



EFFICACY OF CONSTRAINT-INDUCED MOVEMENT THERAPY IN IMPROVING THE LOWER LIMB FUNCTIONS OF CHRONIC STROKE PATIENTS

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ABSTRACT

Background: A stroke can profoundly affect the functionality of the lower limbs. It can significantly impact an individual's walking ability and balance maintenance. This is often due to a stroke disrupting the brain's control over muscle movements. No existing studies have concentrated on using CIMT to enhance lower limb functions. However, CIMT has demonstrated success in improving the lower limb functions of chronic stroke patients.

Aim: The research objective is to analyze the effect of CIMT on enhancing the lower limb functions of chronic stroke patients.

Methods: A comprehensive research on Pubmed, Medline, Google Scholar, and Science Direct databases by employing keywords stroke, interventions used in stroke, lower limb functions, and physiotherapy evidence-based database was utilized for quality assessment.

Results: This review incorporated 13 studies, proving that constraint-induced movement therapy can enhance lower limb functions in patients suffering from chronic stroke.

Conclusion: This review's findings offer ample proof that constraint-induced movement therapy can enhance the functionality of lower limbs in patients recovering from a chronic stroke.

KEYWORDS: constraint-induced movement therapy, stroke, evidence-based practice, lower limb functions, evidence-based physiotherapy.

INTRODUCTION

A stroke is typically defined as a neurological impairment caused by an acute, localized injury to the central nervous system. This injury can be due to a vascular event such as a cerebral infarction, or intracerebral Hemorrhage is a medical term that refers to excessive bleeding, either internally or externally. (ICH), or subarachnoid Hemorrhage is a medical term that refers to excessive bleeding, either internally or externally. (SAH). It stands as one of the foremost reasons for disability and mortality on a global scale.⁽¹⁾ Stroke is a significant and escalating global health issue. It is the main reason for physical disability acquired in adulthood worldwide, and it ranks second as a cause of death in middle-to high-income nations. In these countries, the total incidence of ischemic and hemorrhagic stroke has increased over the past decade to 85–94 per 100,000, but it is substantially higher (1151–1216 per 100,000) in individuals aged over 75 years. Furthermore, low-income countries account for 85% of all stroke-related deaths, and Approximately 87% of the disability-adjusted life years experienced can be attributed to stroke-related issues.⁽²⁾

Considering the recent data revealing that approximately 0.84 out of every 1,000 people face a high risk of stroke, this alarming trend may lead to complications like hemiplegia and hemiparesis. Post-stroke weakness can substantially hinder daily routines and considerably diminish the affected individual's overall well-being.⁽³⁾

Stroke often leads to a variety of pathological symptoms that result in functional disorders, including disturbances in gait. Consequently, a primary objective of rehabilitation is to restore optimal gait. The abnormal gait observed in stroke patients is influenced by several factors such as asymmetrical stride time and length, reduced speed, poor control of joints and posture, muscle weakness and atypical muscle tone, and irregular muscle activation patterns. Muscle weakness, a prevalent issue after a stroke, often plays a substantial role in causing irregular walking patterns among patients. The power of one's lower limbs is significantly connected to their capacity to walk effectively. Therefore, the goal of stroke rehabilitation is to enhance muscle strength, which in turn improves the patient's walking ability.⁽⁴⁾



Constraint-Induced Movement Therapy (CIMT), is a successful method to boost upper limb functionality after a stroke or related conditions. This has resulted in the emergence of LE-CIMT, an enhanced version of the therapy. This therapeutic approach focuses on enhancing the functions of the lower limbs. CIMT and its modified version (mCIMT) are interventions designed for motor disabilities, involving restricted movement in the healthy limb, intensive practice, and behavioral shaping to increase the usage of the affected limb in daily activities. These therapies combat the "learned disuse" phenomenon following a stroke, aiming to enhance the functional use of the impacted upper limb. Research by Ro et al. (2006) demonstrates the beneficial effects of Constraint-Induced Movement Therapy on upper limb motor function and associated neural networks following a stroke. In recent years, mCIMT has been applied to the affected lower limb to counter "learned misuse" and enhance motor function quality.⁽⁵⁾

Constraint-Induced Movement Therapy (CIMT) was initially developed by Edward Taub and his research team, as referenced in their pivotal 1994 study. The main goal of this therapeutic intervention was to counteract the concept of 'learned non-use.' CIMT consists of four essential components: (1) providing daily, intensive therapeutic exercises over a continuous period, (2) employing a 'shaping' technique to offer function-focused, supervised exercises for the involved limb, (3) using Behavioral strategies, also called as a 'transfer package,' to help patients apply the learned skills in their daily activities, and (4) implementing techniques to encourage the use of the impaired limb, such as restraining the non-affected limb during upper extremity CIMT. The works of Morris, Taub, and Mark (2006), and Taub and other researchers in 2006 and 2013, Additionally, it has enhanced our comprehension and fostered the progress of this intervention method.⁽⁶⁾

METHODOLOGY

Study Design

Search Methods and Eligibility Criteria

To gather relevant articles, the search was conducted across Numerous databases, such as PubMed and Google Scholar, which have been used for this purpose., Medline, and Pedro, Based on available studies There is an improvement in lower limb functioning by constraint-induced movement therapy. Keywords used are stroke, lower limb rehabilitation, and constraint-induced movement therapy. Only the studies that focused on enhancing lower limb functionality through constraint-induced movement therapy were included in this research. Any articles not published in English were omitted from the study.

Sample Size

A sample size of 33 articles was searched with the keywords of stroke, lower limb rehabilitation, and constrained-induced movement therapy. Through the application of specific criteria, numerous articles were meticulously screened and narrowed down. Ultimately, 13 articles were selected and thoroughly reviewed for further analysis.

Inclusion Criteria

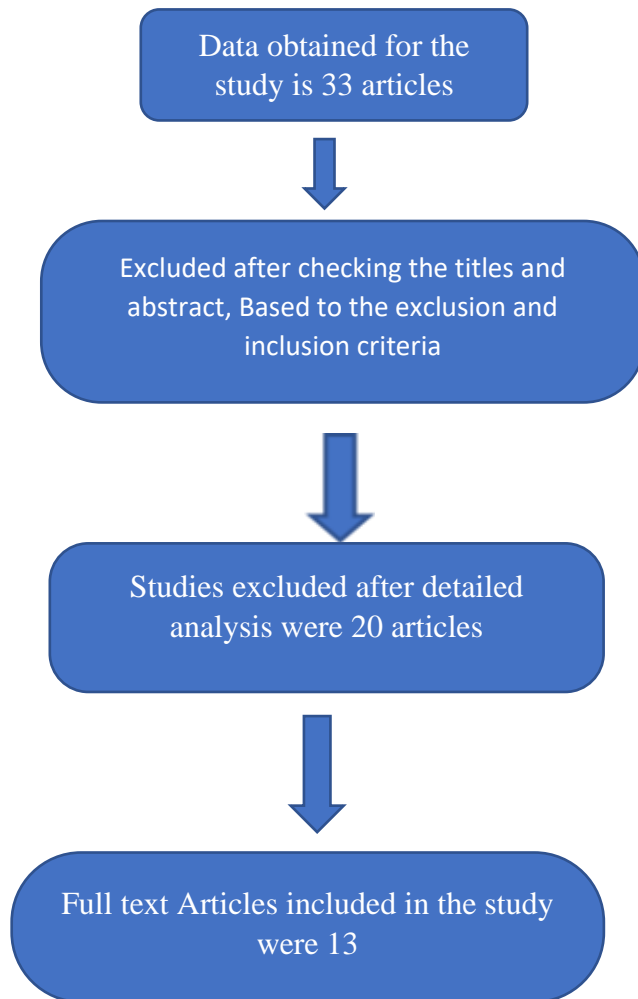
- Articles explaining stroke Rehabilitation were included.
- Articles published in recent years.
- Full-text articles.
- Articles published in English.

Exclusion Criteria

- Articles of past 2014.
- Articles explaining other than stroke were excluded.
- Articles discussed other than constraint-induced movement therapy were excluded.
- Articles not containing relevant discussion were excluded.



Flow Chart



LITERATURE REVIEW

S.no	Author\ year	Title	Study Method	Study Design	Conclusion
1.	Sakshi Jaitley ⁽⁷⁾ 2023	Efficacy of constraint-induced movement therapy to improve functional mobility and balance on lower limb subjects with stroke	They conducted a 6-month quasi-experimental study using the convenient sampling approach, with a 4-week intervention period. A total of 17 individuals, both male and female, ranged in age from 45 to 75 years old.	Experimental study	This study stated that a four-week program of Constraint-Induced Movement Therapy (CIMT) for the lower limb has demonstrated significant improvements in functions such as balance and functional mobility.
2.	Ingela Marklund ⁽⁸⁾ 2023	Lower-extremity constraint-induced movement therapy improved motor function, mobility, and walking after stroke	participants underwent LE-CIMT treatment for 6 hours daily over 2 weeks. The evaluation of functional outcomes was conducted using the following. Fugl-Meyer Assessment (FMA) for the lower extremity, (TUG) test,(10MWT), and (6MWT) before the treatment, immediately after its completion, and at a 3-month follow-up.	Longitudinal cohort study	This study stated that intensive LE-CIMT significantly improved motor function, functional mobility, and walking ability in middle-aged patients during the sub-acute and chronic post-stroke phases.



3.	Jing Zhang ⁽⁹⁾ 2023	Influence of constraint-induced movement therapy on improving lower limb outcomes after stroke.	In this research, A thorough search was performed across various databases, including PubMed and Web of Science, to gather relevant research resources. Cochrane Library, Academic Search Premier via EBSCO Host, and Pedro, The study focused on RCT that utilized Constraint-Induced Movement Therapy (CIMT) to enhance lower limb function, comparing them to dosage-matched active control groups.	Meta-analysis review	The study suggests that Constraint-Induced Movement Therapy (CIMT) demonstrates better effectiveness than conventional treatment in enhancing lower limb functions in the short term.
4.	Saleh M. Aloraini ⁽¹⁰⁾ 2022	Effects of constraint-induced movement therapy for the lower extremity among Individuals post-stroke	A randomized controlled, single-blinded clinical trial was conducted. Participants were randomized into two groups: the CIMT-LE group and the control. Berg balance scale, the ten-meter walk test, the six-minute walk test, and the Fugl-Meyer assessment of lower extremities were the outcome measures. At baseline, outcome measures were collected.	RCT	This study stated that the CIMT-LE program showed significant clinical enhancement in post-stroke survivors compared to a conventional program with equal intensity. Enhancements were noted in lower limb motor rehabilitation, balance control, and walking speed.
5.	Natália Duarte Pereira ⁽¹¹⁾ 2022	Constraint-induced movement therapy for lower extremity use in ADL in people with chronic hemiparesis: multiple case study	The study involved 12 participants, comprising eight men, with an average age of 55 years. This research utilized the lower extremity (LE-MAL), lower extremity motor function test (LE-MFT), (TUG) test, and spatiotemporal gait parameters as clinical assessment tools to assess the intervention's efficacy.	Quasi-experimental study	This study stated that Lower Extremity Constraint-Induced Movement Therapy (LE-CIMT) is a practical approach to enhance the subjective benefits experienced by individuals with chronic hemiparesis. This therapy demonstrates promising effects on improving the utilization of paretic lower limbs in daily mobility tasks.
6.	Mingze Zhou ⁽¹²⁾ 2022	Effect of CIMT on lower extremity motor dysfunction in post-stroke patients	They comprehensively found relevant RCT trials for this study and searched eight databases (PubMed, Embase, The Cochrane Library, Web of Science, CBM, CNKI, WAN FANG, and VIP). They assessed The effectiveness of CIMT in tackling post-stroke lower extremity motor problems was evaluated by focusing on the mean difference. The main measure for this assessment was the Fugl-Meyer Assessment Scale on lower limbs (FMA-L). Secondary indicators included the (BBS), (10MWT), gait speed (GS), 6-min walk test (6MWT), functional	A systematic review and meta-analysis	The research study centered on evaluating the efficacy of CIMT in addressing lower limb motor impairments in individuals after a stroke. However, the findings indicated a notable variation among the studies included.



			ambulation category scale (FAC), (TUGT), Brunnstrom stage of lower limb, weight-bearing, modified Barthel index scale (MBI), functional independence measure (FIM), stroke-specific questionnaire (SSQOL), (WHOQOL), and (NIHSS).		
7.	Jaya Shankar tedla ⁽¹³⁾ 2022	Effectiveness of constraint-induced Movement Therapy (CIMT) on balance And functional mobility in the stroke Population	This research study, an a comprehensive across various sources and platforms Various reputable databases, including Google Scholar, EBSCO, PubMed, PEDro, Science Direct, Scopus, and Web of Science, were utilized for the comprehensive search. were utilized to conduct an extensive search for relevant information. which evaluated 161 studies. Ultimately, eight (RCTs) were included the assessment of methodological quality was conducted utilizing the PEDro Evaluation approach. The study demonstrated that (CIMT) has a positive impact on post-stroke patients' balance, with varying results compared to alternative interventions like neurodevelopmental treatments.	A systematic review and meta-analysis	This study indicates that treatments utilizing Constraint-Induced Movement Therapy (CIMT) have been found to positively influence the recovery of balance-related motor functions in stroke patients, especially compared to other treatment methods such as neurodevelopmental treatment, modified use therapy, and traditional physical therapy.
8.	Ravi Shankar Reddy ⁽¹⁴⁾ 2022	Impact of Constraint-Induced Movement Therapy (CIMT) on Functional Ambulation in stroke patients.	To collect relevant studies, a variety of databases, including EBSCO, PubMed, Pedro, Science Direct, Scopus, MEDLINE, CINAHL, and Web of Science, were employed. For this analysis, the focus was on clinical trials that involved stroke patients across different recovery stages, aged 18 and above, who underwent Lower Extremity Constraint-Induced Movement Therapy (LECIMT). In this review, a total of 10 studies were included and they fulfilled the selection criteria. The impact of LECIMT on outcomes related to gait speed and balance was evaluated using either a random or fixed-effect model.	A Systematic Review and Meta-Analysis	This meta-analysis suggests despite numerous studies pointing to the efficacy of LECIMT in improving lower-limb functions, the enhancements in gait speed and balance did not demonstrate a significant superiority of LECIMT compared to other treatment methods.



9.	Anwal abdullahi Steven trujen et al ⁽¹⁵⁾ 2021	Effects of constraint-induced movement therapy in people with Stroke	To gather relevant data, various databases such as PubMed, Pedro, OT Seeker, and CENTRAL, were searched, covering their entire available timeframes up to February 2021. We focused on lower limb CIMT studies that reported outcomes at both baseline and post-intervention stages. Key aspects like sample size, mean, and standard deviation related to the outcomes of interest, as well as the protocols for both experimental and control groups, were extracted from these studies. A thorough assessment of the methodological rigor of the included studies was conducted using the McMaster Critical Review Form as a comprehensive assessment tool.	a systemic review and meta-analysis	CIMT for lower limbs has shown a positive impact on various aspects such as referring to motor skills, equilibrium, and to perform daily tasks efficiently, gait speed, oxygen uptake, weight-bearing capacity, lower limb kinematics, and overall quality of life. Nonetheless, according to existing research, it demonstrates a notable advantage over control interventions only in enhancing the QOL specifically for stroke patients.
10.	Canadan S, Livanelioglu ⁽¹⁶⁾) 2019	Efficacy of modified constraint-induced movement therapy for lower extremity in patients with stroke.	In this study, A cohort of 30 stroke patients was segregated into two distinct sub-groups. and both received neuro-developmental therapy (NDT) as a baseline treatment for four weeks. Following this, the study group underwent motor-cued Constraint-Induced Movement Therapy (mCIMT) for two weeks, while the control group continued with NDT during the experimental phase. The participants' strength was assessed using the Motricity Index, and their (QoL) was evaluated using the Stroke (SS-QoL) and Stroke Impact Scale (SIS) at three-time points: baseline, after four weeks, and after six weeks.	RCT	The study indicates that (mCIMT) It could potentially serve as a beneficial therapeutic approach for individuals experiencing stroke, as it effectively boosts the strength of enhances the well-being and quality of life for individuals with a compromised lower limb.
11.	Sevim Acroz Ayse ⁽¹⁷⁾ 2017	Effects of Modified Constraint-induced movement therapy for lower limb on Motor Function in stroke patients.	A 2-week randomized controlled study involving 30 participants divided into mCIMT and NDT groups was conducted. Motor function was assessed using FAC, BBS, 10-Meter Walk Test, gait parameters (cadence and step length ratio), and postural symmetry ratio at pre-treatment and post-treatment (twice).	RCT	This study highlights the potential of CIMT (mCIMT) as a superior treatment option compared to neurodevelopmental therapy (NDT) for enhancing motor function, gait, balance, ambulation, and symmetry in stroke patients. This innovative approach to lower limb rehabilitation holds promise for improving overall patient outcomes.



12.	Yulian Zhu ⁽¹⁸⁾ 2016	Effects of modified constraint-induced movement therapy on the lower extremities in patients with stroke	In this research, 22 stroke patients with hemiplegia, resulting from either cerebral infarction or hemorrhagic cerebrovascular accident, were included. They were randomly allocated to either the modified Constraint-Induced Movement Therapy (m-CIMT) group or the standard therapy group (control group). Both groups participated in training sessions for four weeks. The three-dimensional segmental kinematics method was employed to identify the efficacy of treatment by measuring the displacement of the Centre of Mass (COM) and gait parameters before and after the therapy sessions.	A pilot study	This study stated that modified Constraint-Induced Movement Therapy (m-CIMT) has shown effective results reducing the Centre of Mass (COM) displacement in sagittal and frontal planes, and it enhance various gait parameters. This indicates that m-CIMT intervention could be a practical and efficient approach to improve gait in hemiplegic individuals.
13.	Nan-Hyang Kim ⁽¹⁹⁾ 2015	Effect of gait training of induced movement therapy (CIMT) on the balance of stroke patients	In this research study, a total of 20 stroke patients were selected and divided into two groups an experimental group and a control group through a random assignment process. The group under experimentation participated in gait training that included (CIMT). This training was in sessions of 30 min. each, three times a week, over four weeks. Conversely, the control group underwent gait training that did not incorporate CIMT.	RCT	This study stated that Incorporating Constraint-Induced Movement Therapy (CIMT) with gait training can be viewed as a potential treatment method that may potentially improve their balance.

DISCUSSION

Stroke stands as a significant contributor to disability, often resulting in substantial alterations in both independent living and social engagement for approximately half of those affected by hemiparesis or hemiplegia. ⁽²⁰⁾Saleh M.Aloraini et al 2022 performed An investigation that will assess the efficacy of constraint-induced movement therapy- lower limb (CIMT-LE) on improving balance and walking abilities in Individuals post-stroke. The study was a randomized, single-blinded trial, with participants divided into CIMT-LE and control groups. Key evaluation metrics comprised the Fugl-Meyer assessment, Berg balance scale, ten-meter walk test, and six-minute walk test, conducted at baseline, post-therapy, and after three months. Initially, Upon comparing the 38 subjects, two groups with 19 members each, no differences were noted between them. Both groups demonstrated improvements compared to their initial assessments, but the CIMT-LE group showed clinically significant changes. After three months, these improvements were sustained. Compared to an intensity-matched conventional program, CIMT-LE yielded more substantial progress in lower extremity motor recovery, postural balance, and gait speed among stroke patients. Sakshi Jaitely et al 2023 This Quasi-Experimental research evaluates the efficacy of

Constraint-Induced Movement Therapy (CIMT) Concerning the analysis of lower limb functions in people who experienced a stroke. The 4-week CIMT program focused on the lower limb demonstrated Notable enhancements in participants' ability to move and maintain balance in daily activities were observed. The research determined that Constraint-Induced Movement Therapy (CIMT) effectively improves lower limb capabilities, particularly focusing on balance and functional movement. In this study, essential evaluation tools are the BBS Scale, Rivermead Mobility Index, and Barthel Index to assess the results. The results demonstrated substantial positive effects on improving balance and functional mobility. Despite the CIMT program, the Barthel Index did not show significant change observed in stroke patients.

Sevim Acroz et al 2019 performed a study aimed at assessing the effectiveness of constraint-induced movement therapy (mCIMT) targeted at lower limbs, focusing on strength and (QoL) improvements in individuals with stroke. The study included 30 participants, in two groups. Both groups received Neuro-Developmental Therapy (NDT) as a foundational treatment for four weeks. The study group then underwent MCIMT, while the control group continued NDT for two more



weeks as the experimental treatment. Strength was assessed using the Motricity Index, and QoL was evaluated through the Stroke Specific Quality of Life Scale (SS-QoL) and Stroke Impact Scale (SIS) at three time points: baseline, post 4 weeks, and post 6 weeks. Both groups experienced improvements in strength and QoL during all treatment periods ($p < 0.01$). The mCIMT One group exhibited more substantial advancements compared to the other in paretic lower limb strength ($p = 0.029$) and various SS-QoL subdomain scores after the mCIMT period ($p < 0.05$). The perceived recovery domain of SIS was also higher in the mCIMT group compared to the control group ($p < 0.001$). Total changes in strength and QoL were more correlated with improvement during the mCIMT period ($r = 0.709$, $p < 0.01$ and $r = 0.769$, $p < 0.01$) than in the baseline period ($r = 0.660$, $p < 0.01$ and $r = 0.505$, $p < 0.01$). This study suggests that MCIMT can be an efficient approach for enhancing the situation found in this method. paretic lower extremity strength and health-related QoL in stroke patients. Nan-Hyang Kim et al 2015 performed a study investigating the impact of intensive gait training employing a Constraint-Induced Movement Therapy (CIMT) approach targeting the non-paretic upper limb on stroke patients' balance capabilities. The research involved 20 participants randomly divided into experimental and a control group. The experimental group participated in gait training with CIMT for 30 minutes per session, conducted three times weekly, spanning four weeks. In contrast, the control group received standard gait training alone. The experimental group showcased substantial enhancements in their dynamic balance capabilities, with greater enhancement than the control group. Additionally, the experimental group shows advancements in movement distances towards the affected side. In contrast, the control group did not show any substantial improvements in balance indices following the intervention. In conclusion, integrating gait training with CIMT methods in stroke rehabilitation can be a beneficial treatment option, significantly improving the patients' balance.

CONCLUSION

Numerous research studies have consistently shown that constraint-induced therapy (CIMT) and modified constraint-induced movement therapy (MCIMT) yield substantial improvements in gait, balance, motor functions, and ambulation for chronic stroke patients. It is recommended that therapists consider incorporating either CIT or MCIMT in treatment plans for stroke patients.

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