The Research of Medical Science Review

Received: 16 October, 2024
Accepted: 16 November, 2024
Published: 23 November, 2024

ISSN: 3007-1208 | 3007-1216
Volume 2, Issue 3, 2024

EFFECTIVENESS OF CONSTRAINT-INDUCED MOVEMENT THERAPY VS. PROPRIOCEPTIVE NEUROMUSCULAR FACILITATION IN UPPER LIMB REHABILITATION FOR HEMIPLEGIC PATIENTS; A FOCUSED LITERATURE REVIEW

Iqra Ghazanfar[*1], Shaheer Ellahi Khan[2], Aqsa Elahi[3], Aiman Naveed[4], Tehmina Sultan[5], Afsheen Talat[6], Rabab Sakina[7]

*[*1]1MS Scholar, Health Services Academy (HSA), Islamabad. Aiman,*
[2]Associate Professor, Health Services Academy (HSA), Ministry of NHSR&C, Islamabad, Pakistan.
[3]Junior Project Officer, Institute of Rural Management (IRM), Islamabad.
[4]Research Associate, Islamabad Healthcare Regulatory Authority
[5]Research Assistant, Health Services Academy (HSA), Islamabad.
[6]Research Officer, Association for Social Development (ASD), Islamabad.
[7]Research Coordinator, Association for Social Department (ASD), Islamabad.

[*1]Driqranaqvi447@gmail.com, [2]shaheer@hsa.edu.pk, [3]Aksaelahi94@gmail.com, [4]Aimannaveed3232@gmail.com, [5]Tehmina1102020@gmail.com, [6]Afsheen@asd.com.pk, [7]rabab@asd.com.pk

[*1]https://orcid.org/0009-0005-2459-9817, [3]https://orcid.org/0009-0006-6409-081X, [6]https://orcid.org/0000-0002-2316-7028

ABSTRACT

Stroke is the leading cause of disability worldwide, that affects both the motor and the sensory functions of the body. Neurorehabilitation techniques such as CIMT and PNF play the best role in overcoming the post-stroke effects. For the betterment of stroke survivors, it is necessary to compare the effectiveness of both techniques.

The main objective of this literature review is to assess and compare the effectiveness of Constraint-Induced Movement Therapy (CIMT) and Proprioceptive Neuromuscular Facilitation (PNF) in improving upper limb function in patients with hemiplegic stroke, based on randomized controlled trials (RCTs) conducted between 2020 to 2024.

A detailed search was conducted using the Google Scholar, PubMed, and SciHub databases, targeting studies published between 2020 and 2024. The inclusion criteria focused on randomized controlled trials (RCTs) involving hemiplegic patients who received either Constraint-Induced Movement Therapy (CIMT) or Proprioceptive Neuromuscular Facilitation (PNF). Four studies have been selected based on the inclusion criteria. The primary assessment tools were the Fugl-Meyer Assessment (FMA), Motor Activity Log (MAL), functional motor, and spasticity tests. The review identified and compared the effects of Constraint-Induced Movement Therapy (CIMT) and Proprioceptive Neuromuscular Facilitation (PNF) on upper limb motor function in stroke patients. All four studies reported improvements in motor function, with results favoring CIMT over PNF. The Functional Mobility Assessment (FMA) scores indicated significantly greater improvements in patients receiving CIMT than those undergoing PNF.

CIMT shows greater effectiveness than PNF in improving upper limb function for patients with hemiplegia of the upper limb. Continued research into the long-term effects of these therapies could

provide valuable results, helping to refine and improve rehabilitation intervention techniques for stroke survivors.

Keywords: *Proprioceptive neuromuscular facilitation (PNF), Constraint Induced Movement Therapy (CiMT), Hemiplegia, Stroke, and Upper limb hemiplegia*

INTRODUCTION

In the last few years, 80% of the disease patterns have been redirected from communicable diseases (CDs) to non-communicable diseases (NCDs), and stroke is one of them which is a preventable neurological disorder that affects the brain cells. The total mortality rates were recorded as 3.29 million worldwide, out of which 50.3% of deaths were due to stroke, and deaths related to Cardiovascular Diseases (CVDs). (1)

A stroke is defined as an instantaneous neurological defect that occurs due to a vascular obstruction in the central nervous system leading to extensive bleeding or stroke. Studies show that stroke is the second major cause of mortality in middle to low-income countries and the main effects that occur after the stroke are disability in doing physical activities such as Activities of Daily Living ADLs(2). A research study carried out in Nigeria, showed that approximately 1.2% of admissions in hospitals along with 7.3% of admissions in medical wards happened due to cerebrovascular disease such as stroke. Stroke has been increasingly becoming a serious burden for Africa's healthcare delivery system. (3)

The most important concern for health nowadays is the prevention of stroke. It damages the function of motor neurons which results in functional disability, according to research conducted in the UK in 2021. an estimated 900,000 people suffered from the aftereffects of a stroke. According to the results, about 70-75 % of people could not perform their ADLS for example reaching an object, grasping, and picking up something because they can't move their arms, hands, or fingers, which indirectly affected their quality of life. (3)

The most common post-stroke effect is the paraplegia of the arm which can be prevented with a proper exercise plan. Almost two-thirds of patients suffer from dysfunction of the sensory function as well as the motor function after six months of stroke, due to which they are not able to perform their daily living activities. Functional loss of motor neurons can cause weakness of muscles, hypotonic muscles, synergies can be developed in the muscles, as well as postural deformations and abnormal movement patterns because of low or no coordination. To compensate for these movements patients start using their unaffected limbs for performing their daily activities as a result the affected limb is neglected and loses coordination with the brain. (4)

Stroke can be classified into two types: 1: Ischemic stroke and 2: Hemorrhagic stroke. Acute focal neurological deficit is the second name for the ischemic stroke which occurs due to the obstruction in the vessel and the symptoms subside after 24 hours along with the proper clinical betterment that occurs in the brain due to hypoperfusion (5). Some studies reveal that 13% of strokes occur due to the rupture of blood vessels in the hemorrhage while the blood starts to coagulate in the brain tissues rapidly(6). Common risk factors for stroke include age, race/ethnicity, genetics, and high blood pressure. Mostly at the age of 55 the risk factors double and increase with advancing age. (7)

Various studies have been conducted that have shown that a prolonged period of rehabilitation is necessary for regaining the mobility of the upper limb which is lost due to the occurrence of the stroke. Different types of techniques are used in the rehabilitation phase by the physiotherapist for improving motor function such as stretching of the hypertonic muscles, strengthening of the weakened muscles, and hold-relax techniques with a range of motion but the most frequently used techniques are proprioceptive neuromuscular rehabilitation (PNF) and constraint-induced moment therapy (CIMT) along with the different protocols. (3)

Constraint-induced movement therapy (CIMT) is a rehabilitation therapy primarily used for the improvement of motor functioning in neurologically defective patients both in acute as well as in chronic stages. Physiotherapists use this technique in hospital settings as well as in the home(8). In this technique, the therapist restricts the unaffected limb either with a sing, plaster, or splint so the patient cannot use it and starts initiating the exercise on the affected limb, this results in the brain sending neurological signals to the affected side of the body, and all focus will be

diverted towards that limb. A patient has to perform 10-15 tasks in about 10-30 seconds and repeat these tasks about 5-10 times to ensure the proper coordination between the limb and the brain. (9)

Proprioceptive Neuromuscular Facilitation (PNF) improves sensory function by improving the sensory neurons that reside between the muscles and the region of the joint to transmit the signals or impulses so that the patient's limbs get the signal of moving, contracting, relaxing, and resisting commands, and follow them(9). These techniques show better results in the improvement of the upper extremity function when some supplementary form such as an arm sling or Kineso taping is used. (10)

Many preceding studies conducted in the literature review focused on the implementation of the CIMT (Constraint-Induced Movement Therapy) and the PNF (Proprioceptive Neuromuscular Facilitation) techniques on patients who are suffering from upper limb hemiplegic patients. (11)

RESEARCH OBJECTIVES

Four studies have been selected that fulfill the inclusion and exclusion criteria by utilizing the PICO framework (population, intervention, comparison, outcome). These criteria are set for the selection of research that evaluates the effectiveness of CIMT and PNF techniques among upper limb hemiplegic patients in their post-stroke rehabilitation phase.

The main purpose of conducting this study is to investigate the effectiveness of CIMT and PNF among upper limb hemiplegic patients These four RCTs were conducted between 2020 to 2024, which shows a clear apprehension that the Proprioceptive neuromuscular facilitation and the constraint-induced moment therapy techniques have similar effects on improving the mobility of the upper limb hemiplegic patients.

METHODS

To identify studies relevant to research, an inclusive search strategy was utilized by using specific keywords, such as "proprioceptive neuromuscular facilitation,", "CiMT,", "Hemiplegia,", "Stroke,", and "Upper limb hemiplegia" specifically aimed at the individuals who have experienced post-stroke effects and now dealing with the consequences.

For the formulation of the research question PICO framework was used for the identification of the relevant articles and studies to set the inclusion and exclusion criteria. The framework of PICO is acceptable worldwide because of its effectiveness as it comprises crucial components such as Population, Intervention, Comparison, and Outcome. To streamline the process of selecting the relevant studies and articles, the online management tool EndNote 20 was employed, which allows the citation of the literature and studies that were gathered by using databases such as Google Scholar, PubMed, and Scihub.

The selection of the four studies was based on a thorough review of randomized controlled trials conducted between 2020 and 2024 and the effects of two therapeutic approaches such as constraint-induced Movement therapy and proprioceptive neuromuscular therapy were examined in those studies that focus on the betterment/improvement of the functional mobility of the upper extremity among patients who have been suffering from the post-stroke effects.

The primary benchmarks for selecting studies were the Fygl-Meyer Assessment (FMA) and the Motor Activity Log (MAL), which evaluate motor function, balance, sensations, and quality of movement during daily activities. By evaluating these studies, this literature review provides a comprehensive report on how CIMT and PNF techniques regulate the recovery of motor function among upper limb hemiplegic patients.

Inclusion Criteria

1. Studies that include the treatment of both the constraint-induced movement therapy (CIMT) and the proprioceptive neuromuscular facilitation (PNF).
2. Randomized controlled trial studies carried out between 2020 and 2024.
3. The studies that have assessment tools for evaluation of the upper limb function are the Fugl-Meyer Assessment (FMA) the Functional Motor Assessment for Life (MAL) and the Modified Ashworth Scale for spasticity.

Exclusion Criteria

1: Studies that are not randomized control trials (RCTs)

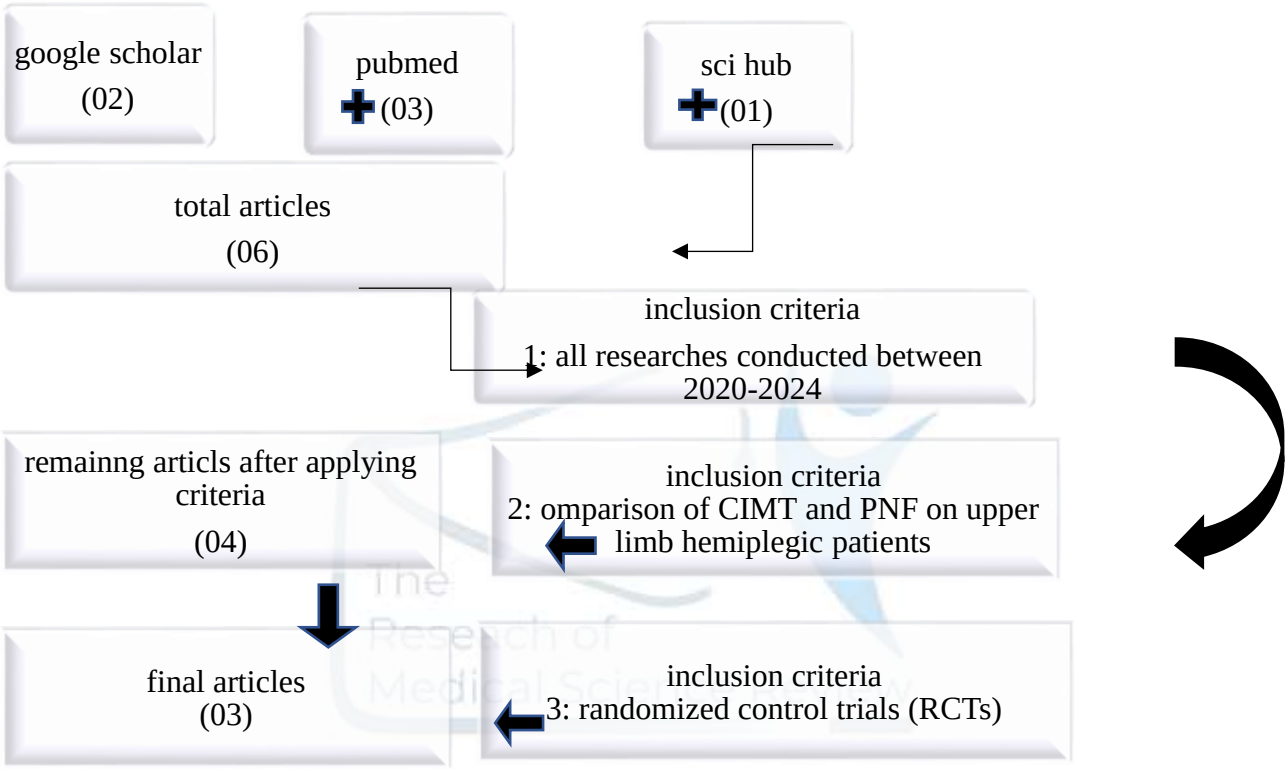
2: Articles that were published beyond the timeframe of 2020-2024.

3: Studies that involve patients not having upper limb hemiplegic stroke.

RESULTS

The search process identified ten articles, three of which met the inclusion criteria (Figure 1). The four studies selected that were conducted by (8) (9), (12), and (13)demonstrated that CIMT produced more significant improvements in upper limb motor function compared to PNF. Both techniques were shown to improve the quality of life in hemiplegic patients, although CIMT resulted in more favorable outcomes

Fig 1: Shows the process of the study selection



The primary outcome measure was the FMA score, which showed substantial improvements in the CIMT group compared to the PNF group. No significant gender differences were noted in the functional outcomes, indicating that both therapies are equally effective across male and female patients.

Study 1:(8)

In this study, 30 patients were divided into two groups, 15 receiving CIMT and 15 receiving PNF. Participants in the CIMT group averaged 59.53±9.92 years, while the PNF group averaged 63.00±7.27 years

Table 1. Demographic and clinical characteristics of participants

Characteristics	CIMT group (n = 15) (mean ± SD)	PNF group (n = 15) (mean ± SD)	df	t	P-value
Age (years)	59.53 ± 9.92	63.00 ± 7.27			
Males, n (%)	8 (50.7)	7 (49.3)			
Females, n (%)	7 (49.3)	8 (50.7)			
Right hemiparesis n (%)	8 (53.33)	10 (66.67)			
Left hemiparesis n (%)	7 (46.67)	5 (33.33)			
Disease duration (weeks)	31.60 ± 5.65	34.13 ± 5.32			
FMA score	**36.80 ± 7.62**	**34.40 ± 9.760**	**28**	**0.750**	**0.459**

Participants in the CIMT group underwent therapy sessions that focused on repetitive exercises performed under the supervision of trained physiotherapists which showed a satisfactory improvement than Group B which underwent PNF interventions.

Table 2: Comparison of Upper limb FMA score in the CIMT and PNF groups

Characteristics	CIMT group (*n* = 15) (mean ± *SD*)	PNF group (*n* = 15) (mean ± *SD*)	df	*t*	*P*-value
Age (years)	59.53 ± 9.92	63.00 ± 7.27			
Males, *n* (%)	8 (50.7)	7 (49.3)			
Females, *n* (%)	7 (49.3)	8 (50.7)			
Right hemiparesis *n* (%)	8 (53.33)	10 (66.67)			
Left hemiparesis *n* (%)	7 (46.67)	5 (33.33)			
Disease duration (weeks)	31.60 ± 5.65	34.13 ± 5.32			
FMA score	**36.80 ± 7.62**	**34.40 ± 9.760**	**28**	**0.750**	**0.459**

Study 2:(9)

This larger study involved 66 stroke survivors (33 in the CIMT group and 33 in the PNF group) after accounting for dropouts. The average age of the group A participants was 59.53±9.92. On the other hand, the group B participant's average age was 63.00±7.27.

Table 3: shows the demographical data of Group A&B

DEMOGRAPHICS	NO OF PARTICIPANTS	MEAN AGE
GROUP A	33	59.53±9.92
GROUP B	33	63.00±7.27

The total period for the application of the CIMT techniques was approximately 45 minutes per session for about four to six sessions per week, which involved the usage of bandage/splint/plaster

for restricting the unaffected limb to divert the focus of the patient toward the affected limb. In comparison, the PNF techniques were applied for about 30-40 minutes per session preceding the application of the hot packs along with the TENS (transcutaneous electrical nerve stimulation) for better circulation of the blood which stimulates the functioning of muscles.

Table 4: shows Friedman's test Within groups

Groups		Mean	S.D	P value
PNF	Pretreatment MAL(amount)	36.6970	7.69531	0.000
	Post treatment mal(amount)	76.6061	7.08405	
MCIMT	Pretreatment MAL(amount)	36.9697	6.86697	0.000
	Post treatment MAL(amount)	82.9091	7.00162	
PNF	Pretreatment MAL(quality)	37.6970	8.08735	0.000
	Post treatment MAL(quality)	77.1818	7.32058	
MCIMT	Pretreatment MAL (quality)	37.7576	8.17783	0.000
	Post-treatment MAL (quality)	85.6061	6.22465	
PNF	Pretreatment FMA score	23.3636	6.06639	0.000
	Post-treatment FMA score	48.6364	5.46476	
MCIMT	Pretreatment FMA score	23.9697	6.40549	0.000
	Post-treatment FMA score	56.2121	6.94063	

Study 3: (12)

The total number of participants that were involved in Study 3 was 30, based on the treatment given they were divided into two groups, group A received CIMT techniques for analyzing the improvement in the functional mobility of the upper limb, while Group B acquired PNF techniques. The mean age of all the participants was 58.06 ± 8.79 in group A and 59.73 ± 9.52 in group B. Group A participants who underwent the CIMT techniques showed more satisfactory betterment as compared to the participants who received the PNF techniques in the improvement of the functioning of the upper limb.

Table 5: shows the demographic data of Group A and Group B

DEMOGRAPHICS	GROUP A	GROUP B
NO OF PARTICIPANTS	15	15
MEAN AGE	58.06 ± 8.79	59.73 ± 9.52

Study 4:(13)
The study involved a sample size of 50 participants, divided into two groups of 25 each. Group A with an average age of 57.3 ±6.2 received CIMT intervention aimed at improving their motor functions while performing activities of daily living (ADLs). In contrast, the average age of Group B participants is 60 ±6.9 received PNF interventions.

Table 6: shows the demographic data of Group A& Group B

DEMOGRAPHICS	GROUP A	GROUP B	P-VALUE
NO OF PARTICIPANTS	25	25	>0.05
MALES	65	35	>0.05
FEMALES	35	65	>0.05
MEAN AGE	57.3 ±6.2	60 ±6.9	>0.05

The study found that PNF was not effective in improving upper limb function compared to CIMT, which demonstrated greater enhancement following its implementation.

Table 7: Shows Outcome measure of ARAT and Spasticity test

Outcome measure		Group A (CIMT)	Group B (PNF)	p-value
Functional Motor skills (ARAT	Pre-treatment	25.47±5.2	11.45±4.73	0.915
	Post-treatment	26.43±4.71	14.45±2.87	0.063
Spasticity	Pre-treatment	10.23±4.5	10.9±5.97	0.852
	Post-treatment	11.29±4.50	15.01±4.69	0.006

The findings of this literature review conclude that CIMT is more effective than PNF techniques for patients who want to improve the function of the upper limb to perform their ADLs.
The outcomes of this literature review show that there is a significant difference in the effectiveness of both CIMT and PNF techniques among upper limb hemiplegic patients by evaluation of the scores of the Fugl-Meyer Assessment (FMA) and Moto Assessment for Life (MAL) right before and after the applications of the interventions.

DISCUSSION:
In this literature review, the effectiveness of CIMT and PNF techniques in refining the function of the upper limb among hemiplegic patients who face difficulties while performing daily activities was assessed. Four RCTs were included in this review which showed the effect of these two interventions on post-stroke hemiplegic patients. The rate of these four studies is six on the PEDro scale which shows that the best methodological quality is used. Different commonly used evaluation tools such as the Motor Activity Log (MAL), Fugl-Meyer Assessment (FMA), and Motor Assessment Scale (MAS) were used to assess the effectiveness of CIMT and PNF techniques which gives favorable outcomes. (4)
The total number of participants across these four studies included in this review was 132. The second study comprised of largest sample size of 72 participants (9), while the least sample size was

about 30 participants that were in the third research(12). The mean age of the participants who were involved in this literature review who experienced post-stroke hemiplegic phase ranged from 58 to 63 years.

All four studies that were involved in this review showed that Constraint-induced movement therapy (CIMT) has greater effectiveness in improving the functional mobility of upper limb hemiplegic patients as compared to the Proprioceptive neuromuscular facilitation (PNF) techniques. It has been recorded that CIMT showed much better effective results when it was applied along with additional exercises such as manual therapy, range of motion, stretching of the stiff muscles, and strengthening of the weak muscles.

The evaluated tools for upper limb functioning in all four studies were the Arm Mobility Test, the Fugl-Meyer upper limb assessment tool, the Motor Assessment Scale, and the spasticity test (modified Ashworth scale). Based on the scoring of the tools, the participants improved their functional mobility, and their quality of life improved after the application of CIMT techniques. Each study showed better outcomes in the group who received the CIMT interventions, additionally, the combination of Kinesio taping with the CIMT significantly improved the motor function in the upper limb and surpassed the results of the group who underwent the PNF interventions.

While the participants who received the PNF interventions in all four studies underwent about 40-45 minutes per session six times per week. Different techniques were applied along with PNF such as isotonic exercises, wrist and elbow stretches, and strengthening exercises of all the upper extremity muscles. Different patterns of diagonal flexion and extension were applied in the PNF interventions under the supervision of the trained physiotherapist in the clinical setting as well as in the homes(8). The other studies showed that when the participants were engaged in different activities and motor skill exercises explicitly then there was a better improvement in upper limb mobility recorded. The diagonal patterns such as D1 flexion/extension, and D2 flexion/extension somehow contributed to improving the quality of life of the upper limb hemiplegic patients. (9)

The third study, conducted in 2024, similarly compared Group A, which received PNF intervention, with Group B, which underwent CIMT along with manual rehabilitation exercises such as stretching, strengthening, range of motion exercises, and the hold-relax technique. The results showed that combining CIMT and manual exercises produced superior outcomes compared to PNF alone. (12)

The fourth study featured in the review in Malaysia in 2024, revealed compelling findings regarding the efficacy of CIMT for patients suffering from upper hemiplegia. The results demonstrated that CIMT produced significantly better outcomes than PNF interventions. Notably, while both groups of participants engaged in distinct therapeutic approaches, they did so over the same duration as the interventions outlined in the earlier studies, highlighting the robustness of the findings. (13)

Table 8: Summary of the selected studies for the literature review

Author's Name	Study design	Number of participants (in CIMT group/PNF group)	Average age of participants (In CIMT group /PNF group)	Type of intervention given in each group	Evaluation parameters and instruments	Results
1: Muhmmad Aliya Abba, Abubakar Shuaibu Muhammad, Umaru Muhammad Badaru, Anwal Abdullah.	Randomized Control Trials (RTs)	Total participants 30 (in CIMT group 15 participants / in PNF group 15 participants)	In the CIMT group mean age is 59.53±9.92 In the PNF group mean age 63.00±7.27	Group A: Constraint-induced movement therapy. Group B: Proprioceptive neuromuscular facilitation therapy.	FMA- Fugl Meyer Assessment tool. Inferential statistics of the t-test were used to determine the effectiveness of the intervention based on FMA scoring among the groups.	Significant differences were found between both groups, the group who received CIMT shows improvement than the group who received PNF techniques.
2: Roshaan Sethi, Fariha Khalid, Mehwish Saghir, Usama Ahmed Khan, Muhammad Kamran Hanif.	Randomized Control Trials (RCTs)	Total participants 72, after dropping out 66 remaining. (in CIMT group 33 participants / in PNF group 33 participants)	In the CIMT group mean age 58.3939 In the PNF group mean age 58.1818	Group A: Proprioceptive neuromuscular facilitation. Therapy. Group B: Constraint-induced movement therapy.	FMA-Fugl Meyer Assessment tool. T-tests were used to determine the effectiveness of the intervention based on FMA scoring among the groups as inferential statistics.	The group who receive CIMT interventions along with manual therapy shows better results than the group who receive only PNF interventions.

3: Dhanalakshmi L.; Alagesan, Jagatheesan; Buvanesh A. (2024)	Randomized control trials (RCTs)	Total: 30 in Group A – 15 Group B-- 15	58,06(±8,79) 59,73 (± 9,52)	Group A: PNF method Group B: Constraint-induced moment therapy	Fugl-Meyer Assessment Upper Extremity FMA-Upper extremity	The CIMT techniques represent better results than the PNF techniques.
4: Zohaib shahid, RegidorIII Poblete Dioso, Muhammad Asghar.	Randomized control trials (RCTs)	Total: 50 Group A: 25 Group B:25	57.3 ±6.2 60 ±6.9	Group A recives the CIMT techniques. Group B receives PNF interventions	Functional Motor Test. Modified Ashworth Scale. The T-test runs to assess the normality and the effectiveness of the techniques that were applied among the groups.	The group that receives the CIMT interventions shows better improvement in upper limb functioning rather than PNF interventions.

LIMITATIONS

Further studies are required for the understanding of the differences that exist in the efficiency of the techniques and the long-lasting effects of the intervention that were given to the patients whose functional mobility and quality of life are affected drastically due to the hemiplegia of the upper limb.

CONCLUSION

The evidence from these four RCTs suggests that the effect of CIMT interventions is more efficacious than PNF techniques to improve the quality of life and the function of the upper limb among upper extremity hemiplegic patients. CIMT's focus on task-specific, repetitive practice appears to drive greater neuroplastic changes, resulting in more substantial functional gains. While PNF remains a valuable rehabilitation technique, its effects on upper limb recovery may be more limited compared to CIMT.

Further research should continue to identify the impacts of the effects of both CIMT and PNF, with particular attention to the sustainability of motor function improvements over time. Additionally, further studies comparing the two interventions across different populations and stroke severities could help refine rehabilitation strategies to optimize outcomes for all stroke survivors.

REFERENCES

Fan J, Li X, Yu X, Liu Z, Jiang Y, Fang Y, et al. Global burden, risk factor analysis, and prediction study of ischemic stroke, 1990–2030. 2023;101(2):e137-e50.

Murphy SJ, Werring DJJM. Stroke: causes and clinical features. 2020;48(9):561-6.

Kaminska A, Sargsjane J, editors. Effectiveness of the proprioceptive neuromuscular facilitation method application on upper limb functions in patients after stroke: a systematic review of the literature. Society integration education Proceedings of the International Scientific Conference; 2024.

Bani-Ahmed aajjopts. Post-stroke motor recovery and cortical organization following Constraint-Induced Movement Therapies: a literature review. 2019;31(11):950-9.

Randolph SAJWH, Safety. Ischemic stroke. 2016;64(9):444-.

Montaño A, Hanley DF, Hemphill III jcjhocn. Hemorrhagic stroke. 2021;176:229-48.

Boehme AK, Esenwa C, Elkind msjcr. Stroke risk factors, genetics, and prevention. 2017;120(3):472-95.

Abba M, Muhammad A, Badaru U, Abdullahi AJPQ. Comparative effect of constraint-induced movement therapy and proprioceptive neuromuscular facilitation on upper limb function of chronic stroke survivors. 2020;28(1):1-5.

Sethi R, Khalid F, Saghir M, Khan UA, Hanif kjjrcors. Effects of modified constraint-induced movement therapy versus proprioceptive neuromuscular facilitation on upper limb motor function in chronic ischemic stroke patients. 2024;12(2).

Moon S-J, Han S-Y, Park D-HJL. The Effects of Proprioceptive Neuromuscular Facilitation Pattern Kinesio Taping on Arm Swing, Balance, and Gait Parameters among Chronic Stroke Patients: A Randomized Controlled Trial. 2024;14(2):242.

Tedla JS, Gular K, Reddy RS, de Sá Ferreira A, Rodrigues EC, Kakaraparthi VN, et al., editors. Effectiveness of constraint-induced movement therapy (CIMT) on balance and functional mobility in the stroke population: a systematic review and meta-analysis. Healthcare; 2022: MDPI.

Dhanalakshmi L, Alagesan J, Buvanesh ajijop, Therapy O. Effectiveness of Constraint Induced Movement Therapy and Proprioceptive Neuromuscular Facilitation on Upper Extremity Functions in Stroke. 2024;18.

Dioso RIP, Asghar MJI-joh, Rehabilitation. Comparison of Effects of Conventional Constrained Induced Movement Therapy Versus Proprioceptive Neuromuscular Facilitation Technique to Improve Functional Motor Skills and Spasticity for Hemiparetic Upper Limb in Sub-Acute Stroke Patients. 2024;2(2 (Health & Rehab)):13-8