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To Compare the Efficacy of Modified Constraint Induced Movement Therapy and Task Specific Motor Imagery Technique in Improving Upper Limb Function in Hemiplegic Patients

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Abstract

Background and Objectives: Around 80% of Stroke survivors have motor impairments of the upper limbs that affect their ability to perform activities of daily living and their social participants. Most widely Interventions used for improving upper limb function are Modified constraint induced movement therapy and Task specific motor imagery technique. MCIMT intensively trains the affected limb by restraining the unaffected one, fostering neuroplasticity, while Task-Specific Motor Imagery activates neural circuits through mental rehearsal. There was sufficient evidence on efficacy of both Modified constraints induced movement therapy and Task specific motor imagery technique in improving upper limb function. But there were no comparative studies available between these two protocols and more studies should be done on establishing their effectiveness.

Methods: A Quasi Experimental study conducted at KIMS General Hospital, KIMS & RF, Amalapuram, 60 subjects were recruited based on convenient sampling, divided into 2 groups, 30 members in Group A (MCIMT) and 30 members in Group B (TSMIT). For Both the groups interventions were given 1 hour per day ,5 days per week, for 5 weeks. The outcome measure was ACTION RESEARCH ARM TEST (ARAT).

Result: Unpaired Paired T test was used to assess the statistical significance between pre and post test scores between groups. Statistical analysis of the data revealed that MCIMT exercise group has more statistical significance than the TSMIT exercise group.

Conclusion: Both Modified Constraint-Induced Movement Therapy (MCIMT) and Task-Specific Motor Imagery Therapy (TSMIT) effectively improve upper limb function in stroke survivors. However, MCIMT yielded significantly greater functional gains, surpassing the Minimal Clinically Important Difference, indicating not only statistical but also clinically meaningful improvements. These results suggest that MCIMT may be the more effective intervention for enhancing hand function in hemiparetic stroke patients.

Keywords: Hemiplegic stroke; MCIMT exercise; TSMIT exercise; Action Research Arm Test

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1. Introduction

Stroke is characterized as a neurological condition caused by an interruption in the blood flow to a specific area of the brain. It is considered a medical emergency that arises when this blood supply is either obstructed or leaks due to vessel damage, ultimately leading to injury of brain tissue[1]. There are two primary types of strokes: ischemic stroke, which results from a blockage in the brain's blood vessels, and hemorrhagic stroke, which is caused by bleeding due to the rupture of these vessels[2]. Common risk factors for stroke include high blood pressure, diabetes, cardiac conditions such as atrial fibrillation, smoking, alcohol intake, elevated cholesterol levels, drug abuse, obesity, and physical inactivity[3].

Worldwide, nearly 16.9 million people suffer a stroke for the first time each year. There are around 33 million stroke survivors and about 5.9 million deaths due to stroke annually[4]. In India, the prevalence of stroke ranges between 84 to 262 per 100,000 people in rural areas and 334 to 424 per 100,000 people in urban populations[5]. Stroke ranks as the second leading cause of death and a major contributor to adult disability[6]. A significant number of stroke survivors—around 80%—suffer from motor impairments, especially in the upper limbs, which limits their ability to carry out daily tasks and affects their social involvement[7]. One of the primary challenges in upper limb recovery post-stroke is a phenomenon known as learned non-use, where the affected limb is underutilized. Initially, individuals may avoid using the impaired arm due to weakness, paralysis, or sensory deficits. Over time, this avoidance can become habitual behavior, even when some functional ability is retained[8].

To counteract learned non-use, several rehabilitation strategies are employed, including electrical stimulation, passive movement therapy, task-specific motor imagery, constraint-induced movement therapy (CIMT), and newer technologies like robotic and app-based interventions[9]. Constraint-induced movement therapy is specifically aimed at reducing upper limb motor deficits and enhancing functional autonomy in individuals with neurological damage. A modified version of CIMT incorporates shorter periods of restraint and less intense training, making it more feasible for certain patients, particularly those with hemiparesis[10].

Task-specific motor imagery, which leverages the brain's mirror neuron system, has also shown promising results in upper limb rehabilitation. These neurons, combining sensory and motor functions, are thought to have a genetic basis and contribute to improved motor performance when used in targeted imagery tasks[11].

For assessing recovery and progress, the Action Research Arm Test (ARAT) is frequently used. It is a reliable, standardized tool that evaluates upper limb function in individuals with cortical damage and resulting hemiplegia, helping to measure specific improvements during stroke rehabilitation[12].

Multiple randomized controlled trials and systematic reviews consistently show that modified CIMT significantly improves upper limb motor function versus conventional rehabilitation in both acute and chronic stroke populations. Additionally, adding task-specific motor imagery to standard physical therapy enhances muscle strength and gait performance, supporting its use as an effective adjunctive technique. This experimental study aims to fill a gap in existing literature by directly evaluating the effectiveness of modified constraint induced movement therapy versus task specific motor imagery technique in improving upper limb function in Hemiplegic patients.

2. Methodology

- STUDY DESIGN: Quasi experimental design
- STUDY SETTING: Department of Physiotherapy, KIMS General Hospital, KIMS & RF, Amalapuram.
- ETHICAL CLEARANCE: Ethical clearance was taken from ethical committee of Kona Seema Institute of Medical Sciences & Research Foundation, Amalapuram.
- Source of data: Outpatient department and In-Patient Neurology, KIMS hospital, Amalapuram.
- STUDY POPULATION: subjects with sub-acute stroke
- STUDY DURATION: The study was conducted during the period between December 2023 to December 2024.
- TREATMENT DURATION: 1 hour/ day; 5 days / week; for 5 weeks
- SAMPLING TECHNIQUE: convenient sampling
- STUDY SAMPLE: A total of 64 subjects were initially recruited for the study. Of these, 2 subjects did not meet the inclusion criteria and 2 subjects were unwilling to participate, leaving 60 participants. These participants were allocated into two groups using convenient sampling. Group A (n = 30) received Modified Constraint-Induced Movement Therapy (MCIMT), while Group B (n = 30) received Task-Specific Motor Imagery Therapy (TSMIT).

2.1. Criteria for selection

2.1.1. Inclusive criteria

- Stroke onset between 3 and 12 months before enrolment for the study
- Age between 45 to 60 yrs
- Unilateral upper limb and hand hemiplegia (Brunnstromm stage<grade 4)
- Subjects capable of extension of at least 10º each at Metacarpophalangeal (MCP), Proximal Interphalangeal (PIP) and Distal Interphalangeal (DIP) joints and 20º at wrist joint.

2.1.2. Exclusive criteria

- Subjects with history of previous strokes, angina, uncontrolled hypertension.
- Significant visual or hearing impairment
- Subjects with hemi neglect, apraxia, and cognitive disorders.
- Subjects with global aphasia
- Subjects with orthopedic disorders prohibit the use of the hemiparetic arm.

2.2. Outcome measures

The outcome was Action Research Arm Test (ARAT)

2.3. Procedure

2.3.1. GROUP A (Modified constrained induced movement therapy)

Prior to the intervention, subjects in Group A were assessed using the Action Research Arm Test (ARAT), and the scores were recorded. Subsequently, the unaffected upper limb of each subject was restrained using a specially designed mitten to limit its use during therapy. Functional tasks included reaching forward or upward to move a cup, picking up coins, using a utensil to eat, combing hair, writing, and other functional movements similar to daily activities for 60mins for 5 days a week. To discourage the use of the less affected hand outside therapy sessions, participants in the modified CIMT group wore a restrictive mitten for a target of 4 hours per day, every day, for 6 weeks.

Figure 1 Chess pieces to move forward

Figure 2 Holding a paper cup and replace to original position

2.3.2. GROUP B (Task specific motor imagery technique)

Prior to the intervention, participants from Group B were instructed to complete the Action Research Arm Test, and their scores were recorded. The participants then underwent task-specific motor imagery exercises combined with mental practice along with physical practice, utilizing a videotape that contained five different tasks over the course of 60 minutes, five days every week for six weeks. Each participant was seated comfortably in front of a table that held the necessary materials for the tasks (a computer screen displaying the videotape, an empty paper cup without a handle, a book, a phone, and a pen). Both the affected and unaffected limbs were positioned on the table. Initially, the subjects were asked to watch the videotape demonstrating motor tasks and were then required to physically rehearse each task ten times using their unaffected hand. Subsequently, they performed mental practice of each motor task ten times, allowing five-minute intervals between each repetition. The participants were directed to signal the start and end of each task by saying "GO." Each session devoted to these motor tasks lasted for a total of 60 minutes. The tasks that were practiced included lifting the empty paper cup without a handle and bringing it to the mouth to make contact, returning the cup to its starting position, turning the pages of a book, reaching to the top of the head, picking up a phone, and holding a pen correctly for writing.

Figure 3 Doing activity by seeing video tape

Figure 4 Turning off the pages by seeing video tape

2.4. Conventional physiotherapy:

For both the groups (A and B):

Conventional physiotherapy includes:

- Passive stretching of biceps, supinator, wrist and finger flexors.
- Joint loading can be done in quadpod position for 5 minutes.
- Facilitation of wrist extension and radial deviation.
- Supination Training.
- Peg board activities.

2.4.1. Outcome measures

The outcome measure was ACTION RESEARCH ARM TEST

Figure 5 Action research arm test

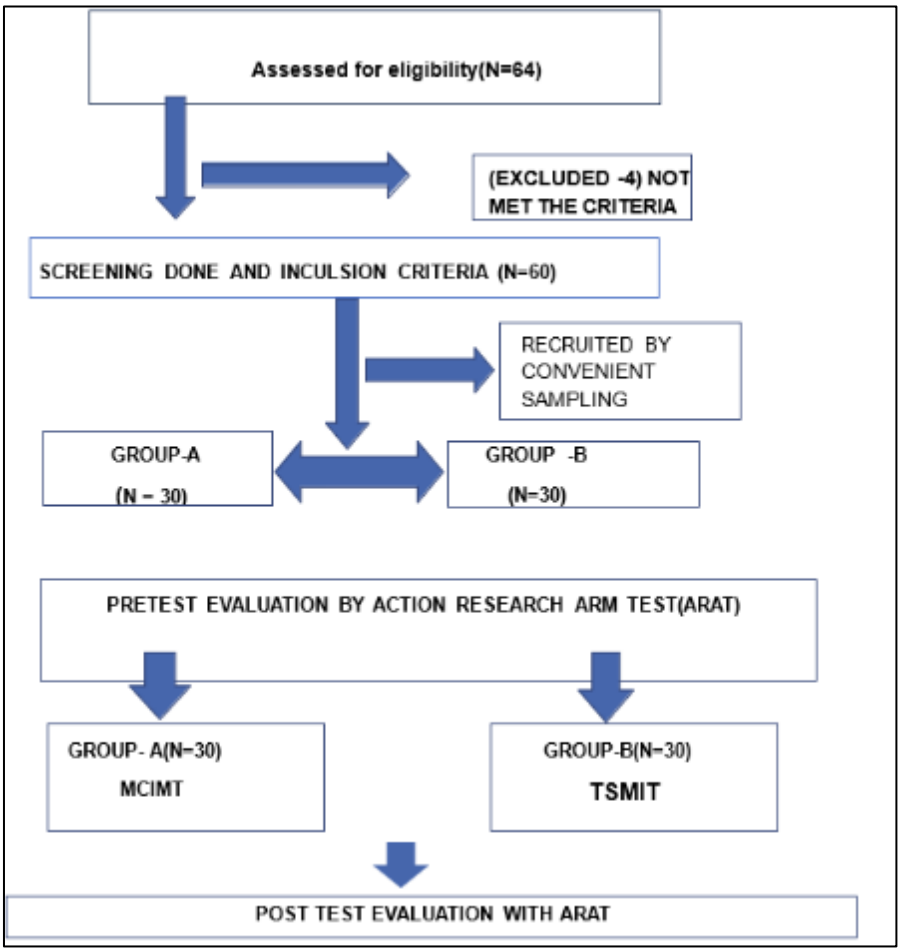

Figure 6 Consort Flow chart of sampling, selection and intervention

3. Statistical analysis and results

- Statistical analysis: T paired test Statistical analysis was performed by using SPSS software version 23.0 and Microsoft Excel- 2019 descriptive statistical data were presented in the form of mean +/- in standard deviation and mean differences percentages were calculated and presented.
- Between the groups: An Independent t-test was performed to analyze the statistically significant difference in mean value between the MCIMT and TSMIT.
- Within groups: A paired t-test was performed to assess statistical differences within the groups for MCIMT and TSMIT.

All 60 subjects completed the entire study program as defined by 5 weeks on an outpatient basis. The outcome measure was ACTION RESEARCH ARM TEST(ARAT)

Table 1 Means of group a (MCIMT) on ARAT scale

Groups	Tests	Mean	Standard deviation	T value	P value
MCIMT	Pre test	24.833	3.0971	-16.273	0.000
	Post test	30.800	3.6709		

The above table inference is that there was a significant difference between pre-test and post-test that is $p<0.05$.

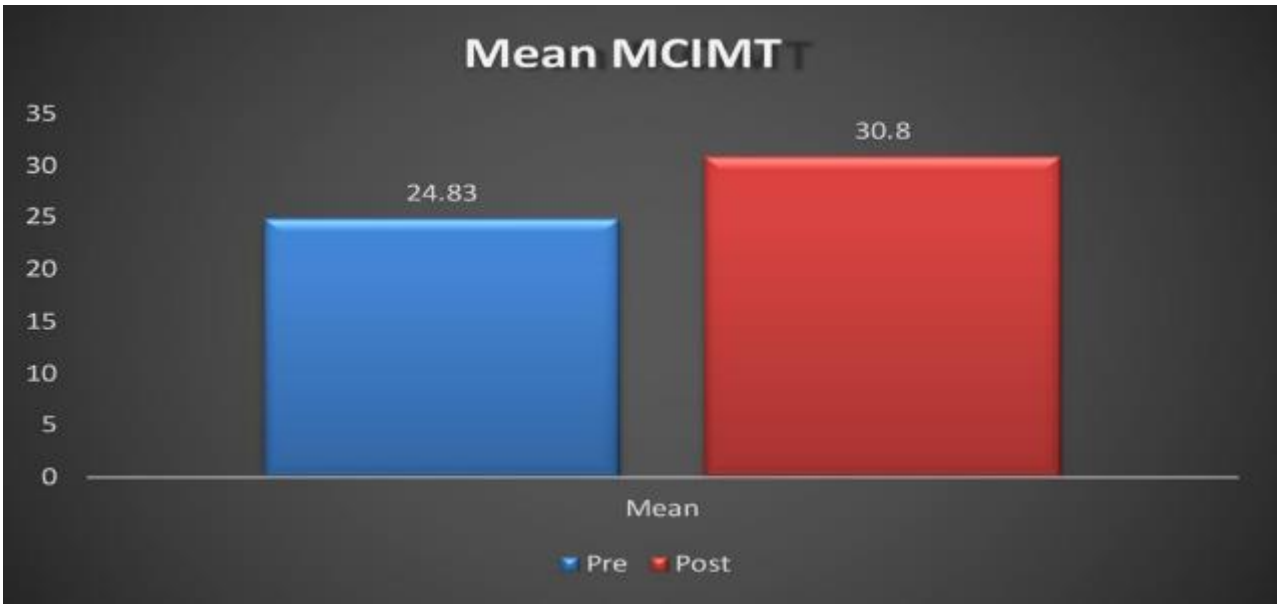

Figure 7 Comparison of pretest and post-test values of ARAT in group A.

Table 2 Means of group B (TSMIT) on ARAT scale

Groups	Tests	Mean	Standard deviation	T value	P value
TSMIT	Pre test	24.400	3.5873	-10.865	0.000
	Post test	26.667	3.8715		

The above table infers that there was a significant difference between pre-test and post- test that is $p<0.05$.

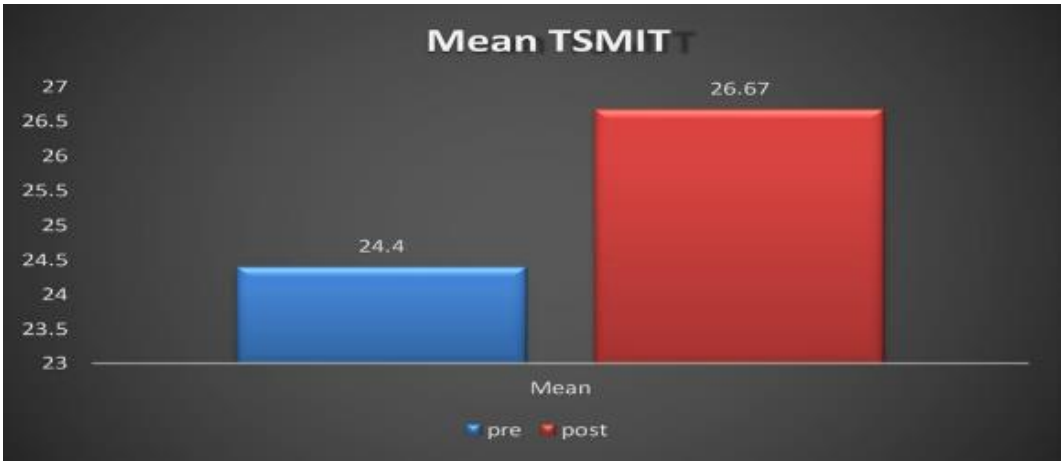

Figure 8 Comparison of pretest and post-test values of ARAT in group B.

Table 3 Difference in means of group A and group B

Group	Mean	Standard deviation	T value	P value
MCIMT	30.800	3.6709	4.243	0.000
TSMIT	26.667	3.8715		

The above shows significant difference between the means of Group A and B with a significant p value < 0.05.

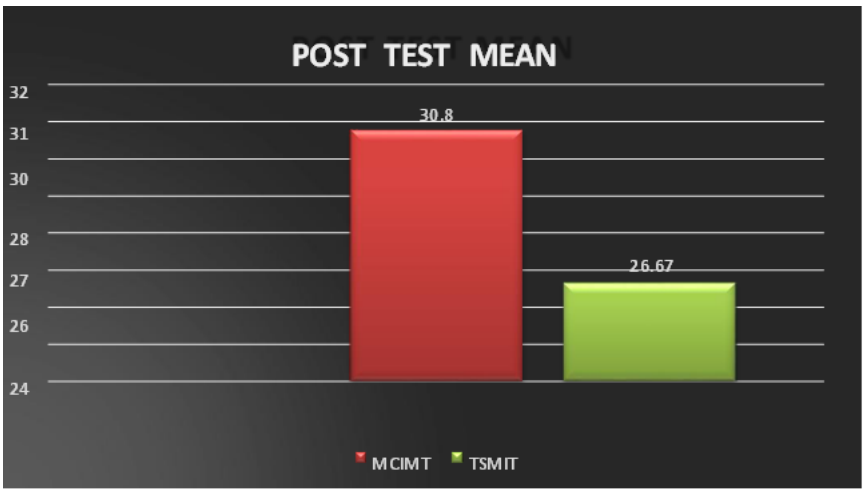

Figure 9 Comparison of the difference in the improvement of ARAT between the Groups

4. Discussion

Stroke, the leading cause of hemiplegia, often results in impaired movement and coordination of the arm, hand, and fingers. This significantly impacts daily activities, from self-care and dressing to work and leisure. Understanding the complexities of upper limb function and developing effective rehabilitation strategies are crucial for improving quality of life in this population. Therapeutic interventions like Modified Constraint-Induced Movement Therapy (MCIMT) and Task-Specific Motor Imagery Therapy (TSMIT) aim to address these challenges. Emphasizing intensive use of the affected limb, these approaches demonstrate superior efficacy in promoting neuroplastic changes and sustained motor improvements 13

Several studies have examined these therapies individually in improving hand function among stroke survivors. However, there is limited comparative evidence evaluating both protocols side by side, which this study aimed to address 14

A total of 64 subjects were initially recruited, of which 60 met the inclusion criteria and completed the intervention. The Action Research Arm Test (ARAT) was used to assess upper limb function. Statistically significant improvements ($p = 0.000$) were observed in both MCIMT and TSMIT groups in pre- and post-intervention scores.

MCIMT promotes upper-limb recovery by inducing neuroplasticity through forced use of the affected limb, thereby disrupting the maladaptive learned non-use pattern 15. This forced-use paradigm leads to synaptic reorganization in the motor cortex and subcortical regions, enhancing cortical excitability and improving voluntary motor control 16

Repetitive task-specific practice further strengthens neural pathways and contributes to functional restoration 17.A study by Al-Khateeb et al. (2017) demonstrated that MCIMT significantly improved hand function in patients with chronic stroke 18

Similarly, di Oliveira et al. (2016) confirmed its superiority over conventional therapy in facilitating hand motor recovery 19

TSMIT, on the other hand, relies on motor imagery and cognitive engagement to activate the motor system via the mirror neuron network. This approach enhances neural representation and motor learning through observation and mental rehearsal it also supports cortical reorganization by reinforcing movement-related circuits without requiring physical exertion 20

Liu et al. (2022) found TSMIT effective in enhancing upper limb motor control through neuroplastic changes 21. In addition, Kumar et al. (2019) reported that structured motor imagery significantly improved upper limb function in sub-acute stroke patients.

The current study reveals that while both interventions—Modified Constraint-Induced Movement Therapy (MCIMT) and Task-Specific Motor Imagery Therapy (TSMIT)—demonstrated improvements in upper limb function, subjects who received MCIMT exhibited significantly greater functional gains, as evidenced by higher post-test ARAT scores. The mean improvement in ARAT scores for the MCIMT group exceeded the Minimal Clinically Important Difference (MCID) of 5.7 points, indicating that the observed change was not only statistically significant but also clinically meaningful. These findings support the Alternate Hypothesis that MCIMT leads to superior recovery of hand function in hemiparetic stroke patients compared to TSMIT.

5. Conclusion

The study concluded that both Modified constraints induced Movement Therapy and Task specific motor imagery therapy are effective in improving the hand function among Hemiparetic Stroke patients. When compared to task specific motor imagery therapy, Modified Constraint induced movement therapy is proved to be better in improving hand function for hemiplegic stroke patients.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest

Statement of ethical approval

Ethical approval was taken for this study from the institutional ethical board of Kona Seema Institute of Medical Sciences & Research Foundation, Amalapuram.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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