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Original Article

The effect of mirror therapy on upper-extremity function and activities of daily living in stroke patients

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Abstract. [Purpose] The purpose of this study was to examine the effects of mirror therapy on upper-extremity function and activities of daily living in chronic stroke patients. [Subjects and Methods] Fifteen subjects were each assigned to a mirror therapy group and a sham therapy group. The Fugl-Meyer Motor Function Assessment and the Box and Block Test were performed to compare paretic upper-extremity function and hand coordination abilities. The functional independence measurement was conducted to compare abilities to perform activities of daily living. [Results] Paretic upper-extremity function and hand coordination abilities were significantly different between the mirror therapy and sham therapy groups. Intervention in the mirror therapy group was more effective than in the sham therapy group for improving the ability to perform activities of daily living. Self-care showed statistically significant differences between the two groups. [Conclusion] Mirror therapy is effective in improving paretic upper-extremity function and activities of daily living in chronic stroke patients.
Key words: Mirror therapy, Stroke, Upper extremity function

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INTRODUCTION

At least 85% of stroke patients experience hemiplegia and upper-extremity function of at least 69% of patients is damaged[1, 2)]. Hemiplegic damage to upper-extremity function has critical effects on the ability to perform independent activities of daily living[3)]. Interventions to improve control of the upper extremities and function in stroke patients have been reported to be associated with neural circuit reconstruction[4, 5)] and subsequent changes in neural networks[6)].

Mirror therapy is an intervention aimed at improving the functional movements of the paretic limb[7)]. It uses visual information to encourage patients to concentrate on the movements of their nonparetic limbs[8–10)]. Visual illusions make the patients feel as if their two hands are moving simultaneously and symmetrically. The visual illusions are activated in the cerebral hemisphere, and this activation functions as the basis of a neurological mechanism for inducing brain plasticity[11)]. Studies on the effects of observation or movement association methods have shed light on how perception or recognition is transformed into actual movements through a series of processes[12, 13)].

Mirror therapy was first introduced in the treatment of limb-amputated patients with phantom limb pain, and resultant reductions in pain were reported[14)]. Mirror therapy conducted on two chronic stroke patients for four weeks led to an increase in upper-extremity function and improvement in movement accuracy and velocity[9, 15, 16)]. Mirror therapy applied to subacute stroke patients for four weeks improved their upper-extremity motor recovery and independent activity scores[17)], as well as their lower-extremity motor recovery and motor function items in the Functional Independence Measure (FIM) scale[10)].

In previous studies, the study subjects were patients in stage I through III according to the Brunnstrom recovery scale[16)]. Thus, the effects of mirror therapy on each of the various stages of recovery have not yet been analyzed. Furthermore, studies on the effects of mirror therapy on programs for upper-extremity function and activities of daily living are scarce[9, 17)]. This study applied mirror therapy to patients with chronic stroke of at least a 6 month duration who were in stage IV according to the Brunnstrom recovery scale. Furthermore, this study examined the effects of the therapy on upper-extremity function and activities of daily living in these patients.

SUBJECTS AND METHODS

This study was conducted with 30 adult hemiplegic patients. Before the interventions were conducted, the homogeneity of the upper-extremity function of the paretic side and the abilities of the patients in the two groups to perform

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Table 1. General characteristics of the subjects

General characteristics	Division	Mirror group (n = 15)		Control group (n = 15)	
		Persons (%)		Persons (%)	
Sex	Males	9 (60.0)		8 (53.3)	
	Females	6 (40.0)		7 (46.7)	
Age (years)			56.2 ± 13.4[a]		56.4 ± 15.1
Lesion type	Hemorrhagic	7 (46.7)		7 (46.7)	
	Ischemic	8 (53.3)		8 (53.3)	
Paretic side	Right	5 (33.3)		11 (73.3)	
	Left	10 (66.7)		4 (26.7)	
Period after the onset of the condition (months)			20.1 ± 6.3		21.7 ± 12.2

[a]Mean ± SD

Table 2. Comparison of the FMA scores and ability to perform BBT in the mirror and control groups

	Mirror group	Control group	
FMA score	9.60 ± 2.66 [a]	4.93 ± 2.81	*
BBT (number of pieces)	7.86 ± 1.76	2.40 ± 5.87	*

FMA: Fugl-Meyer Motor Function Assessment; BBT: Box and Block Test
[a]Mean ± SD. *p < 0.05

Table 3. Comparison of the differences in the FIM scores of the mirror group before and after the intervention with those of the control group

	Mirror group	Control group	
FIM score	8.80 ± 4.12 [a]	4.06 ± 4.92	*

FIM: Functional Independence Measure
[a]Mean ± SD. *p < 0.05

activities of daily living were assessed. The subject selection criteria were as follows: 1) a diagnosis of hemiplegia due to stroke; 2) scores of ≥ 24 points on the Mini-Mental State Exam-Korean (MMSE-K), which indicated the patients had no difficulty with cognitive functions; 3) paretic upper-extremity movements corresponding to Brunnstrom's stage IV classification; 4) no difficulties with perceptual abilities, including hemineglect based on the Motor-free Visual Perception Test (MVPT); 5) stroke of at least a 6 month duration; and 6) voluntary consent to participate in the study. Fifteen of the patients were assigned to the mirror therapy intervention, while the other 15 were used as the control group. This study was approved by the Institutional Review Board of Inje University. The general subject characteristics of each group are shown in Table 1.

For assigning the patients to the mirror and control groups, the names were written on cards, and the cards were randomly selected for each group. Information regarding gender, age, dates of onset, and lesion sites were obtained through the medical records and the MMSE-K. The mirror group participated in the mirror therapy program five times a week for 30 minutes for four weeks, in addition to conventional occupational therapy. The control group was treated with a sham therapy program five times a week for 30 minutes for four weeks, in addition to the conventional occupational therapy. After the interventions, the paretic upper-extremity function, hand coordination abilities, and abilities to perform activities of daily living were re-evaluated with the FMA, BBT, and FIM. To maintain consistency, these parameters were evaluated by the same occupational therapist before and after the treatment in both groups.

The mirror therapy program of Yavuzer et al.[17] was applied to the study subjects. The paretic hand of the patient was placed on the back of the mirror, and the nonparetic hand was placed in front of the mirror. When the program began, the patient was instructed to gaze at the nonparetic upper extremity reflected in the mirror. The mirror showed the reflected movements of the nonparetic side only. The pronation and supination of the forearm and the flexion and extension movements of the wrist and fingers on the nonparetic side were performed sequentially. Five sets of each motion consisting of 30 motions/set were conducted, and a resting time of one minute was given after each set. Each motion was explained by the therapist, and the therapist assisted the patient if assistance was necessary. The sham therapy applied to the control group was conducted in the same way as the therapy applied in the mirror group except that the reflected movements of the nonparetic hand could not be observed because of the use of non-reflecting mirrors.

The collected data were analyzed using SPSS 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to examine the general characteristics of the subjects. Independent sample t-tests were performed to compare paretic upper-extremity function and the abilities of the two groups to perform activities of daily living before and after intervention.

RESULTS

The paretic upper-extremity function and coordination abilities were significantly different between the two groups ($p = 0.000$ and $p = 0.002$, respectively) (Table 2). Comparison of the abilities to perform activities of daily living also revealed statistically significant differences between the two groups ($p = 0.008$) (Table 3).

Table 4. Comparison of the scores of the sub-items of the FIM of the mirror group with those of the control group

	Mirror group	Control group	
Self-care	5.20 ± 2.21 [a]	1.73 ± 2.76	*
Sphincter control	0.06 ± 0.82	0.20 ± 0.56	
Transfer	1.40 ± 1.45	1.26 ± 1.86	
Locomotion	0.86 ± 1.35	0.86 ± 1.30	
Communication	0.20 ± 0.56	0.06 ± 0.25	
Social cognition	0.46 ± 0.83	0.13 ± 0.51	

FIM: Functional Independence Measure
[a]Mean ± SD. *$p < 0.05$

Subitems of the abilities to perform activities of daily living were compared between the two groups. The area of self-care was observed to be significantly different between the two groups ($p = 0.001$) (Table 4). The areas of sphincter control, transfer, locomotion, communication, and social cognition did not significantly differ between the two groups (Table 4).

DISCUSSION

In this study, mirror therapy showed positive effects on upper-extremity function and activities of daily living in chronic stroke patients. In contrast to previous mirror therapy studies, which were conducted with subacute stroke patients[17], this study focused on chronic stroke patients. According to previous work, bilateral motor training is effective in enhancing the activity of the motor cortex and the recovery of motor functions in chronic stroke patients[18]. Consistent with this previous study, the present findings showed the upper-extremity items in FMA improved when mirror therapy was applied.

Differences in upper-extremity function after intervention in the mirror group were compared with those in the control group treated with sham therapy. The mirror group showed significantly greater differences compared to the control group, with improvements in paretic upper-extremity functions ($p < 0.05$). Similar results were reported by Yavuzer et al.,[17] indicating that visual illusions that make patients feel as if their two hands are symmetrically moving simultaneously activate both the left and right cerebral hemispheres and increase the excitability of the paretic limb.

Based on the present result, the mirror group showed a significant improvement in the abilities to perform activities of daily living compared to the control group. The bilateral upper-limb training in mirror therapy using visual feedback improved paretic upper-extremity function, which, in turn, enhanced the performance of activities of daily living. The area of self-care showed statistically significant differences when the subitems of the abilities to perform activities of daily living in the mirror group were compared with those of the control group. This finding is attributed to the recovery of upper-extremity function. Improvement in self-care is one of the most important aspects in performing activities of daily living[17]. That is, if unable to independently perform self-care, the patient cannot live independently and must depend on family members or others for assistance.

This study confirmed that mirror therapy is effective in improving upper-extremity function and self-care in the performance of activities of daily living. A limitation of this study is that the patients met specific selection criteria; hence, the findings cannot be generalized to all stroke patients. In addition, patients with visual-field defects and hemineglect were excluded from this study. Studies with patients with visual-field defects and hemineglect are needed, in addition to long-term follow-up studies to determine whether the interventional effects are sustained. Mirror therapy programs tailored to patients with different levels of functioning and Brunnstrom's stages should be developed. In addition, studies that use brain images are necessary to examine the effects of mirror therapy on the activation of the brain in stroke patients.

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