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Effectiveness of Modified Constraint Induced Movement Therapy in Improving Functional Activities of Hand in Sub Acute Stroke Subjects

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ABSTRACT

BACKGROUND: In stroke, upper limb hemi paresis is a commonly seen impairment and challenging for activities of daily living that have a significant impact on one's quality of life. The majority of studies used both occupational therapy and physiotherapy to improve hand functions in subjects who had chronic strokes. Stroke patients often under-utilizes their paretic limb despite sufficient residual motor function. We hypothesize that acquired non-use can be overcome by reinforcement-based training strategies. The goal of this study is to analyze the efficacy of modified constraint induced movement therapy (m CIMT), to improve functional activities of hand in sub acute Stroke subjects.

AIM: The Objective of this study was to analyze the effectiveness of Modified constraint induced movement therapy in improving hand functions in Sub acute stroke subjects.

Methodology: This study was an Experimental study and the type of sampling was convenient sampling. The sample size was 30 subjects with unilateral hemiplegia with duration of more than 3 months and the study was conducted in outpatient PT Department.

Results: The results were obtained using FMA and MAL on the basis of Pre and Post treatment data and comparing the Control and experimental groups. The statistical analysis showed significant difference between the experimental group and the control group. This shows that subjects in the experimental group who received Modified Constraint induced movement therapy have shown significant improvement than control Group who received only Conventional Physiotherapy.

Conclusion: Modified constraint induced movement therapy can be added in stroke rehabilitation for improvement of activities of daily living and functional independence of stroke patients.

Keywords: Hemi paresis, CIMT, m CIMT

INTRODUCTION

Stroke or Brain attack was first described as the phenomenon of sudden paralysis by Hippocrates. According to WHO, in 1970's Stroke is characterized by "Rapidly developed clinical signs of focal disturbance of cerebral function of presumed vascular origin and of more than 24 hours duration" Stroke is the major cause of human morbidity and mortality. It ranked as the fourth leading cause of death and sixth leading cause of disability in the year 2022. It is a major health problem worldwide with annual incidence of 7.6 million populations per year gets affected with ischemic stroke. Stroke represents 7.4 % of total deaths in India. Stroke is the second leading cause of death worldwide. About 80% of stroke Survivors experience impairment of movement on one side of the body. One of the disabling consequences of

cerebrovascular stroke is functional impairment of the affected upper extremity since its recovery is often delayed than that of the lower extremity. [7][14] Hand and arm impairment in particular is often persistent, disabling and a major contributor to reduced quality of life. [15] The main predictor of long-term outcome of upper limb function is the level of initial impairment. By 3 months, patients with stroke will recover about 70% of the initial upper limb motor impairment that has been observed on day 3 post stroke. [33][36]

Early recovery research by T. E. Twitch et al observed that there was a general pattern of recovery following stroke through which each patient progressed. [36] The finding of these observations that, grip strength tended to recover last, and only if, the arm was fully recovered. This contributed to the classical perception that motor recovery of the upper limb followed a proximal-to-distal gradient. More severe impairments associated with greater involvement of hand function as greater proportion of descending projections from the contra lateral hemisphere targets proximal vs. distal muscles. [44] Also, most of the corticospi-nal tract neurons synapse directly onto hand motor neurons compared with arm motor neurons, [2][30] and there are more alternative descending motor pathways that influence the arm. [42] This suggests that disruption to the corticospinal tract could disproportionately affect motor function of the hand compared with the arm. More than 50% of those 65 years and older who survive a stroke report persistent impairment of upper-extremity (UE) movement. [20] During the initial recovery period, people may have learned that the affected arm was not functional, therefore they compensated by using the unaffected arm. They have been encouraged to use their unaffected UE to perform tasks and progressively avoid use of the affected UE during task performance. This behavior may result in learned nonuse phenomenon hindering a person's recovery of movement and function in the affected limb. [17]

Constraint induced movement therapy (CIMT) has been shown to be substantially reduce the motor deficits and increase the amount of use of the more affected upper extremity of individuals with stroke. [1] [21] Constraint induced movement therapy is a rehabilitative strategy used primarily to increase the functional use of the neurologically weaker upper extremity through massed practice, in combination with intensive task-related training of the more-affected limb while restraining the lesser involved upper extremity over an extended period.[4] Movement improvement has been demonstrated in people with strokes who have had dysfunction of their upper extremity for more than one year period, undergoing a period of constraint induced movement therapy. CIMT capitalizes on the role of use dependent reorganization to reverse learned non use. This is done by using successive approximations towards a task and increasing the demands for Precision, Strength, function and coordination. Altering the behaviorally relevant afferent input to the central nervous system can produce plastic changes in the function and organization of the Brain. Sustained increased use of a body part leads to an increase in the brain's cortical representation of that body part. CIMT produce functional changes in the brains of stroke patients involving increases in the differential excitability, metabolic activity and oxygen consumption of sensory motor regions of the brain but also it induces correlated morphometric changes in these

areas. CIMT though efficacious may be difficult to implement as the patient grew, tied of wearing a mitt and had difficulty with fully adherence and treatment protocol lasting for more weeks with shorter activity sessions. CIMT intervention requires supervised training of the more involved limb for 6–7 h per day over 10 days, with concurrent restraint of the less-involved limb for 90% of waking hours of the stroke patients', over the same 2-week period in contrast to clinical efficacy of CIMT, the acceptance of CIMT among therapists and patients remains poor.

Modified constraint-induced movement therapy (m CIMT) is an effective treatment created to enhance affected upper limb function after a stroke [37] and restricting the use of unaffected upper limb. It is one of the most important stroke rehabilitation measures. [42][5]

The major components of m CIMT include intense repetitive (task oriented) training and behavioral shaping of the impaired limb with immobilization of the unimpaired arm. Modified CIMT (m-CIMT) consists of constraint of the unaffected arm with a padded mitt or arm sling every week day for a minimum of 5 hours per day. The specific techniques of mCIMT involve restraining the use of the unaffected UE and intense motor training through the use of shaping movements of the affected limb. [19] The shaping procedure involves individualized task selection, graduated task difficulty, verbal feedback, prompting, and physically assisting with movements and modeling. [5]

The effects of intensive therapy at the neuronal level and its subsequent functional manifestations are as a result of cortical reorganization. Page et al [10] devised a modified CIMT (m CIMT) with shorter training (e.g. 2h/d on 10_15consecutive weekdays) and restraint (e.g. 6h/d for 2_3wk) time.[9] The m CIMT program was shown to be applicable in chronic or sub acute patients with a wide variety of motor disability.[3][6][10][11][14][18][18]

MCIMT as having three principle parts: first, repeated training of impaired upper limbs for a few hours over 10 weekdays; second, a "transfer package" to guarantee that upper limb use in the patient's everyday life; and finally, a limited use of the unharmed upper limb, forcing the individual to utilize the more impaired upper limb in a number of functional activities such as eating a meal, cleaning dishes and writing. M CIMT significantly influenced motor control and daily activity function of the upper limbs. [3] The main mechanism of m CIMT is to limit the less paretic side and through repeated and concentrated training improve the upper limb function of the paretic side. [5] The purpose of present study is to analyze the effectiveness of modified constraint induced movement therapy in sub acute stroke subjects.

MATERIALS & METHODS

Current study recruited thirty Sub acute Stroke subjects with age ranges from 50-60 years, in those 17 males and 13 females and who fulfilled all of the following inclusion criteria: (*i*) Ischemic stroke patients with duration of more than three months from the onset;

ii) No excessive pain in the affected limb; (*iii*) Ability to understand and follow verbal directions; (*iv*) No major cognitive deficit (Mini-Mental Status Examination score > 24); (*v*) active wrist extension of at least 20º, and 10º of active extension of the meta carpophalangeal

joints; (*vi*) ability to maintain standing for 2 min.(vii)) MRI showing infarction in the middle cerebral artery territory; (viii) no balance problems sufficient to compromise

safety when wearing the project's constraint device;(ix) no excessive spasticity in any of the joints of the affected UE (shoulder, elbow, wrist, fingers) (MAS score-2 in any joint) Potential participants were assessed among the stroke patients admitted to the District head quarters hospital during the period April 2023 to October 2023).Exclusion criteria included the following:1) Intra-cerebral hemorrhage; 2) Previous stroke on the same side; 3) Presence of neglect or a degree of aphasia impeding understanding of instructions; and 4) Patients with conditions that limit the use of the upper limb prior to stroke.5) Patients with spasticity in UL more than grade -2 in modified Ashworth scale

Patient allocation

After initial neurological examination, by using the system of random odd- or even-numbered tickets in sealed envelopes for participants selection was used to allocate patients into either the CRP or the mCIMT group. Patients selected their sealed envelope from a box containing 30 sealed envelopes. Those who selected tickets with even numbers were placed in the CRP group while those who selected odd numbers were placed in the mCIMT group. Informed consent was taken from the participants prior to the treatment.

Intervention

The patients were assigned into one of two groups; CRP group included 15 sub acute stroke patients fulfilling the criteria and they received conventional rehabilitation program. Modified CIMT Group included 15 sub acute stroke patients who were subjected to the modified CIMT.

Conventional rehabilitation: Participants in the CR group received 45 minutes of routine physiotherapy, 3 days per week for 10 weeks. The therapy in the CR group involved strength, balance, manual dexterity exercises (e.g. grasp release, stacking cones), functional task practice when possible, and stretching/weight-bearing by the affected arm, and teaching of activities of daily living (ADL s).

Modified constraint- induced movement therapy: Participants in the mCIMT group received one-hour functional practice sessions, 3 days per week for 10 weeks and with restriction of the less affected upper limb. Therapy sessions consisted of performing tasks only with the affected upper extremity. Task movements included reaching, grasping, lifting and placing. The difficulty level of the practiced task was shaped gradually, with the goal being set just above the patient's ability level to perform it. If this level was achieved, then the goal was set higher, thereby continually challenging the patient without overwhelming him or her. In addition to OT sessions, participants in this group were asked to wear a resting hand splint ensemble on their less-affected upper extremity that prevented use of that arm for

approximately five hours a day, their arms were restrained with a cotton hemi sling, loads were placed in mesh, and polystyrene - filled mitts with Velcro straps around the wrist. Motor activity log was kept to document the use time as well as activities performed by the affected limb during restraint hours. Upper extremity section of Fugl –Meyer motor assessment scale was administered to assess the recovery of upper extremity motor function for both the groups before intervention and 5^{th} and 10^{th} week after intervention.

STATISTICAL ANALYSIS

The data analysis was computed with SPSS. The outcome measures used are upper

extremity section of Fugl – Meyer scale and Motor activity log. Wilcoxon signed ranks test is used to test the significant difference in the outcome of Fugl – Meyer scale within the groups. Mann –Whitney 'U' test is used to test the significant difference in the outcome measures of Fugl –Meyer scale and Motor activity log between the experimental and control group. Level of significance is fixed as 5% for the present study.

Independent t-test is used to test the significant difference in the outcome of motor activity log within the groups and between the experimental and control groups. Level of significance is fixed as 5%.

Table -1 The demographic data

No. of subjects	**N=30**	
Age (Mean)	55.7	
Side involved	Right-12	Left-18
sex	Male	17
	Female	13

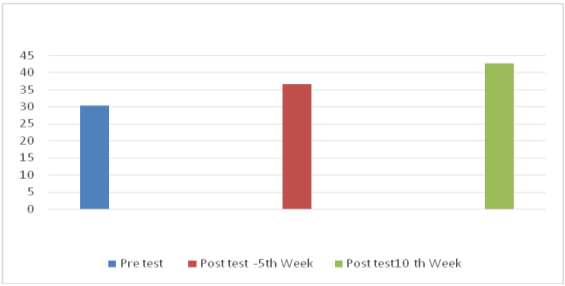
RESULT

Comparing the pre and post test means of UE- Fugl –Meyer motor assessment scale scores in the control group.

Table-2

FMS Scores	**N**	**Mean**	**Z. Value**	**P. Value**
Pre -Test	15	30.33		
Post test 5th week	15	36.533		
Post test 10th week	15	42.733	3.407	0.05

Graph -1

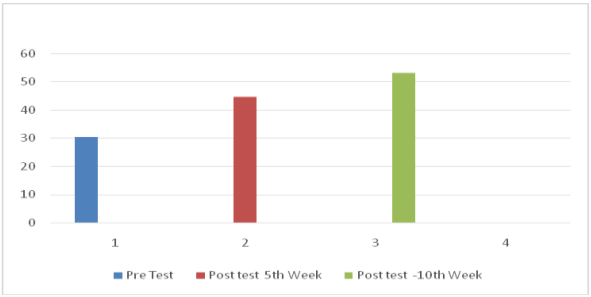


Comparing the pre and post test means of UE - Fugl –Meyer motor assessment scale scores in the Experimental group.

Table-3

FMS Scores	**N**	**Mean**	**Z. Value**	**P. Value**
Pre -Test	15	30.33		
Post test 5th week	15	45.66		
Post test 10th week	15	53	2.755	0.05

Graph -2

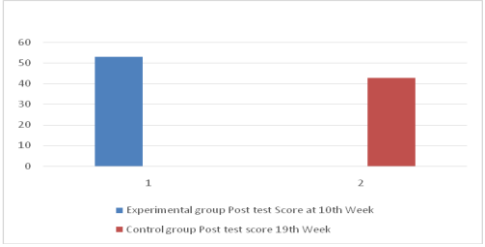


Comparing the pre and post test means of UE-Fugl –Meyer motor assessment scale scores between Control group and the Experimental group.

Table-4

FMS Scores	**N**	**Mean**	**Z. Value**	**P. Value**
Experimental group Post test score at 10th week	15	53		
Control group Post test score 10th week	15	42.733	4.67	0.05

Graph -3

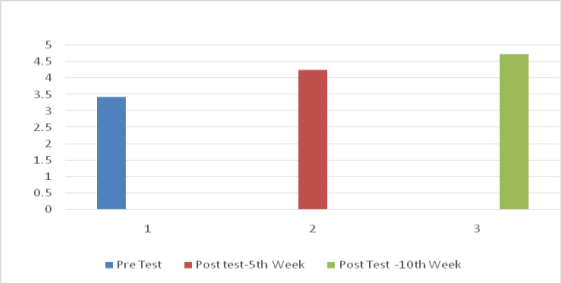


Comparing the pre and post-test means of Motor activity log scores in the Control group.

Table-5

MALScores	N	Mean	Z. Value	P. Value
Pre -Test	15	3.426		
Post test 5th week	15	4.253		
Post test 10th week	15	4.733	3.460	0.05

Graph -3

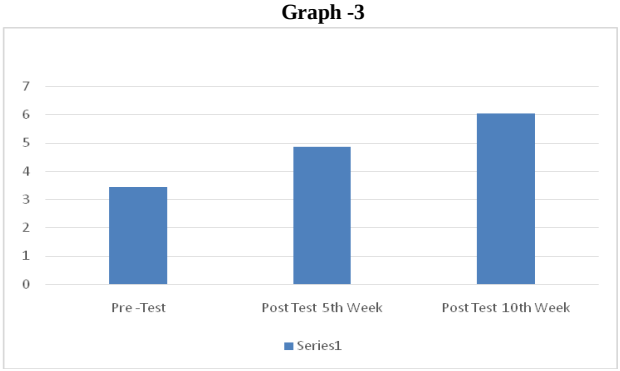


Comparing the pre and post test means of Motor activity log scores in the Experimental group.

Table-6

MAL Scores	N	Mean	Z. Value	P. Value
Pre -Test	15	3.44		
Post test 5th week	15	4.853		
Post test 10th week	15	6.03	3.571	0.05

Graph -3

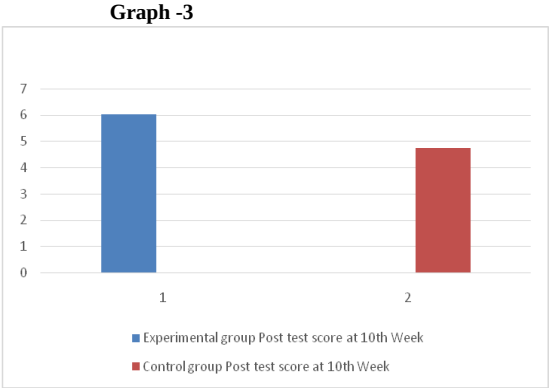


Comparing the pre and post test means of Motor activity log scores between Control group and the Experimental group.

Table-7

MAL Scores	N	Mean	Z. Value	P. Value
Experimental group Post test score at 10th week	15	6.03		
Control group Post test score 10th week	15	4.733	2.925	0.05

Graph -3



DISCUSSION

Improving the Functions of paretic upper limb is one of the primary goals of rehabilitation of hemiplegic patients. Primary motor cortex, dorsal pre motor cortex and supplementary motor area like so many cortical areas shows increased electrical and metabolic neuronal activity during CIMT and m CIMT. This study is to analyse the effectiveness of modified constraint induced Movement therapy to improve hand functions in sub acute stroke subjects. The Patients selected are more than 3 months duration after stroke and aged

between 50-60 Years. The Fugl Meyer assessment scale is used as an evaluative instrument for measuring sensory motor stroke recovery. Before intervention MAL scores were low for all the subjects. After the intervention, subjects in the study group showed significantly better scores of the MAL scale than those in the control group, suggesting the increased use of affected hand for ADL activities both qualitatively and quantitatively. Motor activity log is a semi structured Interview used for hemi paretic stroke patients to assess the use of their paretic arm and hand with quality of movement during activities of daily living. This improvement in the MAL scores after intervention implies that the learned non-use phenomenon observed in the patients could be overcome by mCIMT. All post Treatment assessments were performed using Fugl Meyer scale and motor activity log on 5^{th} and 10^{th} week. The most affected side was right side for 12 participants and left side for remaining 18 participants.

The results of this study indicate that there is significant improvement in subjects trained with modified constraint induced movement therapy than with routine physiotherapy. This ensures that repeated limb use may elicit cortical reorganization and subjects' functional improvement. Stroke patients express greater motor disability on their affected sides and over time, this movement suppression or learned non use becomes so habitual that patients use the less affected side for most ADLs. As the intervention period progressed, modified constraint induced movement therapy patients realizes that they were capable of doing more with their affected limbs than previously thought and often attempted additional ADLs. No significant adverse events occurred during the treatment period and no major compliance issue was faced during our study.

Recovery of arm movement is less complete than recovery of leg movement because arm paresis usually is greater than leg paresis because the arm requires finer movements to perform skilled activities. This is explained by Agranoff et.al. In 2008. Using the unaffected arm in the acute and sub acute phase can lead to negative reinforcement and develop learned non use, this was suggested by Taub et al, in 1993.

In 1993 ,Taub et al reported promising results of forced use therapy in a clinical trial involving 9 patients .Motor recovery after stroke is associated with cerebral reorganization and this was explained by Lee Anne m. Cary et al. Constraint induced therapy might produce its therapeutic effect through the induction of use –dependent cortical reorganization that counteracts adverse brain function changes that occur in the human brain after stroke was explained by a study done by Dettmers C ,et al,in 1997.

A study done by Joachim Lie pert et al 2000 supported that muscle output area size in the affected hemisphere after treatment is increased and there is greatly improved motor performance of the Paretic limb.

A Study done by Johanna H. Vander Lee et al, in1999 showed a small but lasting effect of forced use therapy on dexterity of the affected arm. Constraint induced movement therapy has been shown to improve motor function in the upper extremity of people with mild hemi paresis in chronic stage suggested by a study done by Nancy Bonifer et al, 2003.A study done by Jay L Albert et al,2004 showed significant clinical improvements in hand functions and increased maximum precision grip force.

Studies done by Dyne V Gauthier et al, 2008, on adult stroke patients have

demonstrated functional changes in cortical excitability. The decreased cortical representation area of the paretic muscles of the more affected hand before therapy reflects a reduced excitability of the motor cortex in the affected hemisphere. This is due to reduced use of paretic hand before therapy, explained by willer C et al, 1992.

A study done by Alexander W. Dromeric et al 2000, explained that CIMT could implemented within 2 weeks after stroke and have found a statistically significant improvement and produces functional improvement. A survey done by Page SJ et al, in 2002 found that more than 60% of patients with stroke, who participated in CIMT, prefers therapy lasting for more weeks with shorter activity sessions.

A study done by Naylor et al in 2005 on 9 children with hemiplegic type of Cerebral palsy with age of 18 months to 5 years, showed improvement in grasps, weight bearing, protective extension by the application of modified constraint induced movement therapy. A study done on ten stroke patients with less than 14 days post stroke who exhibiting upper limb hemi paresis and affected limb use and function by the application of modified constraint induced therapy, is proved by page et al., in 2005.

A study done by Stephen J. Page et al in 2002 on patients with sub acute stroke who exhibited learned non use showed improvement by the application of modified constraint induced movement therapy. Modified constraint induced movement therapy may be an efficacious method of improving function and use of the affected arm of patients exhibiting learned non-use is suggested by Levin P .et al .

A study done by Ching-yi Wu, ScD, OTR, Chia-ling Chen et al in 2007 showed that the mCIMT group exhibited significantly greater improvements in motor function, daily function, than the traditional rehabilitation group. Patients in the mCIMT group perceived significantly Greater percent of recovery after treatment than patients in the traditional rehabilitation group.

CONCLUSION

It shows that cortical reorganization and functional improvements can be seen following practice periods of lower durations but with intensive massed practice. Thus, modified constraint induced movement therapy can be added in stroke rehabilitation for improvements of valued activities of daily living.

Declaration by Authors

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