

Original article:

Effectiveness of Mirror Therapy on Upper Limb Motor Functions Among Hemiplegic Patients

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Abstract:

Background: Stroke is the leading cause of disability in the long term. Approximately 70% to 80% of people with a stroke have impairment of the upper limb (UL). The hemiparetic arm is one of the most devastating consequences after stroke. Improving use of the affected UL is important however, because difficulty in using this UL in daily tasks has been related to lower quality of life.

Design: A prospective randomized control trial type study. **Setting:** Malaysia Government and Private Hospitals and also in private Physiotherapy Centre's. **Population:** A total of 25 subjects post stroke were randomly assigned to either in experimental group (n=13) and control group (n=12). **Methods:** Control group received 45 minutes of treatment session and therapy consisted of conventional therapy only with the affected upper extremity whereas experimental group also received 45 minutes of treatment session and therapy consisted of conventional therapy along with mirror therapy for three days/week. Outcome measures used were Fugl-meyer assessment and Functional independent measure. **Results:** Comparison of the changes in the Fugl-meyer assessment and Functional independent measure from baseline to six weeks between control and experimental group, revealed that significant improvement were in experimental group which was (p<0.05). **Conclusion:** Combination of conventional and mirror therapy is an effective method on restoring upper limb motor function among hemiplegic patients.

Keywords : Hemiplegic; Stroke; Upper Extremity; Mirror Therapy; Neuroplasticity

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Introduction

Stroke is defined as rapidly developing clinical signs of focal or global cerebral function disturbance that lasts more than 24 hours or leads to death, with no other apparent cause than that of vascular origin.¹Hemiplegia shows one side of the body paralysis involving one upper and one lower extremity.²The term hemiplegia is often used generically to refer to the wide variety of motor problems that result from stroke. The location and extent of brain injury, the amount of collateral blood flow and the management of early acute care determine the severity of neurological deficits of an individual patient. Impairments may resolve spontaneously as brain swelling subsides, generally

within 3 weeks. Residual neurological impairments are those that persist longer than 3 weeks and may lead to permanent disability.³

Stroke contributes in both developed and developing countries to major morbidity and mortality.⁴Every year; 15 million people worldwide are suffering from stroke. Of these, 5 million lives are claimed by stroke, while another 5 million are permanently disabled. Fifty - three out of 100,000 people die of stroke, and the rate of stroke is higher for people older than 65. It is expected that the number of stroke victims will be 3 times higher in 2030 than today.⁵ People suffering a stroke, one in five will die within 1 month, and one in three will die within one year.⁶

Stroke is one of Malaysia's top five major causes of

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death following ischemic heart disease, carcinoma and sarcoma, septicemia, and lung infection. The mean age of stroke patients in Malaysia is between 54 - 62 years.⁴

Stroke is one of the major causes of death.⁶ Strokes are classified by etiological categories specific vascular territory (anterior cerebral artery syndrome, middle cerebral artery syndrome, internal carotid artery syndrome and posterior cerebral artery syndrome) and management categories, transient ischemic attack.³ Hemiplegia is more likely to be due to discrete focal lesions than diffuse lesions, so these presentations are especially suited to clinical-anatomic localization. The most common cause of hemiplegia is cerebral lesions. The weakness can be caused by lesions in cortical or subcortical structures. A stroke involving the entire territory of the internal carotid artery would be the most likely cause of cortical hemiplegia.⁷

Inflammation of the vessel wall is one of the most common causes of ischemic stroke, the pathogenic mechanisms of initiation and progression of atherosclerotic lesions.⁸ Impairment of the upper extremity motor is the most disabled stroke consequence that limits independent living. Approximately 85 percent of the stroke population shows an initial arm weakness that persists even after three to six months in 55 percent to 75 percent of patients. However, in only 5 to 20 percent of the patient, complete recovery of the hemiplegic arm occurs.⁹ In particular, the effects of treatment on the upper limb are limited to patients with some voluntary finger extension control after stroke.¹⁰ Damage to the pyramidal tract and cortico-reticulospinal fibers results in the upper motor neuron syndrome, which has positive and negative features. Negative components include the loss of strength and dexterity; positive features include spasticity and abnormal postures, characteristics that are not normally present.¹¹ Through insufficient muscle strength and inadequate muscle tone, for example, hemiplegic after a stroke can affect hand movement.¹² Hemiplegic arm reduces the ability to actively execute functional arm movements such as reaching, grasping and manipulating an object that leads to difficulties in everyday life (ADLs).¹⁰ These disabilities may include reduced motor ability and restriction in the functional use of the upper parasitic extremity, leading to muscle weakening or paralysis, abnormal muscle tone, associated reaction, musculoskeletal system problems, and coordination disorder.⁵ Spasticity is

a state of increased muscle tone with exaggerated reflexes. Although there was no difference in the prevalence of spasticity between the upper and lower limbs, spasticity was more severe in upper limb than in lower limb muscles. The distribution of spasticity in the different joints corresponded to the antigravity posture, which constitutes the typical spasticity pattern of post stroke hemiparesis. However the mechanisms underlying the antigravity posture are still obscure. Hypothetically, an impaired vestibulospinal function mediating contributions to postural control is relevant for the development of the antigravity posture.¹¹ The functional disorder due to the sudden onset of the stroke is a major area of social and psychological adjustment.⁵ In recent years, physical exercise was used in stroke experiments for 3 main purposes, namely, the detection of physical dysfunctions, the improvement of motor activity, and the prevention of severe damage.¹³ Moreover, even after conventional treatment, more than 50 percent of patients report continuous disability of upper extremity function, and learned non-use is frequently observed. For those, programs to restore upper extremity function are an important part of stroke rehabilitation. Recently emerging methods of treatment include constrained-induced movement theory, robot arm training, and virtual reality (VR) training, mental practice, and mirror therapy.¹⁴ New treatment methods for rehabilitation of upper extremities are being evaluated based on the theory of motor learning. Motor rehabilitation after a stroke are usually at closer proximity to the lower end of the spectrum of functional recovery.¹⁵ Bilateral priming with active-passive movements before upper limb physiotherapy would promote rebalancing of corticomotor excitability and would accelerate upper limb recovery at the sub acute stage.¹⁶

Unaffected upper extremity (UE) performs the spatio-temporal pattern of movement as that performed by the affected UE and practice of the bilateral movement allows intact hemisphere activation to facilitate the activation of the damaged hemisphere and subsequently improves the motor function of the affected UE.¹⁷ Functional Electrical Stimulation (FES) is performed using a surface electrode connected to an electrical stimulator to directly stimulate the nerves or muscles of paralyzed limbs and an increase in wrist and finger movements has been reported. However, in patients with severe loss of motor function, the intervention is ineffective.¹⁸ Our understanding of motor learning, neuroplasticity

and functional recovery after brain injury has increased significantly in recent years.¹⁹ Mirror therapy (MT) in stroke patients involves performing unimpaired limb movements while observing the reflection of the mirror overlapping the impaired limb, creating a visual illusion of increased movement capacity in the impaired limb.⁵ This is a therapeutic intervention that uses neuroplastic visual feedback and triggers motivation during training through visual feedback.⁵ Ramachandran et al, in the rehabilitation of phantom limb pain, was the first to describe a clinical use of MT, observing a significant improvement after treatment. Subsequently, the use of MT has been extended to other pain syndromes, such as complex regional pain syndromes and iatrogenic peripheral nerves damages. Altschuler et al. introduced MT in the rehabilitation of hemiparetic stroke survivors, showing improvements in their range of motion, speed, and dexterity of the paretic arm.²⁰

Inclusion criteria:

Subjects with Right or Left sided hemiplegic with age group between 45 to 65 years of both genders in chronic phase (over six months and above).²⁰ Scored more than 24 on the Mini-Mental State Examination. Subjects with no previous exposure to mirror therapy and had normal visual perception.

Exclusion criteria:

Subjects presenting with unable to follow visual commands²¹, age group below than 45 years and more than 65 years²⁰, unilateral neglect, and severe cognitive^{20,5} or language deficits that could prevent them from following instructions were excluded²².

Methods

The study was conducted by simple random sampling technique which was conducted on 25 hemiplegic patients. Participants were recruited from the outpatients department of Physiotherapy, Malaysia government hospitals, Private hospitals and from private Physiotherapy centers. Screening was done and 25 participants were randomly selected. In the study 7 female and 18 male participated were 11 right-side involved and 14 left-side involved. Written informed consents were obtained from participants. Outcome measures of the participants were recorded prior to intervention and also after completing 6 weeks of intervention using Fugl-meyer assessment and Functional independent measure.

Procedure

Control group

Patients in control group were in seated position with their affected hand on top of table. Patients in the control group received 45 minutes of consecutive session and therapy consisted of performing tasks only with the affected upper extremity for 3 days/week. The therapy in the conventional group involved mobilization, reaching, grasping & dexterity.

Experimental group

Patients were instructed about the background and aims of mirror therapy treatment. Furthermore, patients should be able to engage in this kind of treatment and that they were asked to imagine that the mirror image is their affected limb. Jewelry and other visual marks should be removed to make it easier for the patient to perceive the reflection as their affected limb when looking into the mirror. Patients should have realistic expectations with respect to the improvements that are achievable by using mirror therapy.

Mirror is placed in front of the midline of the patient so that the affected limb is fully covered by the mirror and the reflection of the unaffected limb is fully visible.

The affected limb positioned in a safe and comfortable position behind the mirror. The non-affected limb should be positioned in a similar position as the affected limb, as this facilitates the intensity of the mirror illusion.

Patients in the experimental group received 45 minutes of consecutive session. First 30 minutes therapy consists of conventional therapy as given conventional tasks only with the affected upper extremity. 15 minutes were continued with mirror therapy which tasks only with the unaffected upper extremity. The therapy in the mirror group involved reaching, grasping & dexterity.

Patients were asked to make five different movements: (a) pronation and supination of the forearm, (b) flexion and extension of the wrist, (c) flexion and extension of the finger, (d) numbering and opposition. Patients were asked to execute ADL movements for task-oriented purposes (grabbing and releasing balls, using a spray bottle, kneading putty, pinching coins, using a spoon and wiping a towel table). In order to use the unaffected side, these movements were performed and each movement was repeated 10 times and 3 days / week.

Ethical approval

The design of the study was approved by Ethics Committee of AIMST University, Malaysia.

Statistical Analysis

Statistical analysis was performed on the 25 subjects by using SPSS version 20.00. Statistical packages analyzed the data.

| Control | Pre-test value | | Post – test value | | T value | P- value |
|--------------|----------------|--------|-------------------|--------|---------|----------|
| | Mean | S.D | Mean | S.D | | |
| FMA | 39.916 | 12.652 | 42.750 | 11.963 | -4.080 | 0.002 |
| FIM | 59.833 | 16.436 | 61.583 | 16.205 | -3.339 | 0.007 |
| Experimental | Pre-test value | | Post – test value | | T value | P- value |
| | Mean | S.D | Mean | S.D | | |
| FMA | 44.000 | 11.853 | 51.000 | 12.013 | -6.666 | 0.000* |
| FIM | 64.384 | 14.648 | 71.462 | 12.829 | -7.243 | 0.000* |

Patients who completed the entire therapy course were included in the analysis.

After completed 6 weeks of intervention, both groups showed a significant improvement except for FIM in control group. In control group FMA the p value was ($p < 0.05$) and for the FIM the p value was ($p > 0.05$). Comparison of changes in the FMA and FIM between groups from baseline to 6 weeks showed significant improvements in the experimental group ($p < 0.05$). This study confirmed the efficacy of mirror therapy in improving motor function of upper - extremity.

Discussion

The finding from the study showed, a significant relationship between control rehabilitation along with mirror therapy in improving upper limb motor functions was observed in experimental group. In addition, the significant value for conventional rehabilitation along with mirror therapy the p value is ($P < 0.05$) for FMA and the p value for is FIM ($P < 0.05$). In addition to a conventional rehabilitation program, the most well - accepted was mirror therapy, which was more beneficial for upper limb motor functions among hemiplegic patients.

Youngju et al. indicated that during the treatment period, MT with tasks that rely on common ADLs may affect the motivation of a patient. Subjects would eventually concentrate and participate more actively in the program, resulting in improved recovery and self - care of the UE motor.²³

Paired sample statistics is the analysis of pre and post intervention within group whereas paired sample test is the analysis of pre and post intervention between groups. Based on the results given in control group, FMA was significant compare to FIM which was

($p < 0.01$) for FMA and for FIM was ($p > 0.05$). In experimental group both tools showed significant value after 6 weeks of intervention which was ($p < 0.01$). In particular, experimental group showed a strong positive correlation.

In line with this earlier study, the present finding showed that the function of the upper extremity motor improved with the application of mirror therapy. However Khandareet al. reported that it is still not known whether this visual image produced by mirror illusion is more significant than the action itself to enhance the recovery of UL function and concluded that mirror therapy can be added along with task specific exercises in the treatment of sub-acute stroke patients to improve upper limb functions.²¹

However Michielsen et al. stated that they did not observed mirror related activity in motor or mirror neuron system areas, but showed an increased activity in precuneus and posterior cingulate cortex, areas associated with awareness of the self and spatial attention during bimanual movement. The authors concluded that, by increasing awareness of the affected limb, the mirror illusion might reduce learnt non-use.²⁴

However based on the present study indicate that, application of MT among hemiplegic patients has effect on recovery of upper limb motor function. Similar results were by Medeiros. et al reported that therapies involving the performance of tasks on the mirror, aimed at functional activities, are more effective when it comes to motor improvements, for they apply and reinforce the concepts of motor

learning. Functional activities are associated with better motor learning, once the tasks are usually more dynamic, with variations and training aimed at specific activities, making assimilation easier. When subjects are trained with simple motor patterns, they can have a good performance, but also more difficulty to associate them to ADLs.²⁵

According to Invernizzi et al. MT combined with a CT is a safe, easy and effective treatment to improve motor recovery of the upper limb. They authors found that motor function of upper extremity improved by MT in addition to a conventional rehabilitation program as compared with a control treatment after 6 weeks of treatment.²⁰

Knutson et al. says that basic and clinical studies have shown that the goal - oriented active repetitive movement training facilitates motor neuroplasticity. Plasticity is related to the presence of temporally correlated neural activity at higher levels of neuronal organizations. Thus, rehabilitation therapies that generate synchronous neuronal activation along motor pathways could facilitate synaptic remodeling along these pathways, leading to neural reorganization and improved motor recovery.²⁶

Based on the present result, the experimental showed that, the effectiveness of mirror therapy on upper limb motor functions among hemiplegic patients

has a significant improvement in the compared to the control group. This finding is attributed to the recovery of upper extremity motor function among hemiplegic patients.

Conclusion

The study shows that significant improvement in motor function among hemiplegic patients was achieved along with conventional therapy by adding mirror therapy. Based on result of the study it can be concluded that mirror therapy along with conventional therapy will be effective at restoring upper limb motor function among hemiplegic patients.

Conflict of Interest

The authors declared no conflict of interest.

Author's contribution

Data gathering and idea owner of this study: Chinnavan E, Priya Y, Ragupathy R, Wah YC

Study design: Chinnavan E, Wah YC

Data gathering: Chinnavan E, Priya Y, Ragupathy R, Wah YC

Writing and submitting manuscript: Chinnavan E, Priya Y

Editing and approval of final draft: All authors

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