

Efficacy of Constraint-Induced Movement Therapy in Upper Limb Recovery after Stroke

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Abstract: ***Background:** Stroke is one amongst the foremost disabling neurological disorders which affects the activities of daily living like eating, dressing, bathing, toileting if the predominant upper limb is affected. Studies have shown that Constraint Induced Movement therapy (CIMT) is an efficient alternate to traditional rehabilitation techniques. **Objective:** This study focuses on efficacy of Constraint Induced Movement therapy in upper limb recovery after stroke as compared with conventional rehabilitation. **Methods :** 28 stroke patients meeting the selection criteria were randomized into case and control groups. Conventional therapy was given to control group and CIMT was given to cases. Initially upper extremity score was assessed by Fugl-Meyer assessment (FMA) upper extremity scale (Total Score-66) before intervention. After 4 weeks of therapy upper extremity score was again assessed by Fugl-Meyer assessment upper extremity scale **Results :** FMA score in CIMT group was statistically significant with p value of 0.000 compared to conventional therapy of p value 0.881. **Conclusion :** CIMT was effective in improving upper limb function than Conventional therapy.*

Keywords: Stroke, Upper limb recovery, Constraint Induced Movement therapy, Conventional therapy, Fugl-Meyer assessment

1. Introduction

Stroke causes major impairment which affects the standard of life especially in personal hygiene activities if the dominant upper limb is affected. Stroke subjects often fail to develop complete use of affected upper limb due to residual muscle weakness, spasticity and decrease in bone strength.[1] Although most stroke patients recover to some point many are left with sensorimotor and cognitive deficits.[2] As a result of these impairments, patients avoid using the affected limb and becomes habituated in using the non-affected limb for activities of daily living (ADL) like feeding, grooming, bathing and toileting which results in learned non-use phenomenon. To enhance activities of daily living reduction in disability could be a main focus of rehabilitative interventions.[3] Most rehabilitation treatment focuses on compensation strategy rather than restoration of upper extremity function like conventional rehabilitation, as patients use the non affected limb for most of the ADL. In contrast, Constraint Induced Movement Therapy(CIMT) encourages the use of affected limb for ADL which helps in overcoming learned non-use phenomenon and restoration of upper limb function.[2] Studies with transcranial magnetic stimulation has showed increase in size of representation of paretic upper limb muscles in the ipsilesional motor cortex after Constraint Induced Movement Therapy. Functional neuro imaging studies have shown changes in activation within the sensorimotor network after CIMT. This could depend on the extent of stroke induced damage to the cortico-spinal tract and descending motor pathways of the brain. Neuroplastic changes in brain occurs in response to CIMT.[4]

2. Review of Literature

Priyanka Singh and Bijayeta Pradhan 2013 did a randomized controlled trial to assess the effectiveness of modified constraint-induced movement therapy in stroke subjects .The study aims to see the effect of m-CIMT in improving the upper extremity function of stroke subjects in 2 hours. 20 stroke subjects were recruited from Central Referral Hospital and STNM Hospital in Sikkim, India by simple random sampling method into intervention and control groups by using lottery method. 20 subjects were recruited in each group. The WMF and Fugl-Meyer assessment (FMA) were administered as an outcome measure for the both the groups . In intervention group, a mitt was used to cover the unaffected limb which makes the subject to do activities with the affected limb. The technique of m-CIMT was given for 2 hours/day for 2 weeks at the frequency of 5 days a week. The control group received standard physical therapy treatment that included compensatory technique for ADL (Activity of Daily Living), upper extremity strength, and range of motion and traditional positioning of affected arm. In intervention group, the pre-test score of FMA was 31.15 ± 6.37 and after 2 weeks of intervention it was 55.7 ± 6.4 ($P = 0.0$) and in control group, pre-test score was 29.3 ± 6.10 and post-test score was 39.1 ± 6.4 after 2 weeks ($P = 0.0$). The study shows that there was a major improvement in upper extremity function and indicates that m-CIMT is effective in improving the motor function of the affected upper limb in stroke subjects [1]

Corwin Boake, Elizabeth A. Noser et al 2007 done a 1st randomized controlled trial of constraint-induced movement therapy (CIMT) in subacute stroke patients to investigate

neurophysiologic mechanisms and long-term outcome. Within 2 weeks after stroke, 23 patients with upper limb weakness were randomized to 2 weeks of CIMT or traditional therapy at an equal frequency of up to 3 h/day. Motor function of the affected upper limb was blindly assessed before treatment, after treatment, and 3 months after stroke. All outcome variables showed improvements favoring CIMT over intensive conventional therapy, but none was statistically significant except for improvements in the Fugl-Meyer (FM) UE motor scale immediately following treatment and reported improvement of hand function at 3 months.[5]

Raj Kumar Yadav, Rajendra Sharma et al 2016 did a study RCT on Efficacy of Modified Constraint Induced Movement Therapy in the Treatment of Hemiparetic Upper Limb in Stroke Patients, to find the efficacy of four week duration of mCIMT in the management of upper limb weakness in hemiparetic patients because of stroke. 30 patients got traditional rehabilitation programme (control group) and 30 patients participated in a mCIMT programme in addition to the normal rehabilitation programme (study group). The mCIMT included three hours therapy sessions emphasizing the employment of affected arm in functional tasks, thrice every week for four weeks. Their normal arm was constrained for five hours per day for five days per week. All the patients were assessed at baseline, one month and three months after end of therapy using Fugl-Meyer Assessment (FMA) score for upper extremity. Post-hoc analysis revealed that compared to traditional rehabilitation group, mCIMT group showed significantly better scores at 1 month {FMA1 (p-value <0.0001), 3 months {FMA3 (p-value <.0001), Hence Four weeks duration of mCIMT is effective in enhancing the motor function in paretic upper limb of stroke subjects.[6]

EL-Helow M. et al 2015 did a prospective study on Efficacy of modified constraint-induced movement therapy in acute stroke to assess the efficacy of m- CIMT on functional recovery of upper extremity (UE) in acute stroke patients, as compared to conventional rehabilitation therapy. sixty patients with acute stroke recruited from neurology department. subjects were assessed by Fugl-Meyer motor assessment (FMA).The tests were performed pre and post rehabilitation. The patients were separated into two groups: Conventional rehabilitation program group (CRP) included 30 patients who were given a traditional rehabilitation therapy for two weeks. CIMT group included 30 patients who received modified CIMT for two consecutive weeks. Total treatment time was same in both groups. CRP group showed a non-significant improvement in FMA . CIMT group showed a significant improvement in FMA(P<0.05). In contrast to traditional rehabilitation therapy, modified CIMT revealed a big functional improvement in stroke patients[7]

Masoud Gharib, Hooman Ghorbani et al 2011 did a interventional study to investigate effect of time constraint induced therapy on function, coordination and movements of upper limb on hemiplegic patients. 15 hemiplegic patients attended structured exercises for 2 hours a day, 5 days per week for 12 weeks, the sound limb was restricted within an

arm sling. Fugl-Meyer & Minnesota Manual Dexterity Test were used for movement and dexterity assessment. The results of Fugl-Meyer & Minnesota Manual Dexterity Test were significantly improved in patients, after the intervention (p<0.05). Study shows that using CIT in affected limb produces significant improvement in motor function.[8]

3. Methodology

Stroke patients meeting the selection criteria are selected for study by randomization into case and control groups. Initially after admission upper limb motor function is assessed by using standard Fugl-Meyer Assessment (FMA).

Selection Criteria

- 1) Stroke patients of age from 40 to 65 years, ischemic and hemorrhagic stroke, male and female, both hands.
- 2) Able to comprehend and obey simple orders
- 3) Duration of stroke from 3 to 9 months.
- 4) Extension of wrist of atleast 20 degrees and finger of atleast 10 degrees. (MCP and IP of all digits and Brunnstorm stage iv)

For experimental group paretic limb is made to use for activities by covering the unaffected arm with mittens, by means of Constraint Induced Movement Therapy (CIMT) for 2 hours/day x 5 days/week x 4 weeks.

For control group conventional rehabilitation for upper limb is given for 2 hours/day x 5 days/week x 4 weeks.

After 4 weeks upper limb motor function is assessed by initially used standard Fugl-Meyer Assessment (FMA).

Method Used

Following therapies were given to conventional rehabilitation group.

- 1) Facilitation techniques-15 minutes.
 - a) Quick stretching.
 - b) Fast brushing.
 - c) Tapping over the biceps and upper trapezius.
 - d) Fast iceing.
 - e) Shoulder shrinking.
- 2) Instrumental activities- 1hour 15 minutes.
 - a) Slanting board: unilateral or bilateral rowing activities-15 minutes.
 - b) Peg board: improving cylindrical grasp and voluntary control-15 minutes.
 - c) Hook grasp rounds:hook grasp-15 minutes.
 - d) Pincher board: pincer grasp-15 minutes.
 - e) Multipurpose hand exercise stand: wrist extension, forearm pronation and supination-15 minutes.
- 3) Physiotherapy upper limb-30 minutes.
 - a) Range Of Motion exercises.
 - b) Stretching and Strengthening exercises.
 - c) Weight bearing activities. Total duration: 2 hours.



Figure 1: Occupational Therapy Instrument



Figure 2: Patient with Right Hemiparesis (Conventional Group) doing pincher and Bead Board Activity

No restraint is used and subjects are free to use either hand for daily activities.

Constraint Induced Movement Therapy (CIMT)

TASKS: 2 hours

- 1) Putting balls, blocks, cubes of various sizes into the basket.
- 2) Transferring water of 500 ml from jar into 1 litre container.
- 3) Writing with affected hand by lifting pen or pencil. (Numbers, Alphabets or Mathematical designs)
- 4) Taking tissue paper out of the box crunching with the hand and disposing in the dustbin.
- 5) Turning the magazine pages with pages folded at the corner.
- 6) In sitting posture using the cane for extension and flexion of the arm.
- 7) Lifting empty water bottle up and down.
- 8) Building block by cubes/blocks.

Each activity was done for 15 minutes with total duration of 2 hours.



Figure 3: CIMT Kit



Figure 4: Patient with Left Hemiparesis (CIMT Group)

Putting the balls of various sizes into the basket and Taking tissue paper out of the box crunching with the hand and disposing in the dustbin with the affected hand



Figure 5: Patient with Left Hemiparesis (CIMT Group) lifting empty water bottle up and down and turning the magazine pages with pages folded at the corner with the affected hand

In CIMT, the subjects are encouraged to wear a mitt in the unaffected arm 10 hours/day for 4 weeks except for activities like eating, bathing and toileting.

4. Results

All the data collected were entered into Microsoft excel spreadsheet 2010. The data was then imported into SPSS version 23 for statistical analysis. Qualitative variables were expressed using proportion and percentages. Quantitative variables were expressed using mean and standard deviation. In order to find out the distribution of qualitative variables between the groups, Chi square test was applied and in order to compare the mean between the two groups, independent sample t test was applied.

Stroke patients meeting the selection criteria were selected by Randomised Control Trial of 14 patients in control group and 14 patients in experimental group with total of 28 subjects. Sample size was calculated by PASS-Power Analysis and Sample Size software version 11 is used.

Mean age in both groups and Comparison of weight and height were statistically similar in both the groups. Distribution of sex, place of residence, occupation, educational status, monthly income, handedness, diagnosis, type of stroke, interval between onset and medical care, duration of stroke, family history of stroke, TIA, LOC diabetes, hypertension, dyslipidemia, cardiac disease were statistically similar in both the groups. Consumption of tobacco and alcohol were statistically similar in both groups.

Table 1: Comparison of FMA pre intervention and post intervention score between conventional groups

FMA	Conventional		t value	df	p value
	MEAN	SD			
Pre Test Score	30.29	2.367	.151	26	0.881
Post Test Score	38	3.162			

Table 2: Comparison of FMA pre intervention and post intervention score between CIMT groups

FMA	CIMT		t value	df	p value
	MEAN	SD			
Pre Test Score	30.14	2.627	9.68	26	0.000
Post Test Score	51.29	4.046			

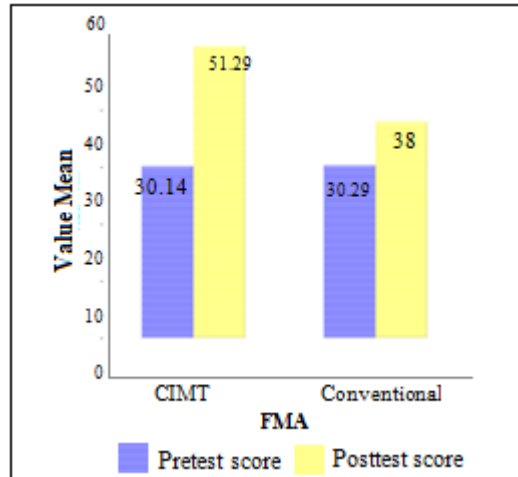


Figure 6: Comparison of FMA Pre Intervention and Post Intervention Score between CIMT and Conventional Groups

After 4 weeks of treatment, both groups were again assessed with Fugl Meyer Assessment (upper extremity score total 66). The pre-intervention score in conventional therapy was found to be 30.29 ± 2.369 and after 4 weeks post intervention score was 38 ± 3.162 . The FMA pre intervention score in CIMT group was 30.14 ± 2.627 and post intervention FMA score was 51.29 ± 4.046 of p value - 0.000 which is < 0.005 . The results are significant as there is significant improvement in FMA post test score as compared to FMA pre test score in CIMT group

5. Discussion

Stroke patients experience greater disability due to upper limb involvement and they tend to use the non affected limb for most of their ADL. Near time this produces movement suppression or learned non-use and they tend to use the non affected limb for most daily activities. This learned non-use can be overcome by CIMT. The m-CIMT protocol emphasizes intensive practice and use of functional tasks to train the affected arm. Intensive practice of the affected arm might provide sufficient proprioceptive and visual feedback to reinforce the movement ability of upper arm.

The study proves that rehabilitation with m-CIMT is safe and feasible as compared with original CIMT of restriction of unaffected arm for 90% of waking hours which is harder and of poor compliance by the patient [1]. Our study involved only 2 hours of therapy for 4 weeks which is very feasible and safe for the patient. No significant adverse effects and loss of motor function by restraint of unaffected arm were noted during the study.

There is also significant improvement in hand functions in CIMT group compared to conventional group. The results were significant in comparison with previous studies by **Priyanka Singh & Bijayeta Pradhan 2013 [1], Rajkumar Yadav et al 2016 [6], Nancy M. Bonifer et al 2005 [9]**.

6. Conclusion

Our study concludes CIMT is more effective in improving upper extremity motor power and ADL in comparison with conventional therapy in stroke patients.

7. Future Scope

The study recommends future studies on examining the benefits of CIMT on long term follow up of the study participants.

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