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EFFECT OF MIRROR THERAPY ON HEMIPARETIC UPPER EXTREMITY IN SUBACUTE STROKE PATIENTS

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ABSTRACT

Background: Stroke is one of the most common causes for chronic disability. Only 5 to 20% of stroke survivors attain complete functional recovery of their affected upper extremity. The primary objective of this study was to investigate the effect of mirror therapy on hemiparetic upper extremity motor recovery and functions in patients with subacute stroke.

Methods: A total of 30 participants were selected for the study. They were randomly assigned to Mirror Therapy Group (MTG) and Sham Mirror Therapy Group (SMTG) with fifteen participants in each group. All the participants equally took part in conventional stroke rehabilitation program 5 days a week for 4 weeks. In addition to the conventional stroke rehabilitation program, MTG participated in 30 minutes of mirror therapy and SMTG received 30 minutes of sham mirror therapy for the affected hemiparetic upper limb. The participants were measured for upper extremity motor recovery and functions by Fugl-Meyer Assessment (FMA-UE) and Upper Extremity Functional Index (UEFI) scales respectively.

Results: Wilcoxon signed ranks test and Mann Whitney U test were used to statistically analyze the data. Spearman correlational technique was used to analyze the relationship between upper limb functions and motor recovery of hand. Based on Wilcoxon signed ranks test, the results were highly significant ($p < 0.05$). On the basis of Mann Whitney U test, Mirror therapy group showed high significance ($p < 0.05$) than sham mirror therapy group. The Spearman's rho value was 0.65 which indicated moderate to maximum positive correlation between the two variables and the alpha level was set at 0.01.

Conclusion: This study concludes that incorporating mirror therapy in subacute stroke rehabilitation program improves the hemiparetic upper extremity motor recovery and its functions and also motor recovery of hand can directly influence the upper limb functions.

Keywords: Stroke, Hemiparesis, Mirror therapy, Mirror neurons, Motor recovery, Upper extremity functions.

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INTRODUCTION

Stroke contributes to a major proportion of morbidity and mortality in developed and developing countries. Stroke produces a major economic burden to both the family and the country. In Malaysia, stroke ranks among the five leading causes of fatality including ischemic heart disease, septicemia, malignant neoplasms and pneumonia. It is also one of the top 10 causes for hospitalization in Malaysia. Patients affected with stroke in Malaysia are within the age range of 54·5 and 62·6 years. Globally, stroke leads to a greatest disease burden based on Disability-Adjusted Life Years (DALY).[1] Stroke is one of the most common causes for chronic disability. About one third of the survivors is functionally dependent and experience difficulties in most of the activities of daily living (ADL). Stroke survivors constitute the largest group of patients admitted in hospitals. Another indicator of disability due to stroke is the fact that approximately 26 percent of patients with stroke are institutionalized in a nursing home. The direct and indirect costs of stroke are estimated around 56.8 billion U.S. dollars in the year 2005.[2]

Loss of upper limb function is one of the direct consequences of stroke. It is proved in research that about 83% of stroke survivors learn to walk again, but only 5 to 20% of stroke survivors attain complete functional recovery of their affected upper extremity. Approximately 70% to 80% of people who sustain a stroke have upper extremity impairment and most of them do not regain functional use of their paretic upper limb, which can make them dependant in their activities of daily living and participation in community life. Overall it brings reduction in the quality of life.[3] Coordination of joints and muscle functions at multiple levels is required to restore the function of affected extremity. The recovery of proximal joints functions are often faster than distal joints. Activities of daily living are much limited due to failure of recovery of distal joints (wrist and fingers) even though regaining of strength and coordination at proximal joints has occurred (shoulder and elbow). Thus, recovery of hand function is a critical component in stroke rehabilitation.[4,5]

The severely paretic arm is one of the most devastating syndromes that occur following a stroke episode. Few therapeutic options are available to treat it effectively. The extent of structural damage and the level of cortical stimulation during active or passive movement of the affected limb are the two main factors that determine the functional deficits after stroke.[6] Most of the interventions need intensive labor and require one to one manual interactions with therapists for several weeks to months, which make the provision of complete treatment for all patients difficult. Mirror therapy can be recommended to improve upper-extremity functions in stroke patients as it is simple, inexpensive and patient-directed. The human brain is capable of significant recovery after a vascular insult. Among its sequelae, hemiparesis has been treated with mirror-therapy for promoting cortical changes. This method is thought to use the concentration of brain on movement to stimulate the motor processes that is involved in that movement.[7,8]

Only limited studies are available which includes mirror therapy in the management protocol for improving motor recovery and hemiparetic upper extremity functions in subacute stroke patients. The primary objective of this study was to investigate the effect of mirror therapy on hemiparetic upper extremity motor recovery and functions in patients with subacute stroke. The secondary objective of this study was to find out the relationship between hemiparetic upper extremity functions and motor recovery of hand.

MATERIALS AND METHODS

Study Design, Setting and Population

This study was a prospective comparative study. A total of 30 participants were selected for the study on the basis of inclusion and exclusion criteria from nursing homes in Petaling Jaya, Malaysia and were randomly assigned to mirror therapy group (MTG) and sham mirror therapy group (SMTG) with fifteen participants in each group. The duration of intervention for each subject was 4 weeks (5 times / week).

The inclusion criteria were male and female patients aged between 50 to 70 years, first episode of unilateral stroke with hemiparesis, duration of 2 months to 12 months post stroke, diagnosis of stroke with involvement of middle cerebral artery on MRI or CT scan by neurologist. Participants with poor cognitive function as assessed with Mini Mental State Examination score < 24, uncontrolled systemic hypertension, perceptual or apraxic deficits, visual deficit such as homonymous hemianopia, reflex sympathetic dystrophy, severe shoulder subluxation, contracture in the affected upper limb and botox injection within past 6 months to the affected upper limb were excluded from the study. The university research ethical committee approved the study and informed consent was obtained from all subjects after the study protocol had been clearly explained to them.

Intervention

All the participants equally took part in conventional stroke rehabilitation program 5 days a week, 1 hour a day, for 4 weeks and rest intervals were given whenever necessary. In addition with the rehabilitation program, the mirror therapy group participated in 30 minutes of mirror therapy and sham mirror therapy group received 30 minutes of sham mirror therapy for the affected hemiparetic upper limb.

The procedure had been carried out with the patient in close sitting to a table and the mirror placed vertically in midsagittal plane. The paretic upper limb was positioned behind the mirror and the normal limb was placed parallel to the mirror to reflect the mirror image. Only the normal limb can be seen by the participants in the mirror while the paretic limb was hidden from sight. The movements involved on the non paretic hand were simple movements such as finger flexion, finger extension, finger abduction, finger adduction, wrist flexion, wrist extension, wrist ulnar deviation and radial deviation and task specific movements such as power and prehension grip using different size and weighted objects.

Participants need to focus their full attentiveness on the mirror when the movement of the non paretic hand is performed. Observing the reflection of their non involved hand on the mirror, the similar movement was stimulated over the involved hand as a result of seeing the mirror. With this the participants were asked to make an effort to achieve the same movements with the paretic hand while they were moving the non-paretic hand. In the sham mirror therapy group, the similar procedures were followed for the same duration, but the non-reflecting side of the mirror was used in such a way that the paretic hand was concealed from vision.

Figure 1: Flow diagram showing the procedure used in the study.

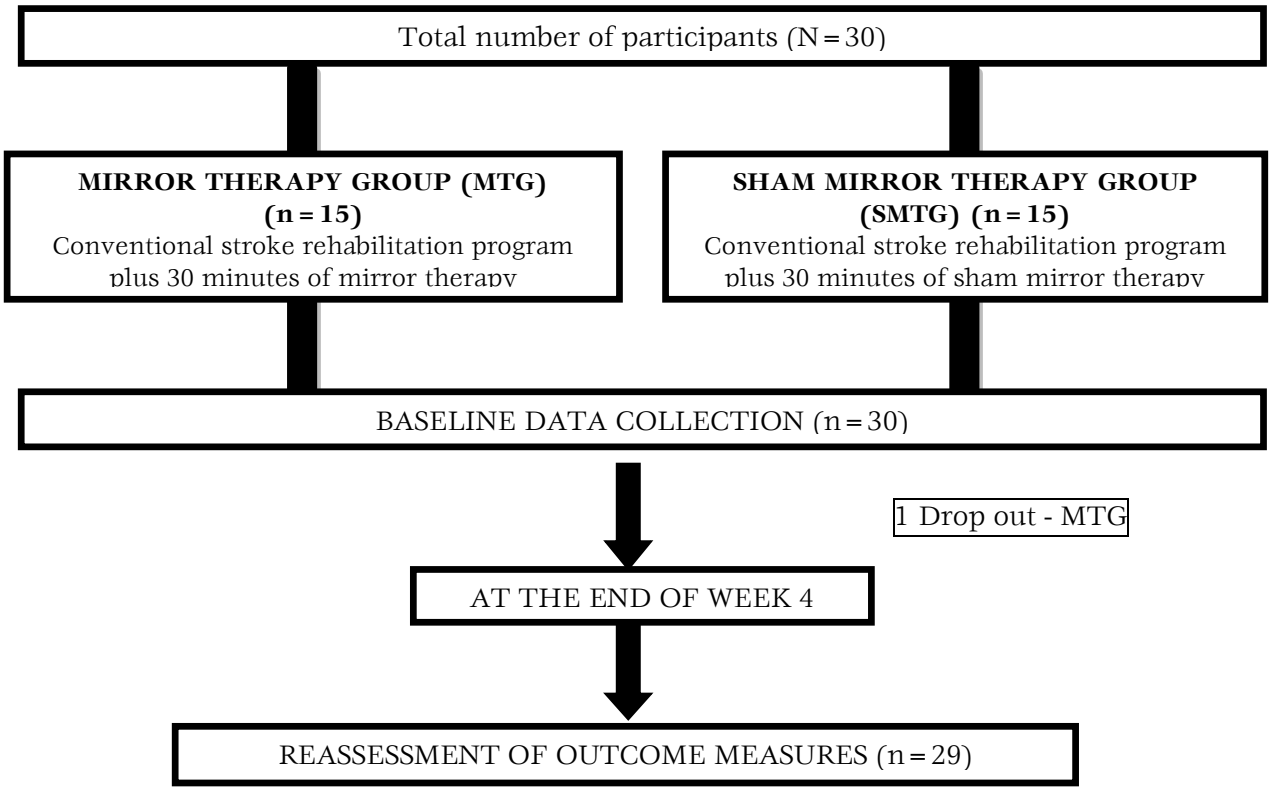


Figure 2: Focusing movement of non paretic hand on the mirror in MTG.

Outcome Measures

Hemiparetic upper extremity motor recovery was assessed by Fugl-Meyer Assessment (FMA-UE) scale and its functions were assessed by the Upper Extremity Functional Index (UEFI) scale.

Statistical Analysis

Data analysis is the method by which the validity of a research study is evaluated. Data were

analyzed using SPSS version 23 (Windows 10). Demographic statistics were analyzed for both groups. As all the variables were non-parametric in nature, non-parametric statistical analysis was done. Within group comparison was statistically analysed using Wilcoxon signed rank test and between groups comparison was analyzed using Mann Whitney U test. Moreover, the relationship between hemiparetic upper extremity functions and motor recovery of hand was analyzed using Spearman correlational technique.

RESULTS

Descriptive statistics was used to evaluate the subject's demographic and clinical characteristics which are explained in Table 1. In within group analysis, data were arranged based on ranks. Rank mean and sum of ranks were seen based on Wilcoxon statistics. Furtherly, positive and negative ranks were analyzed. Based on Wilcoxon signed ranks test, the results showed high significance with an alpha value of 0.05. These are explained in Tables 2 and 3. Mann Whitney U test was used to analyze the data between groups. The results showed that there were highly significant values between the two groups in all variables. So, Mirror therapy group mean ranks are higher than the Sham mirror therapy group. Mirror therapy group showed high significance than sham mirror therapy group. These changes are explained in Table 4 & 5 and Graph 1.

TABLE 1- DEMOGRAPHICS AND CHARACTERISTICS OF SUBJECTS

VARIABLES	MTG	SMTG
Gender: Male/Female	11/4	10/5
Hemiparetic side: Right/Left	13/2	14/1
Lesion type: Ischemic/Hemorrhagic	9/6	11/4
Age (Years)	57.8 ± 5.3[a]	58.2 ± 5.7
Duration (Months)	5.06 ± 2.1	4.93 ± 2.4
FMA-UE score (Motor Function)	23.8 ± 5.5	17.6 ± 7.0
UEFI score	17.2 ± 7.7	13.4 ± 3.7

FMA-UE: Fugl-Meyer Assessment Upper Extremity, UEFI: Upper Extremity Functional Index, [a]Mean ± SD

TABLE 2 – WILCOXON RANK TABLE FOR ALL VARIABLES

		N	Mean Rank	Sum of Ranks
UEFI POST TEST – PRE TEST	Negative Ranks	0[a]	.00	.00
	Positive Ranks	29[b]	15.00	435.00
	Ties	0[c]		
	Total	29		
FMA – UE POST TEST – PRE TEST	Negative Ranks	0[d]	.00	.00
	Positive Ranks	29[e]	15.00	435.00
	Ties	0[f]		
	Total	29		
FMA - WRIST POST TEST – PRE TEST	Negative Ranks	2[g]	7.75	15.50
	Positive Ranks	23[h]	13.46	309.50
	Ties	4[i]		
	Total	29		
FMA - HAND POST TEST – PRE TEST	Negative Ranks	0[j]	.00	.00
	Positive Ranks	27[k]	14.00	378.00
	Ties	2[l]		
	Total	29		
FMA - SPEED POST TEST – PRE TEST	Negative Ranks	0[m]	.00	.00
	Positive Ranks	26[n]	13.50	351.00
	Ties	3[o]		
	Total	29		
FMA - TOTAL P POST TEST – PRE TEST	Negative Ranks	0[p]	.00	.00
	Positive Ranks	29[q]	15.00	435.00
	Ties	0[r]		
	Total	29		

TABLE 3 – WILCOXON INFERENTIAL STATISTICS

TEST STATISTICS[a]						
	UEFI POST - PRE	FMA-UE POST -PRE	FMA-WRIST POST – PRE	FMA-HAND POST - PRE	FMA-SPEED POST - PRE	FMA-TOTAL POST - PRE
Z	-4.707[b]	-4.706[b]	-3.984[b]	-4.554[b]	-4.520[b]	-4.705[b]
Asymp. Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
a. Wilcoxon Signed Ranks Test						
b. Based on negative ranks.						

TABLE 4 – MANN WHITNEY U RANK TABLE

	GROUP	N	Mean Rank	Sum of Ranks
UEFI POST TEST	MIRROR THERAPY	14	19.93	279.00
	SHAM GROUP	15	10.40	156.00
	TOTAL	29		
FMA – UE POST TEST	MIRROR THERAPY	14	21.64	303.00
	SHAM GROUP	15	8.80	132.00
	TOTAL	29		
FMA – WRIST POST TEST	MIRROR THERAPY	14	21.29	298.00
	SHAM GROUP	15	9.13	137.00
	TOTAL	29		
FMA – HAND POST TEST	MIRROR THERAPY	14	22.07	309.00
	SHAM GROUP	15	8.40	126.00
	TOTAL	29		
FMA – SPEED POST TEST	MIRROR THERAPY	14	21.96	307.50
	SHAM GROUP	15	8.50	127.50
	TOTAL	29		
FMA – TOTAL POST TEST	MIRROR THERAPY	14	22.39	313.50
	SHAM GROUP	15	8.10	121.50
	TOTAL	29		

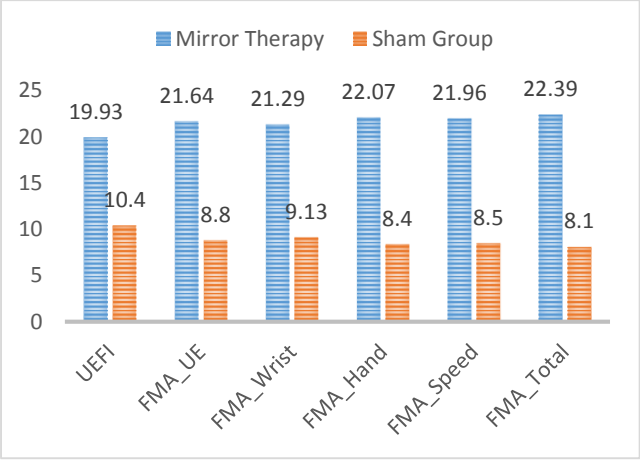
TABLE 5 – MANN WHITNEY U INFERENTIAL STATISTICS

TEST STATISTICS[a]						
	UEFI POST TEST	FMA UE POST TEST	FMA WRIST POST TEST	FMA HAND POST TEST	FMA SPEED POST TEST	FMA TOTAL POST TEST
Mann-Whitney U	36.00	12.00	17.00	6.00	7.50	1.50
Wilcoxon W	156.00	132.00	137.00	126.00	127.50	121.50
Z	-3.018	-4.069	-3.951	-4.343	-4.355	-4.523
Asymp. Sig. (2-tailed)	.003	.000	.000	.000	.000	.000
Exact Sig. [2*(1-tailed Sig.)]	.002[b]	.000[b]	.000[b]	.000[b]	.000[b]	.000[b]
a. Grouping Variable: GROUP						
b. Not corrected for ties.						

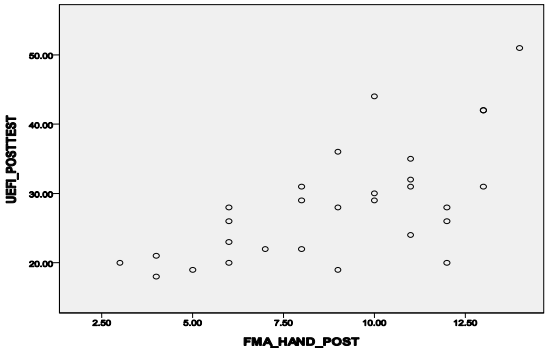
TABLE 6 - SPEARMAN'S CORRELATION COEFFICIENT

			UEFI POST TEST	FMA - HAND POST TEST
SPEARMAN'S RHO	UEFI	Correlation Coefficient	1.000	.650**
		Sig. (2-tailed)	.	.000
		N	29	29
	FMA HAND	Correlation Coefficient	.650**	1.000
		Sig. (2-tailed)	.000	.
		N	29	29
**. Correlation is significant at the 0.01 level (2-tailed).				

GRAPH 1 – COMPARISON OF MEAN RANK OF THE VARIABLES (MANN WHITNEY U TEST)



GRAPH 2 - SCATTER PLOT FOR CORRELATION COEFFICIENT FOR UEFI AND FMA – HAND



Spearman's Correlation Coefficient was used to find out the relationship between upper extremity functions and motor recovery of hand. The Spearman's rho value is 0.650 which indicate moderate to maximum positive correlation between the two variables (Table 6). This statistical analysis was done in alpha level 0.01 and it showed that it was highly significant in 2-tailed ($p < 0.01$). In graph 2, scatter plot analysis was done based on the results of Spearman's Correlation Coefficient analysis and it showed a positive correlation effect. So, the results showed that improving motor recovery of hand can directly influence on improving the upper limb functions.

DISCUSSION

The aim of this study was to investigate the effect of mirror therapy on hemiparetic upper extremity motor recovery and functions in patients with subacute stroke. Totally 30 participants were recruited in this study and were randomly assigned to mirror therapy group (MTG) and sham mirror therapy group (SMTG) with fifteen participants in each group. There was one drop out from MTG due to medical emergency. The results of the present study showed that there was a significant improvement in both groups in terms of upper extremity motor recovery and functions. When compared the improvement between groups, MTG showed significant improvement than SMTG in both upper limb motor recovery and functions.

Mirror neurons constitute a part of the nervous system. Execution or observation of motor action has produced changes over the adjacent cortical penumbra area in post-stroke patients with sensorimotor disorders. When using the mirror box, these mirror neurons get stimulated and help in recovery of the affected limb.[8] Similar findings were found from previous studies on upper extremity motor recovery and functions. Mirror therapy principle is based on the visual illusions that make patients feel as their two hands are symmetrically moving simultaneously. This delusion may activate a hemispheric cortical motor network that accelerates recovery.[9-13] The results of this study also showed a positive correlation between the hemiparetic upper extremity functions and motor recovery of hand. Thus motor recovery of hand influences hemiparetic upper extremity functions. The control group also showed significant changes over motor recovery and functions and the reason might be due to the conventional stroke rehabilitation program.

The study limitations were an inability to generalize the results to all types of stroke patients, not identify the influence of spasticity on hemiparetic upper extremity motor recovery and

functions and absence of follow-up. Further studies are necessary to evaluate the effectiveness of mirror therapy as a part of stroke management in a long term basis on hemiparetic upper extremity motor recovery and its functions in stroke patients.

CONCLUSION

This study finding concludes that incorporating mirror therapy in subacute stroke rehabilitation program improves the hemiparetic upper extremity motor recovery and functions. In addition, motor recovery of hand has a great impact on the hemiparetic upper extremity functions.

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