Original Article

Effects of mirror therapy vs modified constraint induced movement therapy on upper extremity in subacute stroke patients

Kamatchi kaviraja[1], Tharani. G[2], Yuvarani.G[3], Kaviraja.N[4], Jenifer Augustina.S[5], Aarthi .C[6]

Abstract

Objective: To compare and to examine the effectiveness of mirror therapy and modified constraint induced movement therapy (mCIMT) on upper extremity in subacute stroke patients. *Background:* Stroke or cerebral vascular accident is sudden dead of the brain cells due to inadequate blood flow. The WHO defines stroke as rapidly developing clinical signs of focal disturbance of cerebral function, with symptoms lasting for 24hrs or longer or leading to death, with no apparent cause other than of vascular origin. The most common consequence of stroke is loss of upper limb function. The protocol planned for improving the function of upper limb are mirror therapy and modified constraint induced movement therapy (mCIMT). Mirror therapy is a simple and inexpensive treatment which uses the visual information activating the premotor and motor cortex of the brain. This is explained by activation of so called mirror-neuron system. Whereas mCIMT utilises the redundant pathway in brain through neuro plasticity. *Methodology:* A total of 30 participants with subacute stroke were selected. The inclusion criteria are both gender of age 55-70 years and duration of 2-12 months of post stroke. Participants with mini mental state examination score<24, uncontrolled systemic hypertension, severe shoulder subluxation, previous stroke and severe cardiac failure were excluded. The outcome measures were measured using Upper Extremity Functional Index (UEFI) and Fugl Meyer Upper Extremity Scale. *Procedure:* All 30 participants with sub-acute stroke were divided into two groups. Both the group individuals were assessed for pre test using Fugl Meyer Upper Extremity Scale and Upper Extremity Functional Index Scale. Group A (15) was assigned to mirror therapy for 5 days a week, for 4 weeks and rest intervals was given. Similarly group B (15) was assigned to modified constraint induced movement therapy for 5 days a week, for 4 weeks. Both the groups were given conventional therapy for 20 mins. At the end of study subjects were assessed for post test using UEFI and Fugl Meyer upper extremity scale. *Results:* The Modified Constraint Induced Movement (mCIMT) is more effective than Mirror Therapy in improving the hemiparetic upper extremity in subacute stroke patients.

Keywords: Stroke; Mirror therapy; Mirror neuron; Modified constraint induced movement therapy.

1. Kamatchi kaviraja
2. G.Tharani.
3. G. Yuvarani
   Assistant Professor, Faculty of Physiotherapy, Dr. M.G.R. Educational & Research Institute, Velappanchavadi, Chennai - 600 077, Tamil Nadu, India.
4. N Kaviraja, Pediatric Developmental Therapist, KAVI'S Physiotherapy and Pediatric Therapy Centre
5. Jenifer Augustina.S, Tutor, Saveetha College of physiotherapy, Saveetha University Thandalam.
6. C Aarthi, Student, Faculty of Physiotherapy, Dr. M.G.R. Educational & Research Institute, Velappanchavadi, Chennai - 600 077, Tamil Nadu, India.

Correspondence to: Kamatchi kaviraja, Assistant Professor, Faculty of Physiotherapy, Dr. M.G.R. Educational & Research Institute, Velappanchavadi, Chennai - 600 077, Tamil Nadu, India.
E-Mail: physiokamatchikaviraja@gmail.com, kamatchi.physio@drmrgdu.ac.in

Introduction

The operational definition of stroke was a rapidly developing sign of focal disturbance of cerebral function lasting more than 24 hours with no apparent non-vascular cause[1.] Stroke is the third most common cause of death in developed countries, after coronary heart diseases and cancers.Three million women and 2.5 million men die from stroke every year worldwide[2.] Annually, each 15 million people worldwide suffer from stroke. Out of 15 million people, 5 million die and another 5 million are left permanently disabled causing a burden on family and community[2]. The incidence and prevalence rates of stroke are decreasing in developed countries, but an opposite trend is taking place in the Asia Pacific, where an increasing number of patients are being diagnosed with acute stroke[3].A recent systematic review showed that the effectiveness of most interventions for affected limbs is driven by repetition and principles of task and context specific motor learning[4]. Mirror therapy and modified constraint induced movement therapy (MCIMT) can be recommended to improve UEF in stroke patients. As human brain is capable of significant recovery after a vascular insult, these therapies are thought to use the concentration of brain on movement to stimulate the motor processes that is involved in that movement.Mirror therapy (MT) was first introduced in treatment of limb amputated patients with phantom limb pain and resultant reductions in pain were reported. MT uses visual information to encourage patients to concentrate on movements of their non-paretic limb[5,6,7]. This visual illusion enhances activation of premotor and motor cortex of the brain. This effect can be explained by the activation of so called mirror neuron system, which plays a central role in the process of motor relearning by action observation[8].CIMT is one of the tasks specific activity given by Taub, et al showed its effect in motor and functional recovery in all stages of stroke. Steffen Page has given modified version of CIMT which is a 30 mins application of therapy[9]. mCIMT contains 3 components:

i. Enhancing task specific use of the affected limb for up to 6hrs a day.

ii. Constraining the non paretic limb to promote the use of the impaired limb.

iii. Adherence- enhancing behavioural methods designed to transfer the gain to patient's real world environment[9].

Methodology: This experimental study was conducted at the Faculty of Physiotherapy (A.C.S Medical College and Hospital) for 30 patients using simple random sampling method. This study was conducted for about 3 months. Pre and post test will be done using Fugl Meyer Upper Extremity Scale and Upper Extremity Functional Index Scale. The inclusion criteria includes patients with sub acute stroke in upper limbs irrespective of gender and age group between 55-70 years. The study excluded patients with Mini Mental State Examination score < 24, uncontrolled systemic hypertension, past stroke history, severe cardiac failure.

Procedure

A total of 30 stroke patients with hemiparesis were included in the study. All the patients were randomly divided into 2 groups as group A and group B. Each subject was given conventional therapy for 20mins. The study was conducted for duration of about 4 weeks.

MIRROR THERAPY:

Group A was given mirror therapy for 5 days a week for duration of 30mins. Patients were made to sit near a table with a mirror placed vertically in mid sagittal plane. The paretic limb was positioned behind the mirror and normal limb was placed parallel to the mirror. Simple movements such as finger flexion, extension, adduction and abduction, wrist flexion, extension, ulnar and radial deviation were encouraged. Patients were asked to see the reflection on the mirror and similar movements was stimulated over the paretic limb.

MODIFIED CONSTRAINT INDUCED MOVEMENT THERAPY (mCIMT):

Group B received 30mins of mCIMT for 5days a week along with conventional therapy. In mCIMT, patient's non paretic limb was constraint using a sling. Movements such as finger flexion, extension, adduction, abduction, wrist flexion and extension, ulnar and radial deviation were forced to perform in their paretic limb. Patients were instructed to constraint their non paretic limb for about 6 hours a day.

All the 30 members in both the groups were screened for pre test measures using Fugl Meyer Upper Extremity Scale and Upper Extremity Functional Index Scale before the start of the intervention.

Post test measures were taken after 4 weeks of intervention.

Ethical clearance: Institutional Review Board 001/PHYSIO/IRB/2017-2018

The procedures were followed according to the recommendations of Helsinki Declaration of 1964 (as revised in 2008). This study was registered under Faculty of Physiotherapy, Dr.MGR educational and Research institute with [001/PHYSIO/

DATA ANALYSIS

Table-1: Comparison of Fugl Meyer upper extremity score betweenGroup – A and group - B in pre and post test

#FMUE	#GROUP - A		#GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	28.40	6.87	25.73	7.01	1.05	28	.302*
POST TEST	34.00	6.53	42.13	5.40	-3.71	28	.000***

#GROUP A –Mirror therapy,#GROUP B – Modified constraint induced movement therapy

(*- P > 0.05)

(*- P ≤ 0.001)**

The above table reveals the Mean, Standard Deviation (S.D), t-test, degree of freedom (df) and p-value of the Fugl Meyer Upper Extremity Score between (Group A) & (Group B) in pre test and post test weeks.

This table shows that there is no significant difference in pre test values of the FMUE between Group A& Group B (*P > 0.05).

This table shows that statistically highly significant difference in posttest values of the FMUE between Group A& Group B (***- P ≤ 0.001)(Graph –I)

Both the Groups shows significant Increase in the post test Means but (Group-B) which has the Higher Mean value is more effective than (Group-A)
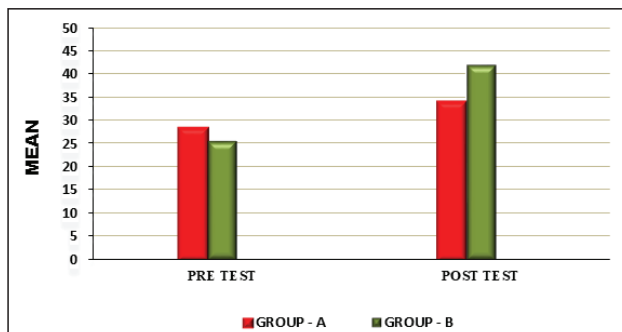
GRAPH – IComparison of FUGL MEYER upper extremity score between GROUP – A AND GROUP - B in pre and post test
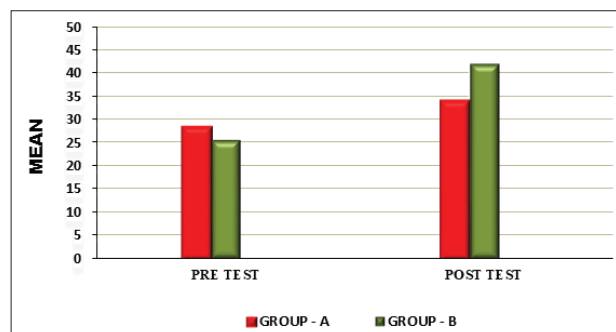
Graph – II: comparison of upper extremity functional index scale between group – a and group - b in pre and post test

IRB/2017-2018]. The study was carried out during november2017 to march 2018.

Result

On comparing the Mean values of Group A & Group B on Fugl Meyer Upper Extremity Score, it shows significant Increase in the post test Mean

values but (Group B - Modified Constraint Induced Movement Therapy)shows (42.13) which has the Higher Mean value is more effective than (Group A - Mirror Therapy) (34.00) at P ≤ 0.001. Hence Null Hypothesis is rejected.

On comparing the Mean values of Group A & Group B on Upper Extremity Functional Index Scale, it

Table- 2: Comparison of upper extremity functional index scale between GROUP – A and GROUP - B in pre and post test

#UEFIS	#GROUP - A		#GROUP – B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	16.26	6.51	15.93	5.53	.151	28	.881*
POST TEST	22.00	7.05	28.86	6.25	-3.71	28	.000***

#GROUP A – MIRROR THERAPY,# GROUP B – MODIFIED CONSTRAINT INDUCED MOVEMENT THERAPY

(*- P > 0.05)

(*- P ≤ 0.001)**

The above table reveals the Mean, Standard Deviation (S.D), t-test, degree of freedom(df) and p-value of the Upper Extremity Functional Index Scale between (Group A) & (Group B) in pre test and post test weeks.This table shows that there is no significant difference in pre test values of the UEFIS between Group A& Group B (*P > 0.05).

This table shows that statistically highly significant difference in posttest values of the UEFIS between Group A& Group B (***- P ≤ 0.001)(Graph –II)Both the Groups shows significant Increase in the post test Means but (Group-B) which has the Higher Mean value is more effective than (Group-A)

shows significant Increase in the post test Mean values but (Group B - Modified Constraint Induced Movement Therapy) shows (28.86) which has the Higher Mean value is more effective than (Group A - Mirror Therapy) (22.00) at P ≤ 0.001. Hence Null Hypothesis is rejected.

On comparing Pre test and Post test within Group A& Group B on Fugl Meyer Upper Extremity Score &Upper Extremity Functional Index Scale shows highly significant difference in Mean values at P ≤ 0.001

Discussion

The aim of this study was to investigate the effect of mirror therapy and modified constraint induced movement therapy on hemiparetic upper extremity motor recovery and functions in subacute stroke patients. Totally 30 patients were recruited in this study and were randomly assigned to mirror therapy

Table – 3: comparison of fugl meyer upper extremity score within Group – a & group – b between pre & post test values

#FMUES	PRE TEST		POST TEST		t - TEST	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D		
GROUP- A	28.40	6.87	34.00	6.53	-15.44	.000***
GROUP-B	25.73	7.01	42.13	5.40	-10.67	.000***

#GROUP A – MIRROR THERAPY,# GROUP B – MODIFIED CONSTRAINT INDUCED MOVEMENT THERAPY

(*- P ≤ 0.001)**

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value of the FMUES between pre-test and post-test within Group – A &Group – B

In FMUES, there is a statistically highly significant difference between the pre test and post test values within Group A and Group B(***- P ≤ 0.001).(Graph-III)
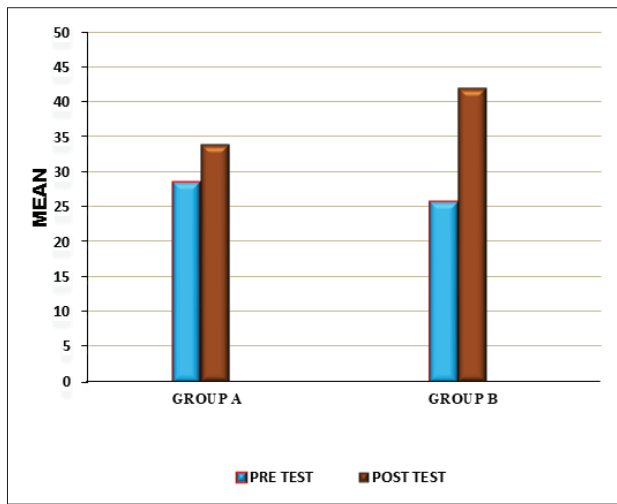
GRAPH – III: COMPARISON OF FUGL MEYER UPPER EXTREMITY SCORE WITHIN GROUP – A & GROUP – B BETWEEN PRE & POST TEST VALUES
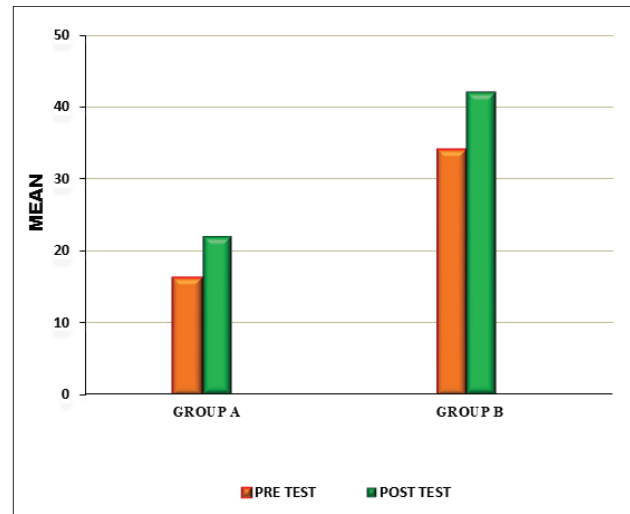
GRAPH – IV: Comparison of upper extremity functional index scale within group – A & group – B between pre & post test values

Table – 4: comparison of upper extremity functional index scale within Group – A & Group – B between pre & post test values

#UEFIS	PRE TEST		POST TEST			SIGNIFICANCE
	MEAN	S.D	MEAN	S.D	t - TEST	
GROUP- A	16.26	6.51	22.00	7.05	-13.67	.000***
GROUP-B	34.00	6.53	42.13	5.40	-25.28	.000***

#**GROUP A – mirror therapy,**# **GROUP B – modified constraint induced movement therapy**

(***- P ≤ 0.001)

The above table reveals the Mean, Standard Deviation (S.D), t-value and p-value of the UEFIS between pre-test and post-test within Group – A & Group – B.

In UEFIS, there is a statistically highly significant difference between the pre test and post test values within Group A and Group B(***- P ≤ 0.001).(Graph-IV)

(group A) and mCIMT (group B) with 15 participants in each group. The results of this present study showed that there was a significant difference in both groups in terms of upper extremity motor recovery and functions. But when compared the improvements between the groups, Group B (mCIMT) showed significant improvement than Group A (mirror therapy).

mCIMT is one of the most developed training approaches for motor restoration and it is based on a theory of brain plasticity and cortical functional reorganization. It has emerged as a promising tool of rehabilitation for paretic upper limb[9]. Constraint and massed and repeated practice may correct the learned nonuse and then improve functional performance of affected extremity[10, 11, 12, 13].mCIMT involves massed and intensive practice with more affected upper extremity and includes two components: use of unaffected upper extremity is restraining during 90% of waking hours, and at the same time, more affected upper extremity receives repeated and intensive training for 6hours / more a day. By this means, the

use of the more affected arm may be increased and learned nonuse may be overcome[11,13,14,15,16].

The main difference between mirror therapy and mCIMT is the part of the extremity engaged in the rehabilitation exercise. In mirror therapy, unaffected arm is moved and patient receives only visual feedback from mirror. However in mCIMT, unaffected arm is restrained and affected arm is voluntarily engaged even though the arm itself is not effectively moved. At most, the intention to move the paralyzed arm is activated. YumiJu, et al(2018) concluded that patient's attempt to move the affected side results in improved performance in activities of daily living as well as physical function. In mCIMT group (B) patients tried to move their affected arm, while those in mirror therapy group did not. As the patient engages in repetitive exercises with the affected limb, brain grows new neural pathways. This change in brain is referred to as cortical reorganization or neuroplasticity. Neuro imaging studies have demonstrated that the brain undergoes neuroplastic changes in function and structure in stroke patients who participated in mCIMT[17,18].Several previous literature of constraint induced movement therapy has advocated that the motor or functional recovery of CIMT group is because of the enhanced neural plasticity and cortical reorganization of the learned function in the undamaged surrounding cortices and even in the opposite hemisphere[9].Explanation for these improvements could possibly be obtained by relating these measured changes to measurements of changes in cortical reorganization through functional MRI studies, which are responsible for motor changes[19]. Similarly results has been shown by Riya Antat, Dr. Varsha A Kulkarni (2018) suggesting in their study that both modified constraint induced movement therapy and mirror therapy are helpful in improving the hand function along with conventional therapy. But modified constraint induced movement therapy showed more effect than mirror therapy.

Patients of both groups were assessed using Upper Extremity Functional Index (UEFI) scale and Fugl Meyer Assessment (FMA) scale. Fugl Meyer upper extremity scale is a stroke specific, performance based impairment index designed to assess motor functioning, balance, sensation and joint functioning. For the purpose of this study, the FMA will adapt by using only the tests that measures the motor functions. And it showed significant improvement in mCIMT group than mirror therapy group. Hence, this study reveals the effective of mCIMT in improving upper extremity function and self care in the performance of activities of daily living than mirror therapy.

Conclusion

The present study concluded that four weeks duration of training with mCIMT is effective in improving the hemiparetic upper extremity motor recovery and functions in patients with subacute stroke. However modified constraint induced movement therapy (mCIMT) seems to have shown better results in subjects with hemiparetic upper extremity.

Conflict of interest: Nil
Source of funding: Self

References:

1. Thorvaldsen P, Kuulasmaa K, RajakangasAM, Rastenyte D, SartiC and Wilhelmsen L, Stroke trends in WHO MONICA project. *Stroke*, 1997; **28**:500-506. https://doi.org/10.1161/01.STR.28.3.500

2. World Health Organization.Deaths from stroke. 2015. Retrieved on August 16, 2015, from http://www.who. int/ cardiovascular_diseases/en /cvd_atlas_16_death_ from_stroke.pdf?ua=1

3. Othman Z, Wong ST, Drahman I and Zakaria R. Caregiver burden is associated with cognitive decline and physical disability of elderly post-stroke patients, *Middle-EastJournal of Scientific Research*, 2014; **22**(9):1265-1271.

4. GertKwakkel, J.M.Veerbeek, et al, Constraint induced movement therapy after stroke. [https://www.ncbi.nlm. nih.gov/pmc/articles/PMC431809/].

5. JY Park, Moonyoung Chang, et al; Effect of mirror therapy on upper extremity function and activities of daily living.[https://www.ncbi.nlm.nic.gov/pmc/articles/ PMC4499960/].

6. Bae SH, JeongWS,Kim KY : Effect of mirror therapy on subacute stroke patients brain waves and upper extremity function. *J Phys.Ther.Sci 2012; 24:1119-1122. https://doi.org/10.1589/jpts.24.1119*

7. Ji SG, Cha HG, Kim MK, et al: Effect of mirror therapy integrating functional electrical stimulation on gait of strokepatients.*JPhysTherSci,*2014,*26*:497-499[pubmed] https://doi.org/10.1589/jpts.26.497

8. Yavuzer G, Selles R, Sezer. Mirror therapy improves hand function in subacute stroke patients: A randomized controlled trial. *Arch.Phys.Med Rehabil* 2008;**89**:393-398 [https://www.ncbi.nlm.nih.gov/pubmed/18295613]. https://doi.org/10.1016/j.apmr.2007.08.162

9. Kiran Prakash Pappala [https://www.ijphy.org/ view_issue.php?title=EFFECT-OF-MODIFIED-CONSTRAINT-INDUCED-MOVEMENT-THERAPY-ON-UPPER-LIMB-FUNCTIONAL-RECOVERY-IN-YOUNG-STROKE-SUBJECTS.]

10. Taub, E. Crago, J.E., &Uswatte.G Constraint induced movement therapy: a new approach to treatment in physical rehabilitation. *Rehabil Psychol*.1998; **43**:152-170. https://doi.org/10.1037/0090-5550.43.2.152

11. Van der Lee,J.H, et al. Forced use of upper extremity in chronic stroke patients: results from single blind randomized clinical trial. *Stroke* 1999; **30**:2369-2375. https://doi.org/10.1161/01.STR.30.11.2369

12. Taub, Miller, N.E., et al. Technique to improve chronic motot deficit after stroke. Arch.Phys.Med.Rehabil.1993; **74**:347-354.

13. Page SJ, Levine P, Modified CIMT in chronic stroke: results of single blinded randomized controlled trial. *Phys.Ther*, 2008; **88**:333-340. https://doi.org/10.2522/ptj.20060029

14. Lin, KC., Wu, CY., et al. effects of mCIMT on reach to grasp movements and functional performance after chronic stroke: a randomized controlled study. *Clin Rehabil*.2007**; 21**:1075-1086. https://doi.org/10.1177/0269215507079843

15. Sunderland, A &Tuke A. Neuroplasticity, learning and recovery after stroke: a critical evaluation of CIMT. *Neuropsychol Rehabil* 2005; **15**:81-96.https://doi. org/10.1080/09602010443000047

16. ge SJ, Sisto S, et al. Efficacy of mCIMT in chronic stroke: a single blinded randomized controlled trial. *Arch.Phys. Med Rehabil* 2004; **85**:14-18.https://doi.org/10.1016/ S0003-9993(03)00481-7

17. Neural basis of CIMT. Wittenberg GF, *Schaechter JD Curr Opin Neurol* 2009 Dec; **22**(6):582-8 [https://www.ncbi.nlm.nih.gov/pubmed/19741529/] https://doi.org/10.1097/WCO.0b013e3283320229

18. Cortical reorganization following mCIMT a study of 4 patients with chronic stroke. Page SJ, et al. *Arch.phys. Med.Rehabil*.2006 Aug **87**(8)1052-8 pubmed/16876549. https://doi.org/10.1016/j.apmr.2006.04.018

19. Sarah Blanton & Steven Wolf. An application of upper extremity constraint induced movement therapy in patient with subacute stroke. *Phy.Ther*.1999.Sep; **79**(9):847-53. [https://www.ncbi.nlm.nic.gov/m/pubmed/10479785]. https://doi.org/10.1093/ptj/79.9.847