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系　　所：職能治療學系

考試科目：英文文獻評析　　考試日期：0228，節次：4

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

請閱讀本篇試卷所提供之學術文章內容 (第 2 至 6 頁)，回答以下問題:

一、請根據美國心理學會(American Psychological Association)手冊-論文寫作格式第六版，寫出此學術論文之參考文獻格式。(6%)

二、請以中文回答下列問題(精簡但不失關鍵資訊為原則) (共 40%):

1. 請根據內文說明 Mirror Therapy 的可能機制，以及過去文獻之相關佐證? (10 分)
2. 請說明本篇論文中，實驗組所接受的完整治療流程? (20 分)
3. 請根據內文闡述本篇論文的貢獻為何? (10 分)

三、假若要進一步查詢與此論文相關主題之文章，你認為適用之關鍵字為? (請列出 5 個) (5%)

四、請將此論文之 Study Limitations 段落，翻譯為中文 (17%)

五、請以英文寫出本篇論文的摘要，內容包含: (1) Objective、(2) Design、(3) Setting、(4) Participants、(5) Intervention、(6) Main Outcome Measures、(7) Results、(8) Conclusions，每部分以 1 至 5 句為原則。(32%)

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ORIGINAL ARTICLE

Mirror Therapy Enhances Motor Performance in the Paretic Upper Limb After Stroke: A Pilot Randomized Controlled Trial

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A major challenge in stroke rehabilitation is paresis of the upper extremity resulting in limited functional performance.[1,2] Existing stroke rehabilitation includes impairment-oriented exercise training of the paretic arm,[3,4] functional electrical stimulation,[5] robotic-assisted rehabilitation,[6] bilateral arm training,[7] constraint-induced movement therapy,[8] and biofeedback.[9] The basic premise of these therapy modalities is that repeated physical practice improves motor activity, allowing the brain to reestablish the circuitry that mediates voluntary movement.[10] However, these interventions have limited use in the presence of severe hemiparesis, which is very often accompanied by sensory deficits. A few of these interventions are also costly and labor intensive, limiting their implementation on a wider population.[11]

Recent research articles suggest that the information provided by imagination (motor imagery)[10] and observation of movements (mirror therapy [MT]) might be an additional rehabilitation strategy that could be beneficial for motor rehabilitation after stroke.[12-14] The concept of using a mirror box is adapted from the work of Ramachandran and Rogers-Ramachandran,[12] who used mirror images of limbs to examine phantom kinesthetics and, in some cases, treat phantom limb pain. The principle of using a mirror to give visual feedback is that the input from an intact

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sensory system can be used to access and recruit dormant neural circuits in other brain regions.[13,15] A review article by De Vries and Mulder[14] states that the prefrontal cortex, the premotor cortex, the supplemental motor area, the cingulate cortex, the parietal cortex, and the cerebellum, which are normally involved in movement planning and execution, are also active during the observation and imagination of a movement.[14]

MT requires the patient to sit in front of a mirror placed in the midsagittal plane so that the patient is presented with a mirror image of his or her nonaffected arm as if it were the affected one.[2] Previous studies, although undersized and not sufficiently controlled, suggest that MT may be beneficial for motor function recovery of the paretic hand after stroke.[1,2,11,16-18] MT has been shown to improve range of motion, speed, and accuracy of arm movement[16] and functional improvements.[1,2,11,17] Studies also show that MT was effective in improving only visuospatial neglect but had no effect on sensorimotor function of the arm,[18] activities of daily living, and quality of life.[11,18]

In summary, MT may be an effective method to support recovery from hemiparesis after stroke. The focus of this study was to evaluate whether MT combined with bilateral arm training and graded activities improves motor performance and reduces spasticity in the paretic upper limb after stroke.

Methods

Participants

Participants were recruited from the inpatient stroke rehabilitation center of a tertiary care teaching hospital. Inclusion criteria for the study were patients aged between 18 and 60 years with a first-time ischemic or hemorrhagic stroke confined to the middle cerebral artery tertiary occurring <6 months before the commencement of the study. All patients were in the Brunnstrom I to IV stages of recovery for the arm and hand. An additional criterion was a score of more than 24 on the Mini-Mental State Examination. This score is consistent with an adequate cognitive ability to follow therapy instructions and to report any adverse effects such as pain or fatigue during the intervention period.

After the initial screening, 21 patients were eligible to be included in the study, and among them 1 did not wish to participate. The research proposal was approved by the Institutional Review Board and Ethics Committee (institutional review board no. 7156).

Study design

This study was a single-blinded, randomized controlled design. A computer-generated random number was used to allocate participants arbitrarily to the MT and control groups. An occupational therapist blinded to the allotment procedure administered the pretest and posttest assessments. The primary therapist for each patient who administered the conventional therapy program was not blinded to the group receiving the intervention (MT). All

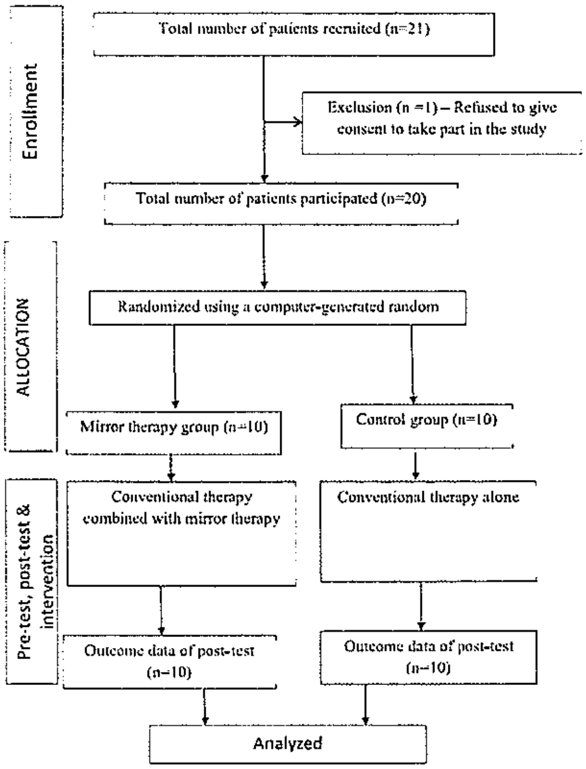

Fig 1　Flow diagram for randomized subject assignment in this study.

therapists who participated in this study had previous training in the MT program protocol (fig 1).

Intervention

Mirror box

A closed wooden box (length 29", width 7.5", and height 11") with a mirror on one side and hollow space to accommodate the paretic hand on the other side was used in this study (fig 2).

During MT, participants were seated in front of the mirror box with the nonparetic upper limb facing the reflective surface and the paretic upper limb placed inside the mirror box. Participants were asked to observe the reflection of the nonparetic upper limb while moving their wrist and all fingers including the thumb at a self-directed speed and were to perceive the mirror reflection of the nonparetic upper limb as if it were the affected one. All sessions were supervised by trained occupational therapists.

Participants in the MT group received 1 hour of MT every day in addition to conventional stroke rehabilitation therapy. This 1 hour of MT was divided into two 30-minute sessions to reduce fatigue. In the first 15 minutes of each session, participants performed nonparetic wrist flexion, extension, radial and ulnar deviation, circumduction, fisting, releasing, abduction, and adduction of all fingers in front of the mirror box attempting the same movements with the paretic hand (bilateral arm training).[1,2,16] In the next 15 minutes of the session, they practiced 3 different activities in front of the mirror box using the nonparetic hand.[11] Altogether, each participant practiced 18 different activities in 30 sessions (2 sessions per day, 5 d/wk, 3-wk duration). Activities were graded during the second and third

List of Abbreviations:

BBT	Box and Block Test
CI	confidence interval
FMA	Fugl-Meyer Assessment
MAS	modified Ashworth scale
MT	mirror therapy

Fig 2　Mirror therapy.

Table 1　List of graded activities used for the MT group

Week	Session 1 Activities	Session 2 Activities
1	Squeezing a sponge ball	Exercising a grip strengthener
	Stacking rings	Building blocks
	Coloring a box with crayons	Stamping with ink pads
2	Flipping a card	Placing clothes clips around the rim of a cup
	Placing beads over an upright pole	Counting the marbles
	Transferring rice to another cup	Connecting dots with pen
3	Placing pegs on a board	Making balls out of theraputty
	Shape sorting	Placing pins on a board
	Copying shapes on a paper using stencils	Pasting thermacol balls on drawn shapes

weeks of training. The activities consisted of (1) arm-hand dexterity activities such as squeezing sponges, placing beads or pegs in a hole, and flipping a card and (2) finger dexterity activities such as placing pins in a hole, counting marbles, and fine shape sorting (table 1).

Participants of both the groups underwent a patient-specific multidisciplinary rehabilitation program involving conventional occupational therapy, physical therapy, and speech therapy (if required) for 5 days, 6 h/d, over 3 weeks.

Outcome measures

Upper Extremity Fugl Meyer Assessment for motor recovery

The Fugl-Meyer Assessment (FMA) is a quantitative assessment tool that measures motor recovery in stroke in the shoulder, elbow, forearm, wrist, and hand.[19,20] Total scores for the upper extremity range from 0 and 66. It uses a 3-point ordinal scale (0, cannot perform; 1, perform partially; 2, perform completely). This scale has a high reliability (overall intraclass correlation coefficient=.96), and the intraclass correlation coefficient for the upper extremity subsection was .97.[19]

Brunnstrom stages of motor recovery

The Brunnstrom stages of motor recovery consist of 6 sequential stages. These stages of motor recovery are based on clinical assessments done on the quality of movement and it reflects the motor control. Higher Brunnstrom stages indicate better motor recovery.[1] This has an interrater reliability correlation coefficient ranging from .74 to .98.[21]

The Brunnstrom stages of motor recovery for the hand includes the following: (1) flaccidity; (2) little or no active finger flexion; (3) mass grasp, use of hook grasp but no release, no voluntary finger extension, and possibly reflex extension of digits; (4) lateral prehension with release by thumb movement, semi-voluntary finger extension with a small range; (5) palmar prehension, cylindric and spheric grasp, awkwardly performed and with limited functional use, voluntary mass extension of digits; and (6) all prehensile skills under control, full-range voluntary extension of digits, individual finger movements present but less accurate than on the opposite side.

Upper extremity functioning using the Box and Block Test

Gross manual hand dexterity is assessed by using the Box and Block Test (BBT). In this test, the subject seated in front of a divided box positioned waist high has to grasp a block from the first compartment and lift and move the blocks one by one to the other side within a minute. The number of blocks transferred from one compartment of a box to another within 1 minute is counted. A higher value for the number of blocks indicates better manual hand dexterity.[22] The test-retest reliability for the BBT was reported as excellent (intraclass correlation coefficient=.89−.97).[23]

Modified Ashworth scale to assess the spasticity

Spasticity is clinically graded with the modified Ashworth scale (MAS), a 5-point rating scale with scores ranging from 0 to 4. Higher scores correspond to spasticity or increased tone, whereas lower scores indicate normal muscle tone. It has good inter-rater reliability (weighted $\kappa=.84$) and intrarater reliability (weighted $\kappa=.83$).[24]

Statistical analysis

We analyzed the data using SPSS for Windows (version 16).[a] All 20 participants' demographic and clinical characteristics were analyzed to check for homogeneity between the 2 groups. The independent Mann Whitney *U* test was used for age, and the independent student *t* test was used for continuous variables (education, duration of stroke, Mini-Mental State Examination, FMA, BBT). For the categorical variables, the chi-square test (sex, side of lesion, Brunnstrom recovery stages for arm and hand, and MAS) and the Fisher exact test (side of paretic limb and type of lesion) were used.

To investigate the effect of MT on the study group compared with the control group, pretest and posttest scores of both groups were analyzed and compared using the paired student *t* test. The size of the treatment effect was estimated by using the group's mean difference at 95% confidence intervals (CIs). To test the study hypothesis, 1-way analyses of variance with repeated measures with a between-subject factor at 2 levels (MT and control group) was used. Significance was set at .05.

Results

Participants recruitment was done between June 2011 and March 2013. Pretests and posttests were administered 1 to 2 days before and after the treatment period. No participants missed any session during the study. There were no adverse events such as pain or

Table 2 Participants' characteristics at baseline in the MT and control groups

	MT group		Control group			
Characteristic	n	Mean ± SD* (min–max)	n	Mean ± SD* (min–max)	P	Test Used
No. of patients	10		10			
Age (y)		48.4±15.58 (23–72)		53.9±11.57 (34–72)	.549	Mann-Whitney *U* test
Education (y)		12±2.8 (8–16)		12.5±3 (8–16)	.704	Independent *t* test
Duration between stroke and study inclusion (wk)		3.7±1.1 (2–5)		4.4±1.4 (2–7)	.231	Independent *t* test
Female/male	2/8		2/8		0	Chi-square
Side of lesion (right/left)	6/4		4/6		.800	Chi-square
Paretic limb (right/left)	5/5		6/4		.738	Fisher exact test
Dominance (right/left)	10/0		10/0			
Lesion type (ischemic/hemorrhagic)	8/2		6/4		.667	Fisher exact test
MMSE		28.2±1.99 (25–30)		27±2 (25–30)	.195	Independent *t* test
FMA		9.7±10 (0–27)		4.3±9.9 (0–32)	.245	Independent *t* test
Brunnstrom-hand		1.6±1 (1–3)		1.1±0.3 (1–2)	.689	Chi-square
Brunnstrom-arm		2.5±1.4 (1–4)		1.7±0.8 (1–3)	.437	Chi-square
BBT (no. of blocks transferred per minute by the paretic limb)		1.1±3.5 (0–11)		0	.056	Independent *t* test
MAS		0.8±1.8 (1–2)		0.8±0.9 (1–2)	.465	Chi-square

Abbreviation: MMSE, Mini-Mental State Examination.
* Significance at .05.

swelling reported by the participants during the treatment process. The demographic and baseline clinical characteristics of the study participants in both the groups did not differ significantly (table 2).

Table 3 represents comparisons between the MT group and the control group for motor performance and spasticity. In the MT group, participants showed a significant improvement for the FMA ($P=.005$), Brunnstrom stages of motor recovery for the arm ($P=.001$) and hand ($P=.02$), and the BBT ($P=.02$). The control group showed a significant improvement only for the FMA ($P=.01$) and Brunnstrom stages of motor recovery for the arm ($P=.004$), but not in the hand ($P=.37$) nor the BBT ($P=.31$). Neither group showed a significant difference in MAS scores.

The mean score changes and the 95% CI of the FMA (mean, 21.1; 95% CI, 8.9–33.3 vs mean, 4.5; 95% CI, 0.8–8.2; $P=.008$). Brunnstrom stages of motor recovery for the arm (mean, 2; 95% CI, 1.5–2.4 vs mean, 0.9; 95% CI, 0.3–1.4; $P=.003$) and hand (mean, 1.6; 95% CI, 0.8–2.4 vs mean, 0.4; 95% CI, 0.03–0.8; $P=.003$), and the BBT (mean, 5.5; 95% CI, 1.5–9.6 vs mean, 0.7; 95% CI, −0.9 to 2.3; $P=.022$) showed more improvement in the MT group than in the control group. No significant differences were found in both groups for the MAS (mean, 0.5; 95% CI, −0.1 to 1.1 vs mean, 0.7; 95% CI, −0.06 to 1.5; $P=.647$).

Discussion

Our study demonstrated the effect of MT in enhancing motor performance in the paretic upper limb in the early phase of stroke. Hence, a conventional stroke rehabilitation program that includes MT combined with bilateral arm training and graded activities as an adjunct may have beneficial effects. Spasticity was not influenced by MT.

Both the MT and control groups showed improvement in the motor performance of the paretic upper limb after stroke. The improvement (change from baseline scores) in voluntary control (FMA), motor recovery of the arm and hand (Brunnstrom stages), and hand dexterity (BBT) in the MT group was, however, much higher than in the control group. In previous studies,[2,11] this

Table 3 Effects of a 3-wk MT program on motor performance and spasticity in hemiparetic arm after stroke

Characteristic	Group	Pretest	Posttest	P	Test Used	Mean Difference (95% CI)	P	Test Used
FMA	MT	9.7±10	30.8±23.9	.005*	Paired *t* test	21.1 (8.9 to 33.3)	.008*	1-way repeated-measures ANOVA
	Control	4.3±9.9	8.8±13.9	.01*	Paired *t* test	4.5 (0.8 to 8.2)		
Brunnstrom-arm	MT	2.5±1.4	4.5±1.4	.001*	Paired *t* test	2.0 (1.5 to 2.4)	.003*	1-way repeated-measures ANOVA
	Control	1.7±0.8	2.6±1.1	.004*	Paired *t* test	0.9 (0.3 to 1.4)		
Brunnstrom-hand	MT	1.6±1	3.2±1.4	.02*	Paired *t* test	1.6 (0.8 to 2.4)	.003*	1-way repeated-measures ANOVA
	Control	1.1±0.3	1.5±0.7	.37	Paired *t* test	0.4 (0.03 to 0.8)		
BBT (no. of blocks transferred per minute by the paretic limb)	MT	1.1±3.5	6.6±8.4	.02*	Paired *t* test	5.5 (1.5 to 9.6)	.022*	1-way repeated-measures ANOVA
	Control	0	0.7±2.2	.31	Paired *t* test	0.7 (−0.9 to 2.3)		
MAS	MT	0.8±1.8	1.3±0.7	.05	Paired *t* test	0.5 (−0.1 to 1.1)	.647	1-way repeated-measures ANOVA
	Control	0.8±0.9	1.5±0.7	.06	Paired *t* test	0.7 (−0.06 to 1.5)		

Abbreviation: ANOVA, analysis of variance.
* Significance at .05.

improvement was seen only in the distal muscles, unlike our study, in which the motor control also improved proximally as represented by Brunnstrom stages of the arm. This could be attributed to the incorporation of bilateral arm training and graded activities used during the MT in our study.

The greater improvement in the motor performance of the distal limb in the MT group may be related to the findings of previous studies, which reported that the effect of MT on motor performance appears to be most evident for those patients who have no distal function at the beginning of the therapy.[2,11] This has significant clinical implications because most stroke rehabilitation therapies, such as constrained-induced movement therapy[25] and biofeedback,[26] can lead to functional improvements only when there is partial preservation of distal motor function before starting therapy.[2]

MT, when combined with bilateral arm training, was found to increase the visual or mental imagery feedback, which facilitates upper limb motor function.[1,11] This improvement in upper limb motor function may give rise to functional improvements in the control of the paretic upper limb.[27] In addition to bilateral arm training, participants in the MT group observed repetitive visual images of their nonparetic hand performing activities based on in-hand manipulation and diverse grasp patterns. The images were mirrored so it appeared that the paretic hand was doing these activities. In a previous study, [11] in which mirror therapy was combined with task-oriented rehabilitation, greater improvements in movement performance occurred in the MT group than in the control group, similar to the findings of this study.

Our results support the recommendation of a previous study done on patients with subacute stroke that reported that MT would benefit patients in recovery of upper extremity function if implemented at an early stage of stroke rehabilitation.[1] The mean duration from onset of stroke to recruitment for the study was 4 weeks. In a previous study, the use of MT at 8 weeks poststroke resulted in functional improvements.[2]

Spasticity as measured by the MAS was not changed either after the routine therapy or after MT and did not show any significant difference between the groups. A previous study[1] showed a similar lack of effect of MT on spasticity. Visual feedback such as MT alone might not be enough to either influence or control it.[1]

Study limitations

The results should be considered with caution because of the preliminary nature and size of this study. Although there is no statistical difference in groups' demographic characteristics and baseline clinical measures, the MT group is younger, with more right brain damage, and has higher pretest scores on most of the outcome measures than does the control group. This could have also contributed to the greater effects of MT. Another important consideration is that the control group did not undergo placebo therapy. The interactive nature of the experimental conditions precluded blinding of therapists and participants. The long term effects of MT were not measured and the small sample size may affect the generalizability of the study findings.

Conclusions

MT, when combined with bilateral arm training and graded activities, was effective in improving the motor performance of the paretic upper limb if treatment was started within 2 to 5 weeks of the onset of the stroke. MT is one of the few treatments to affect hand function in patients who have no or limited distal limb function. The equipment is simple and inexpensive to make, making it accessible to most therapy settings.

Supplier

a. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.

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