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Research Article

A Comparative Study on the Effectiveness of Mirror Therapy (Mt) and Constraint-Induced Movement Therapy (Cimt) for Improving Hand Function and Recovery in Acute Stroke Patients

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A B S T R A C T

Introduction: A stroke may be caused by a disruption in the blood flow to the brain. The brain cells run out of oxygen when there is an interruption in blood flow, and they start to die. MT and CIMT are both non-invasive interventions that improve function and recovery in stroke. The purpose of this study was to evaluate the speed of recovery and compare the efficacy of CIMT and MT in hand rehabilitation for stroke patients who had acute disability.

Aim: To compare the effectiveness of mirror therapy and constraint-induced movement therapy for hand improvement and recovery in acute stroke patients.

Methods: 50 subjects were selected and allocated into two groups using a simple random sampling method. 25 subjects were allocated to group A (CIMT group) where they underwent CIMT protocol and 25 subjects were recruited to group B (MT group) where they underwent MT for 3 weeks, 4 sessions per week. Subjects were assessed at the start of treatment and reassessed after 3 weeks to find the persisting effects of the same.

Results: Data was analysed using a t-test for both groups, both protocols used in the study were effective, but group A (CIMT) showed a greater effect than group B (MT).

Conclusion: The study's findings demonstrate that both CIMT and MT significantly improve the gross and fine motor skills of patients with acute stroke in their upper extremities during treatment, giving better results than conventional therapy alone. The CIMT group showed better results than the MT group.

Keywords: Stroke, hand rehabilitation, constraint-induced movement therapy, mirror therapy, intervention

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Introduction

A stroke is a medical condition that involves a sudden, severe impairment of neurological function due to vascular injury (ischaemia, haemorrhage) affecting the brain or spinal cord. In low- and middle-income nations, it is a leading cause of both mortality and morbidity. Stroke is a heterogeneous disorder that has various aetiologies, risk factors, and pathophysiological mechanisms.[1] The global stroke initiative is a collaborative effort involving international organisations like the World Health Organisation (WHO), the International Stroke Society (ISS), and the World Federation of Neurology (WFN). They work together to address stroke-related challenges. Main Goal: The primary focus of this initiative is to pool resources and implement existing knowledge and strategies. They seek to enhance stroke management and prevention, particularly in middle- and low-income nations where the prevalence of stroke is high. Threefold purpose: Raise awareness (the initiative aims to increase awareness about stroke, its risks, and how to prevent it). Better data (they want to generate accurate surveillance data on stroke cases globally). Improved strategies (using this data, they plan to develop better strategies for preventing and managing strokes.[2]

Numerous risk factors, disease processes, and mechanisms can contribute to stroke, which is not a single disease. Most strokes (about 85%) are ischaemic, which means they happen when a blood vessel in the brain gets blocked. Another cause of ischaemic stroke is small vessel arteriolosclerosis i.e. narrowing of small blood vessels due to the thickening of their walls. Cardioembolism, i.e. blood clots from the heart travel to the brain and block blood flow. Large Artery Atherothromboembolism, i.e. blockage in large brain arteries due to atherosclerosis (plaque buildup). Haemorrhagic stroke is when about 15% of strokes worldwide are intracerebral haemorrhages, where a blood vessel in the brain leaks or ruptures. There are two types of strokes – ischaemic stroke and haemorrhagic stroke.[3] Stroke is currently the second leading cause of death in India. Approximately 185,000 strokes occur every year, which means nearly one stroke every 40 seconds. Shockingly, there's one stroke-related death every 4 minutes. Stroke in India varies between 105 and 152 cases per 100,000 people annually. This means that a significant number of individuals experience stroke-related health issues each year.[4]

The mirror Therapy Program was invented by Vilayanur S. Ramachandran. This therapy uses mirrors to treat phantom limb pain experienced by people who've had amputations. The idea is to help the brain "relax" the phantom limb by creating an illusion that it's moving. Ramachandran introduced this method in 1996. In order to give the appearance of function in the missing area, patients utilise a mirror to see the reflection of their unaffected side. For example, if someone lost their left arm, they'd see their right arm's reflection in the mirror. This visual feedback helps reduce phantom pain and improve motor control. Mirror therapy (MT) is a treatment used for various neurological disorders, including stroke. To trick the brain into thinking that the damaged limb is moving as though it were the unaffected limb, a mirror is used to give visual input.[5]

Constraint Induced Movement Therapy is a neurorehabilitation technique that was developed by Dr Edward Taub and is designed to help improve motor functions in the upper extremity after stroke. This approach constrains the unaffected arm and forces the patient to use the affected arm by making them wear a mitt on the unaffected arm. Currently, the patient spends roughly six to seven hours a day performing repetitive exercises with the injured arm while wearing a mitt on the unaffected arm for 90% of the patient's waking hours. Modified forms of the technique (mCIMT) have been developed over the years that focus on repetitive, task-specific training of the affected arm.[6] Several studies have shown that both CIMT and MT interventions are beneficial for improving the gross as well as the fine motor functions of the upper limb in patients with mild to moderate impairments from stroke.[6-10] To determine how quickly patients recover from a stroke and to compare the efficacy of CIMT and MT in hand rehabilitation, this study was carried out.

Objectives

1. To investigate how individuals with acute stroke who have hand impairments can improve their hand function using constraint-induced movement therapy.
2. To study the effect of mirror therapy in improving hand function for patients with hand impairments in acute stroke
3. To compare the efficacy of CIMT and MT on hand rehabilitation in patients with acute stroke.

Hypothesis

- **Null hypothesis:** There will not be a significant improvement in both the CIMT and MT groups for hand rehabilitation in acute stroke.
- **Alternate hypothesis:** There will be a significant improvement in either the CIMT or MT group for hand rehabilitation in acute stroke.

Methodology

The University's Research & Ethics Committee accepted the current study, which was a comparative experimental study, and participants gave their informed consent prior to the study. The total study duration was 6 months, from January 2024 to June 2024. The study involved a total number of 50 patients who were included after fulfilling the inclusion criteria. The samples were collected from various hospitals after obtaining permission and consent.

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Inclusion Criteria

Individuals with a stroke-related diagnosis of hemiplegia, who have a mini-mental state examination (MMSE) score of greater than 24 and are capable of at least basic communication, active wrist extension of >10 degrees, and thumb abduction of >10 degrees on the affected arm, both genders, aged between 45 to 65 years, patients with adequate cardiopulmonary function, and patients who are open to participating in the research.

Exclusion Criteria

Patients who were unable to cooperate, with upper limb and neck musculoskeletal problems, recent surgeries on the affected limb, any hearing and visual difficulties, and who are unable to sit unsupervised.

Outcome measures

Chedoke Arm and Hand Activity Inventory-9 (CAHAI-9)

The Chedoke Arm and Hand Activity Inventory-9 was used to assess the upper limb's capacity to perform functional tasks. Pre-interventional values were measured on nine distinct tasks (opening a jar, making a phone call, using a ruler to draw a line, pouring water, wringing out a washcloth, pressing up to five buttons, applying toothpaste to a toothbrush, using a towel to dry off and slicing medium consistency putty with a knife). It has scored from 1 (total assistance) to 7 (complete independence) for all 9 tasks, resulting in a total score of 63.[11]

Fugl-Meyer Assessment-Upper Extremity (FMA-UE)

The FMA-UE is a tool used to assess how well the body functions or has deficiencies. 33 elements in the upper limb are scored using an ordinal scale, for a possible total score of 66.[12]

Materials used

- **CAHAI 9:** Closed jar, ruler and pencil, towel, toothpaste and toothbrush, medium consistency putty, washcloth, and a glass of water.
- **FMA-UE:** A scrap of paper, a ball, acotton ball, a pencil, a reflex hammer, a small can or jar, a goniometer, a stopwatch, a blindfold, a chair, and a bedside table.

Study Settings

Two groups (group A and group B) were formed from patients who met the inclusion requirements. The consent forms were signed by the eligible patients, and the baseline measurements were performed. The procedure was explained to the participants and subjected to clinical examination. The patients in group A were given a treatment protocol consisting of activity-based exercises using CIMT and group B received MT techniques. In addition to their experimental interventions, both groups got conventional medical care.

Protocols

- **Group A:** In this group, the participants were required to keep the less affected arm in constraint for 40 minutes/day, every day for 3 weeks. They focused on repetitive functional tasks such as pouring a glass of water, combing hair, reaching forward, picking up coins or similar objects, etc. They further received conventional therapy for 20 minutes each session for 4 days a week.
- **Group B:** In this group, MT intervention was performed for 40 mins per day for 4 days/week, for 3 weeks in total. The patient followed verbal instructions to execute basic movements during mirror treatment, including pronation/supination of the forearm and flexion/extension of the shoulder, elbow, wrist, and finger. They also received conventional therapy for 20 minutes per therapy session.

Statistical Analysis

The statistical analysis for this study was aided by the use of the Statistical Package for the Social Sciences (SPSS) version 27. Once the normal distribution of each group was confirmed, all quantitative variables between the two groups were counted using a paired sample t-test. An independent sample t-test was used to evaluate the difference between the two groups' outcome measure scores.

Results

The results were taken before giving the interventions and after 3 weeks of interventions. It was calculated for both the scales which were used in the study.

CAHAI-9: The difference between the pre- and post-test between the groups was significant after getting CIMT treatment (Table 1). The difference between the pre-and post-test values after getting MT interventions, which are also significant, is shown in Table 2. Both the groups have shown improvements post-test in functional activity of the upper limb, but group A has more improvements as compared to group B (Table 5).

Since, the p-value is very small, i.e., (< 0.01) in both the groups. Hence, it may be concluded that both CIMT and MT improve hand function for patients with hand impairments in acute stroke under CAHAI-9.

FMA – UE: A significant difference was observed between pre-test and post-test FMA-UE scores seen after applying CIMT (Table 3). In the case of the MT group also, we saw significant differences in values (Table 4). According to the data, we can conclude that the changes in FMA-UE scores after the post-test are higher in Group A (CIMT) as compared to Group B (MT), as shown in Table 6.

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Table 1.T-Test showing CAHAI-9 pre- and post-test values after applying CIMT in Group A

CIMT (Group A)		Mean	SD	t-stat	p-value
CAHAI-9	Pre-test	23.16	3.7603	-11.1942884	2.59765E-11 (which is very small i.e. <0.01) *
	Post-test	31.48	5.2051		

Table 2.T-Test showing CAHAI-9 pre- and post-test values after applying MT in Group B

MT (Group B)		Mean	SD	t-stat	p-value
CAHAI-9	Pre-test	22.76	3.3575	-19.20227259	2.25079E-16 (which is very small i.e. <0.01) *
	Post-test	27.96	3.7358		

*p<0.05 indicates significant

Table 3.T-Test showing FMA-UE pre- and post-test values after applying CIMT in Group A

CIMT (Group A)		Mean	SD	t-stat	p-value
FMA-UE	Pre-test	23.28	4.0877	-9.50901	6.51E-10 (which is very small i.e. <0.01) *
	Post-test	31.64	4.1319		

Table 4.T-Test showing FMA-UE pre- and post-test values after applying MT in Group B

MT (Group B)		Mean	SD	t-stat	p-value
FMA-UE	Pre-test	22.24	2.8907	-21.8174	1.23E-17 (which is very small i.e. <0.01) *
	Post-test	27	2.8867		

*p<0.05 indicates significant

Because the p-value in both groups is extremely low, that is, less than 0.01. Therefore, it can be said that under FMA-UE, patients with hand impairments following an acute stroke benefit from both CIMT and MT in terms of hand function.

Comparison between Group A and Group B

For CAHAI-9

Table 5.t-Test Two-Sample Assuming Equal Variance

Variables	CIMT (Group A)	MT (Group B)
Mean	-8	-5
Variance	15.92	2.8
Observations	25	25
Pooled Variance	9.36	-
t Stat	-3.53553	-
P(T<=t) one-tail	0.000444	-
t Critical one-tail	1.675905	-
P(T<=t) two-tail	0.000888	-
t Critical two-tail	2.008559	-

Based on the statistics shown here, we may conclude that the CAHAI-9 pre- and post-values differ significantly. Subsequent analysis shows that the CIMT outperformed the MT group.

For FMA-UE

Table 6.t-Test: Two-Sample Assuming Equal Variances

Variables	CIMT (Group A)	MT (Group B)
Mean	-8.36	-4.76
Variance	19.32333	1.19
Observations	25	25
Pooled Variance	10.25667	-
t Stat	-3.97424	-
P(T<=t) one-tail	0.000118	-
t Critical one-tail	1.677224	-
P(T<=t) two-tail	0.000236	-
t Critical two-tail	2.010635	-

We can infer from the aforementioned statistics that the pre- and post-values for FMA-UE change significantly. Upon further analysis, it is shown that the CIMT has a better result compared to the MT group.

Discussion

Following stroke, both CIMT and MT have been provided beneficial in the overall improvement of hand function

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with the type of stroke and the degree of severity taken into consideration. There are fewer published articles on the benefits of either of the interventions in the case of chronic stroke situations. The efficacy of the treatment methods hasn't been established well in such conditions. The RCT by Iuly Treger et al. found the early application of modified CIMT to prevent learnt non-use, citing the period to be the best for patients to respond to motor learning and that patients suffering from mild to moderate impairment improved functional use of the impaired limb substantially, which continued over 2 years, indicating that this intervention may have long-lasting benefits.[7] An RCT by Hamza Y. Madhoun et al. showed a significant difference between the task-based MT group's FMA scores and those of the control group, indicating that motor function and activities of daily living were effectively improved. They also reported slight improvements in the recovery of spasticity.[9] In a study comparing the effectiveness of mCIMT and traditional therapy on the functional recovery of the upper limb in patients who had suffered an acute stroke, Fathalla M. et al. found that CIMT produced better outcomes in terms of functional use and motor evoked potential, indicating that the damaged hemisphere was more engaged.[11] Gyrd Tharne et al. in their RCT demonstrated a short-term effect on motor function and dexterity in patients with subacute stroke by the application of CIMT but found that it didn't affect long-term motor function (i.e. after 6 months). They observed significantly better Wolf Motor Function Test results in the CIMT group (n=24) which led them to believe that CIMT might facilitate faster recovery as compared to conventional treatment.[14] Dong Wong et al. conducted a review of constraint-induced movement therapy (CIMT) in stroke rehabilitation in 2022. CIMT stimulates the injured limb to be used more and limits the usage of the healthy limb to improve motor function. It has proven to provide significant advantages for upper limb use, including functional ability, limb utilisation, and movement quality. Moreover, CIMT may improve gait, balance, and lower limb function. However, there are disadvantages and alternative tactics to consider. All things considered, CIMT is a successful therapy for stroke recovery; however, more research is needed to fully understand its long-term consequences and enhance its use.[15] Kamal Narayan Arya et al. (2016) concluded that mirror therapy (MT) has a strong neurological foundation for helping stroke patients regain their motor function. This simple, low-cost technique stimulates the brain non-invasively while promoting beneficial neuroplasticity and motor recovery. The therapy activates the ipsilateral brain in addition to the brain regions linked to the moving hand through the mirror illusion of movement. MT can heal damaged brain tissue by restoring equilibrium to both hemispheres of activity. Overall, MT has potential as an effective technique for motor rehabilitation in stroke patients thanks to its strong neurological foundation. as well as the ability to stimulate the brain without surgery.[16] More individualised therapy regimens based on patient variables, such as the severity of the stroke, particular motor impairments, and brain imaging data, may be one of the future uses of CIMT. Virtual reality (VR) and augmented reality (AR) can be combined with CIMT to create immersive environments that motivate patients to engage in therapeutic activities. Exercises that are repeated, customisable, and more engaging could be provided by VR-based CIMT. To improve results, CIMT may be used in conjunction with other rehabilitation strategies, including brain-computer interfaces (BCI), functional electrical stimulation (FES), or robotic-assisted therapy. These combos might aid in getting over CIMT's drawbacks and enhancing recovery in more serious situations.

By fostering more engaging and immersive situations where patients receive improved visual feedback, virtual reality, and augmented reality have the potential to greatly improve mirror therapy. Patients might wear virtual reality (VR) headsets in place of a physical mirror, enabling more dynamic and individually tailored mirror therapy sessions Future research could focus on combining MT with non-invasive brain stimulation techniques such as transcranial magnetic stimulation (TMS) or transcranial direct current stimulation (tDCS). By activating brain regions linked to motor function, these technologies can amplify the effects of MT by encouraging a quicker recovery and more robust neuroplastic alterations. Research on MT's efficacy may lead to the development of scalable, affordable versions of the therapy for application in resource-constrained environments. To optimise stroke recovery outcomes, CIMT and MT are both effective rehabilitation techniques that are frequently combined with other therapies.

Limitations

The validity and generalisability of the findings may be impacted by the small sample size of 50 used in this investigation. The effect of ageing has not been taken into account, and no follow-up was done after treatment was finished.

Scope for Further Research

Further studies with larger sample sizes are recommended, along with longer intervention periods, and proper follow-up at longer periods should be done.

Conclusion

The study found that while both mirror therapy and constraint-induced movement therapy are useful for enhancing hand function in acute stroke patients, CIMT outperforms MT in terms of ADLs and overall recovery. Combining the interventions with traditional therapy is more beneficial than traditional therapy alone.

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References

1. Murphy SJ, Werring DJ. Stroke: causes and clinical features. Medicine. 2020 Sep 1;48(9):561-6. [Google Scholar] [Pubmed]
2 Bonita R, Mendis S, Truelsen T, Bogousslavsky J, Toole J, Yatsu F. The global stroke initiative. The Lancet Neurology. 2004 Jul 1;3(7):391-3. [GoogleScholar] [Pubmed]
3 Murphy SJ, Werring DJ. Stroke: causes and clinical features. Medicine. 2020 Sep 1;48(9):561-6. [Google Scholar] [Pubmed]
4 Jones SP, Baqai K, Clegg A, Georgiou R, Harris C, Holland EJ, Kalkonde Y, Lightbody CE, Maulik PK, Srivastava PM, Pandian JD. Stroke in India: A systematic review of the incidence, prevalence, and case fatality. International Journal of Stroke. 2022 Feb;17(2):132-40. [Google Scholar] [Pubmed]
5 Yeldan I, Huseyınsınoglu BE, Akıncı B, Tarakcı E, Baybas S, Ozdıncler AR. The effects of very early mirror therapy on functional improvement of the upper extremity in acute stroke patients. Journal of physical therapy science. 2015;27(11):3519-24. [Google Scholar] [Pubmed]
6 Corbetta D, Sirtori V, Castellini G, Moja L, Gatti R. Constraint-induced movement therapy for upper extremities in people with stroke. Cochrane Database of Systematic Reviews. 2015(10). [Google Scholar] [Pubmed]
7 Treger I, Aidinof L, Lehrer H, Kalichman L. Modified constraint-induced movement therapy improved upper limb function in subacute poststroke patients: a small-scale clinical trial. Topics in stroke rehabilitation. 2012 Jul 1;19(4):287-93. [Google Scholar] [Pubmed]
8 Chinnavan E, Ragupathy R, Wah YC. Effectiveness of mirror therapy on upper limb motor functions among hemiplegic patients. Bangladesh Journal of Medical Science. 2020 Jan 16;19(2):208-13. [Google Scholar]
9 Madhoun HY, Tan B, Feng Y, Zhou Y, Zhou C, Yu L. Task-based mirror therapy enhances the upper limb motor function in subacute stroke patients: a randomized control trial. European journal of physical and rehabilitation medicine. 2020 Mar 25;56(3):265-71. [Google Scholar] [Pubmed]
10 Yoon JA, Koo BI, Shin MJ, Shin YB, Ko HY, Shin YI. Effect of constraint-induced movement therapy and mirror therapy for patients with subacute stroke. Annals of rehabilitation medicine. 2014 Aug 28;38(4):458-66. [Google Scholar] [Pubmed]
11 El-Helow MR, Zamzam ML, Fathalla MM, El-Badawy MA, El Nahhas N, El-Nabil LM, Awad MR, Von Wild K. Efficacy of modified constraint-induced movement therapy in acute stroke. Eur J Phys Rehabil Med. 2015 Aug 1;51(4):371-9.[Google Scholar] [Pubmed]
12 Jane Rowland T, Turpin M, Gustafsson L, David Henderson R, James Read S. Chedoke Arm and Hand Activity Inventory-9 (CAHAI-9): perceived clinical utility within 14 days of stroke. Topics in stroke rehabilitation. 2011 Jul 1;18(4):382-93. [Google Scholar] [Pubmed]
13 Hernandez ED, Galeano CP, Barbosa NE, Forero SM, Nordin Å, Sunnerhagen KS, Murphy MA. Intra-and inter-rater reliability of Fugl-Meyer assessment of upper extremity in stroke. Journal of rehabilitation medicine. 2019 Aug 28;51(9):652-9. [Google Scholar] [Pubmed]
14 Thrane G, Askim T, Stock R, Indredavik B, Gjone R, Erichsen A, Anke A. Efficacy of constraint-induced movement therapy in early stroke rehabilitation: a randomized controlled multisite trial. Neurorehabilitation and neural repair. 2015 Jul;29(6):517-25. [Google Scholar] [Pubmed]
15 Wang D, Xiang J, He Y, Yuan M, Dong L, Ye Z, Mao W. The mechanism and clinical application of constraint-induced movement therapy in stroke rehabilitation. Frontiers in Behavioral Neuroscience. 2022 Jun 21;16:828599. [Google Scholar] [Pubmed]
16 Arya KN. Underlying neural mechanisms of mirror therapy: Implications for motor rehabilitation in stroke. Neurology India. 2016 Jan 1;64(1):38-44. [Google Scholar] [Pubmed]

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