronic stroke, Mirror therapy, Muscle strengthen

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INTRODUCTION

Stroke is a major problem causing disability in adults[1)]. Most survivors experience decreased motor function and do not fully recover[2)]. After a stroke, patients have physical therapy such as neuromuscular re-education and functional tasks including weight-bearing training in a standing position[3)].

Since it is related to independent functional activity, treatments for patients focus on muscle strengthening of extremities on the paretic side[4)]. Muscle strengthening exercise of the paretic side is important to increase motor function and quality of daily activities[5)]. However, patients who have severe paralysis often dislike a treatment approach focusing on paretic side recovery[6)]. Instead, a treatment method using the non-paretic side has potential. Carroll et al.[7)] showed that elbow flexor muscle exercise increased activity of the elbow flexor muscle, which performs the same function on the opposite side.

Visual feedback through motion in the mirror enables bilateral exercise training and helps improve brain function in subacute stroke[8)]. Mirror therapy using activation of the mirror neuron system is a cognitive training method used to increase motor function and motor learning[9, 10)]. Mirror therapy is task-oriented therapy based on imagery therapy in which patients see their non-paretic side with imaging as their paretic side[11)].

Therefore, the purpose of this study is to assess the effect of muscle strengthening exercise using a mirror for muscle strength treatment in chronic stroke patients.

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SUBJECTS AND METHODS

Thirty subjects who voluntarily participated in this study and signed written consent forms were assigned to control group, experimental group 1, and experimental group 2 in random order. The ethical committee of Daegu University approved this study (IRB: 1040621–201702-HR011-02). The control group performed lower extremity exercise without a mirror, experimental group 1 performed lower extremity exercise using a mirror, and experimental group 2 performed lower extremity exercise using a mirror with a sandbag on the ankle.

General subject characteristics are as follows: gender (male: 13, female: 17), paretic side (control group: right 6, left 4, experimental group 1: right 2, left 8, experimental group 2: right 5, left 5), age (years) (control group: 62.1 ± 9.52, experimental group 1: 69.6 ± 12.24, experimental group 2: 72.3 ± 11.35), height (cm) (control group: 167.76 ± 7.15, experimental group 1: 160.67 ± 7.01, experimental group 2: 159.43 ± 11.59), weight (kg) (control group: 65.67 ± 16.24, experimental group 1: 61.12 ± 11.72, experimental group 2: 56.48 ± 8.62), Brunnstrom stage (grade) (control group: 3.1 ± 0.73, experimental group 1: 3.3 ± 0.48, experimental group 2: 3.0 ± 0.66), and MMSE-K (score) (control group: 25.1 ± 1.20, experimental group 1: 25.6 ± 2.46, experimental group 2: 2 26.4 ± 1.65).

Muscle strength of knee extensor and flexor on the paretic and non-paretic side were measured before and after intervention. This study used a modified mirror therapy program of Sütbeyaz et al.[12] and added a sandbag to the intervention. The low extremity exercise is the following: 1) subjects sit back in the chair, 2) subjects flex hip and knee 90 deg. and maintain ankle dorsiflexion, 3) while keeping that position, subjects fully extend knee, then flex 90 deg., 4) subjects repeat this procedure 30 times (30 times is 1 set), 5) after one set, subjects take a rest for a minute and start again, 6) subjects do five sets daily, five times weekly for four weeks.

Muscle strength in the knee extensor and flexor of paretic and non-paretic side were measured using PowerTrack II MMT (COMMANDER, JTech Medical, USA). This study compared and analyzed the mean value after three measurements.

The analysis used SPSS (IBM Corp. Released 2013. IBM SPSS Statistics for Windows, Version 22.0. IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to test the normal distribution. To compare differences within a group pre- and post-test, the paired t-test was used. To verify differences among groups, one-way ANOVA was used. LSD (least significant difference) was used for post-hoc analysis. Null hypotheses of no difference were rejected if p-values were less than 0.05.

RESULTS

Muscle strength of knee extensor and flexor significantly increased in all subjects after intervention ($p<0.05$) (Table 1). No significant differences were found among groups ($p>0.05$).

DISCUSSION

This study examines the effect on muscle strength of lower extremity muscle strength exercise while using a mirror on the non-paretic side in patients with chronic stroke. After intervention, muscle strength of all subjects significantly increased, but there were no significant differences among groups.

Fujiwara et al.[13] reported that using cross-effect contracting muscles of non-paretic side could activate muscles on the paretic side in patients with stroke. Therefore, in this study, muscle strength increased not only on the non-paretic side but the paretic side.

Sütbeyaz et al.[12] found significant increases of Brunnstrom stage and FIM score after intervention using ankle dorsiflexion with mirror therapy, and suggested that general physical therapy with mirror therapy could increase motor recovery in

Table 1. Change in characteristics in the three groups (values are presented as means and standard deviations)

		CG (n=10)	EG1 (n=10)	EG2 (n=10)	F
Quadriceps	Pre.	37.3 (7.5)	36.3 (8.6)	35.1 (9.7)	0.2
In paretic side	Post.	41.6 (8.8)*	44.8 (10.0)*	44.2 (9.5)*	0.3
Hamstring	Pre.	28.3 (5.2)	26.5 (4.6)	26.7 (3.7)	0.5
In paretic side	Post.	34.2 (8.2)*	33.4 (5.0)*	33.4 (5.2)*	0.1
Quadriceps	Pre.	44.0 (8.5)	43.4 (11.1)	43.2 (8.8)	0.0
In non paretic side	Post.	55.6 (9.9)*	56.2 (11.7)*	58.4 (8.2)*	0.2
Hamstring	Pre.	37.7 (8.3)	35.2 (4.4)	36.7 (8.2)	0.3
In non paretic side	Post.	50.2 (11.6)*	50.9 (9.5)*	52.7 (9.7)*	0.2

CG: control group; EG1: Experiment group 1; EG2: Experiment group 2.
*$p<0.05$.

patients with subacute stroke. A meta-analysis by Lee et al.[14] proposed that mirror therapy could be more effective in stroke patients in the early stage. Judging by the results of this study, which did not find a significant difference among groups, disease period is important in mirror therapy. However, since there was greater increase in the experimental groups 1 and 2 compared with the control group, the mirror therapy had an effect. Since this study used a lower intensity strength exercise because of subjects' age and long disease duration, there were no large effects in the comparison between experimental group 1 and 2.

Therefore, more research using mirror therapy with high-intensive muscle strength in acute and subacute patient younger age than 60 years is needed.

In conclusion, muscle strength exercise using a mirror on the non-paretic side increased muscle strength, and this method could be used for increasing muscle strengthening in patients with chronic stroke.

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