

COMPARATIVE ANALYSIS OF TASK-SPECIFIC TRAINING AND MODIFIED CONSTRAINT-INDUCED MOVEMENT THERAPY ON WRIST AND HAND RANGE OF MOTION AND SPASTICITY AMONG HEMIPLEGIC STROKE PATIENTS

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Keywords

Stroke; Hemiplegia; Task-Specific Training; Modified Constraint-Induced Movement Therapy; Upper Limb Rehabilitation; Range of Motion; Spasticity.

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Abstract

Background:

Stroke remains one of the leading causes of long-term disability worldwide, with upper-limb impairment, reduced joint mobility, and spasticity being major barriers to functional independence. Rehabilitation approaches targeting upper-extremity recovery are essential for improving daily living activities among stroke survivors. Task-Specific Training (TST) focuses on purposeful functional activities, whereas Modified Constraint-Induced Movement Therapy (m-CIMT) promotes repetitive use of the affected limb by restricting the unaffected extremity. However, limited evidence exists regarding direct comparison of these interventions specifically for wrist and hand range of motion (ROM) and spasticity outcomes.

Objective:

The present study aimed to compare the effectiveness of Task-Specific Training and Modified Constraint-Induced Movement Therapy on wrist and hand ROM and spasticity among patients with hemiplegic stroke.

Methodology:

A randomized controlled trial was conducted among 66 hemiplegic stroke patients. Participants were randomly allocated into two equal groups (n=33 each). Group A received Task-Specific Training, while Group B received Modified Constraint-Induced Movement Therapy for six weeks. Wrist and hand ROM were assessed using a universal goniometer, while spasticity was evaluated using the Modified Ashworth Scale (MAS). Data were analyzed using ANCOVA with baseline values controlled as covariates.

Results:

The findings demonstrated that m-CIMT produced significantly greater improvements in wrist and hand ROM compared with TST. The adjusted mean wrist flexion ROM was 71.42° in the m-CIMT group compared with 62.88° in the TST group ($p < 0.001$, partial $\eta^2 = 0.548$). Similar significant improvements were observed across MCP, PIP, and DIP joint movements.

Conversely, TST demonstrated superior reduction in spasticity, with significantly lower adjusted MAS scores for wrist, finger, and thumb movements compared with m-CIMT ($p < 0.001$).

Conclusion:

Both rehabilitation approaches were effective in improving upper-limb recovery after stroke; however, their therapeutic benefits differed. m-CIMT demonstrated greater effectiveness for improving wrist and hand mobility, whereas TST was more beneficial for reducing spasticity. Selection of intervention should therefore depend on the primary rehabilitation objective.

1. INTRODUCTION

Stroke is one of the major neurological disorders responsible for mortality and long-term disability worldwide. (Rocha et al., 2021) Survivors frequently experience persistent motor impairments, particularly involving the upper extremity, which significantly restrict independence in daily activities. (Tanzina, 2025) Upper-limb dysfunction following stroke commonly manifests as reduced voluntary movement, decreased range of motion (ROM), abnormal muscle tone, and spasticity. (Alaca & Öcal, 2022) These impairments affect essential activities such as grasping objects, dressing, feeding, and personal care, thereby reducing quality of life. (Noor et al., 2020)

Post-stroke rehabilitation focuses on restoring functional movement through neuroplasticity-based interventions. (Mahboob et al., 2023) Modified Constraint-Induced Movement Therapy (m-CIMT) is a widely used rehabilitation approach that encourages active use of the affected limb by restricting movement of the unaffected limb. (AIZENOSA, 2025) Through repetitive and intensive practice, m-CIMT aims to overcome learned non-use and facilitate motor recovery. Recent studies have reported positive effects of m-CIMT on upper-limb function, motor control, and quality of life among stroke survivors. (Ceylan et al., 2023)

Task-Specific Training (TST) is another rehabilitation approach based on functional and meaningful activities. Unlike impairment-focused exercises, TST emphasizes repeated practice of real-life tasks, enabling patients to develop motor strategies required for daily activities. Evidence

suggests that task-oriented interventions improve functional performance and upper-limb coordination after stroke. (Abdel Ghafar et al., 2025)

Although both interventions have demonstrated effectiveness individually, limited research has directly compared m-CIMT and TST regarding specific outcomes such as wrist and hand ROM and spasticity. (Sahu, 2021) Previous investigations have primarily compared these approaches with conventional therapy or combined interventions rather than examining their relative effects on joint mobility and muscle tone. (Shahid, Kashif, & Shahid, 2023)

Therefore, this randomized controlled trial was conducted to determine whether Task-Specific Training or Modified Constraint-Induced Movement Therapy provides greater improvement in wrist and hand ROM and reduction of spasticity among hemiplegic stroke patients. (Ma et al., 2022)

The objectives of this study were:

1. To compare the effects of TST and m-CIMT on wrist and hand ROM among hemiplegic stroke patients.
2. To compare the effects of TST and m-CIMT on wrist and hand spasticity among hemiplegic stroke patients.

2. Methodology**2.1 Study Design and Setting**

A randomized controlled trial (RCT) design was adopted to compare the effectiveness of Task-Specific Training (TST) and Modified Constraint-Induced Movement Therapy (m-CIMT) among hemiplegic stroke patients. The study was

conducted at Ibne Sina Hospital Multan and BARKI Complex Multan, Pakistan. Pasted text The study protocol was approved by the ethical committee of TIMES University Multan, and written informed consent was obtained from all participants before participation. Pasted text

2.2 Participants and Sample Size

The study population consisted of first-time hemiplegic stroke patients from Multan. A total sample size of **66 participants** was recruited based on G*Power calculation. Participants were equally divided into two intervention groups, with **33 participants allocated to the Task-Specific Training group (Group A)** and **33 participants allocated to the Modified Constraint-Induced Movement Therapy group (Group B)**. Pasted text Participants included individuals aged **40-60 years**, diagnosed with first-time hemiplegic stroke confirmed through MRI or CT imaging, with stroke duration between **3 months and 1 year**. Patients with cognitive impairment, severe wrist and hand contractures, major neurological or musculoskeletal disorders, uncontrolled hypertension, visual impairment, or previous Botox injection in the affected limb were excluded. Pasted text

2.3 Sampling and Randomization

A non-probability purposive sampling technique was used. After eligibility assessment and baseline evaluation, participants were randomly allocated into two groups using a lottery method. Equal allocation was maintained to ensure comparable group sizes. Pasted text

2.4 Intervention Protocol

Both groups received baseline physiotherapy consisting of:

- Hot pack application (5 minutes)
- Range of motion exercises
- Strengthening exercises

The interventions were administered for **six weeks, four sessions per week**, with approximately one-hour sessions. Pasted text

Group A: Task-Specific Training (TST)

Participants performed functional, goal-directed activities designed to improve upper-limb use. Exercises included:

- Gripping and releasing objects of different sizes
- Manipulation activities such as opening jars, turning keys, and handling coins
- Fine motor activities including buttoning clothes, handling cutlery, and thumb-finger coordination tasks

Each activity was performed with repeated practice to improve functional movement control. Pasted text

Group B: Modified Constraint-Induced Movement Therapy (m-CIMT)

Participants wore a constraint device on the unaffected hand to encourage increased use of the affected limb. The intervention included:

- Wrist extension exercises
- Radial and ulnar deviation
- Forearm pronation and supination
- Weighted wrist curls
- Finger opposition
- Finger extension and abduction
- Ball squeezing
- Claw gripping
- Towel wringing

The m-CIMT protocol was conducted for six weeks with repeated practice of affected upper-limb movements. Pasted text

2.5 Outcome Measures

Range of Motion Assessment

A universal goniometer was used to measure active ROM of:

- Wrist flexion
- Wrist extension
- Radial deviation
- Ulnar deviation
- Metacarpophalangeal (MCP) joints
- Proximal interphalangeal (PIP) joints
- Distal interphalangeal (DIP) joints

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Spasticity Assessment

The Modified Ashworth Scale (MAS) was used to assess muscle tone and spasticity of:

- Wrist flexors and extensors

- Finger flexors and extensors
- Thumb flexors and extensors

The MAS scores ranged from 0 (no increase in muscle tone) to 4 (rigidity of the affected limb).

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2.6 Statistical Analysis

Data analysis was performed using IBM SPSS Statistics version 27. Descriptive statistics were used for demographic characteristics. Analysis of covariance (ANCOVA) was applied to compare post-treatment outcomes between groups while

controlling baseline values. Statistical significance was considered at $p < 0.05$, and partial eta squared (η^2) was reported to determine treatment effect magnitude. Residual normality was evaluated using the Shapiro–Wilk test. Pasted text

3. Results

3.1 Participant Characteristics

A total of 66 hemiplegic stroke patients completed the study, with 33 participants in each intervention group. The mean age of participants was 47.67 ± 4.708 years. Pasted text

Table 1. Demographic Characteristics of Participants

Variable	Frequency (n)	Percentage
Total participants	66	100%
Mean age	47.67 ± 4.708 years	—
Male	39	59.1%
Female	27	40.9%
Left-sided stroke	34	51.5%
Right-sided stroke	32	48.5%

The distribution demonstrated balanced representation of affected sides, with slightly higher left-sided involvement. Pasted text

3.2 Stroke Duration Distribution

Table 2. Duration Since Stroke

Duration	Frequency	Percentage
3–6 months	19	28.8%
7–9 months	28	42.4%
10–12 months	19	28.8%

Most participants belonged to the 7–9 month post-stroke category. Pasted text

3.3 Comparison of Spasticity Outcomes (Modified Ashworth Scale)

The ANCOVA results demonstrated significant differences between groups for all MAS outcomes.

Table 3. Comparison of Post-treatment Spasticity Between TST and m-CIMT

Body Region	MAS Variable	TST Mean	Adjusted	m-CIMT Mean	Adjusted	F-value	p-value	Partial η^2
Wrist	Flexion	1.057		1.610		25.294	<0.001	0.286
Wrist	Extension	1.095		1.935		41.561	<0.001	0.397
Fingers	Flexion	1.228		1.863		30.405	<0.001	0.326
Fingers	Extension	0.911		1.726		21.546	<0.001	0.255
Thumb	Flexion	0.467		1.624		46.874	<0.001	0.427
Thumb	Extension	0.580		1.784		43.040	<0.001	0.406

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Interpretation

The TST group consistently demonstrated lower MAS scores compared with m-CIMT, indicating greater reduction in spasticity. The largest difference was observed in thumb extension and

thumb flexion, suggesting that task-oriented repetitive movement may have a stronger influence on abnormal muscle tone regulation.
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3.4 Comparison of Wrist Range of Motion**Table 4. ANCOVA Comparison of Wrist ROM**

Movement	TST Adjusted Mean (°)	m-CIMT Adjusted Mean (°)	Mean Difference	F-value	p-value	Partial η^2
Flexion	62.884	71.419	8.535	76.27	<0.001	0.548
Extension	49.698	57.151	7.453	55.59	<0.001	0.496
Ulnar deviation	22.667	28.302	5.635	128.53	<0.001	0.671
Radial deviation	15.968	19.850	3.882	66.311	<0.001	0.513

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Interpretation

m-CIMT produced significantly greater improvements in wrist mobility compared with TST. The strongest effect was observed for ulnar deviation ($\eta^2=0.671$), demonstrating a large treatment effect. Pasted text

3.5 Comparison of Hand Range of Motion Outcomes**Metacarpophalangeal (MCP) Joint ROM**

The ANCOVA analysis demonstrated that Modified Constraint-Induced Movement Therapy produced significantly greater improvements in MCP joint ROM compared with Task-Specific Training. The m-CIMT group showed higher adjusted mean ROM values across index, middle, ring, little finger, and thumb MCP movements.

Table 5. Comparison of MCP Joint ROM Between TST and m-CIMT Groups

Joint	Movement	TST Adjusted Mean (°)	m-CIMT Adjusted Mean (°)	F-value	p-value	Partial η^2
Index MCP	Flexion	71.135	76.471	11.454	0.001	0.154
Index MCP	Extension	38.132	41.989	89.727	<0.001	0.588
Middle MCP	Flexion	75.819	77.848	5.709	0.020	0.083
Middle MCP	Extension	38.525	41.596	47.197	<0.001	0.428
Ring MCP	Flexion	75.102	78.534	20.210	<0.001	0.243
Ring MCP	Extension	36.695	41.760	68.822	<0.001	0.522
Little MCP	Flexion	74.774	78.135	15.869	<0.001	0.201
Little MCP	Extension	37.885	41.781	83.902	<0.001	0.571
Thumb MCP	Flexion	41.056	49.399	175.623	<0.001	0.736
Thumb MCP	Extension	7.110	9.042	64.145	<0.001	0.508

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Interpretation

The largest treatment effect was observed in thumb MCP flexion (partial $\eta^2 = 0.736$), indicating a substantial advantage of m-CIMT. These findings suggest that repeated active use of the affected limb and restriction of the unaffected limb may enhance joint mobility and motor activation, particularly in smaller functional

movements requiring hand control.

3.6 Proximal Interphalangeal (PIP) Joint ROM

The results indicated significant improvement in PIP joint mobility following m-CIMT. The adjusted mean ROM values were consistently higher in the m-CIMT group across finger movements.

Table 6. Comparison of PIP Joint ROM Between TST and m-CIMT Groups

Joint	Movement	TST Mean (°)	m-CIMT Mean (°)	F-value	p-value	Partial η^2
Index PIP	Flexion	87.693	90.671	17.571	<0.001	0.218
Index PIP	Extension	-4.427	-3.361	14.590	<0.001	0.188
Middle PIP	Flexion	87.300	90.124	27.402	<0.001	0.303
Middle PIP	Extension	-3.742	-1.288	94.625	<0.001	0.600
Ring PIP	Flexion	88.745	90.436	5.286	0.025	0.077
Ring PIP	Extension	-3.579	-1.996	25.491	<0.001	0.288
Little PIP	Flexion	84.372	88.659	53.869	<0.001	0.461
Little PIP	Extension	-4.164	-1.260	59.517	<0.001	0.486
Thumb IP	Flexion	57.224	81.413	280.660	<0.001	0.817
Thumb IP	Extension	15.300	19.276	148.810	<0.001	0.703

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Interpretation

The strongest effect was observed for thumb IP flexion ($\eta^2 = 0.817$), demonstrating a very large difference between groups. m-CIMT produced

greater improvement in finger and thumb mobility, indicating its potential effectiveness in restoring functional hand movements required for grasping and manipulation activities.

3.7 Distal Interphalangeal (DIP) Joint ROM

The DIP joint analysis also demonstrated superior improvement in the m-CIMT group.

Table 7. Comparison of DIP Joint ROM Between TST and m-CIMT Groups

Joint	Movement	TST Mean (°)	m-CIMT Mean (°)	F-value	p-value	Partial η^2
Index DIP	Flexion	70.812	78.855	68.583	<0.001	0.521
Index DIP	Extension	-1.455	-0.606	35.436	<0.001	0.360
Middle DIP	Flexion	68.417	76.553	56.647	<0.001	0.473
Middle DIP	Extension	-1.230	-0.618	15.465	<0.001	0.197
Ring DIP	Flexion	68.281	74.749	5.963	0.017	0.086
Ring DIP	Extension	-1.221	-0.355	44.960	<0.001	0.416
Little DIP	Flexion	71.221	78.506	53.056	<0.001	0.457
Little DIP	Extension	-1.241	-0.274	56.236	<0.001	0.472

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Interpretation

m-CIMT resulted in significantly greater improvement in distal finger mobility. The strongest improvements were observed in index DIP flexion and little finger extension. These results indicate that m-CIMT may provide greater benefits in restoring fine motor components of hand function.

4. Discussion

The present randomized controlled trial compared Task-Specific Training and Modified Constraint-Induced Movement Therapy for improving wrist and hand ROM and reducing spasticity among hemiplegic stroke patients. The findings demonstrated that both interventions produced beneficial effects; however, their treatment effects differed according to the outcome measured. m-CIMT showed superior improvement in ROM, whereas TST produced greater reductions in spasticity. (Banihani & Choukou, 2024)

The greater improvement in ROM following m-CIMT may be explained by its intensive practice-based approach. m-CIMT encourages repeated activation of the affected limb while limiting compensatory use of the unaffected limb. This increased motor practice may enhance cortical reorganization, improve motor recruitment, and promote functional recovery. Recent evidence from systematic reviews indicates that m-CIMT can improve upper-limb function among stroke survivors, particularly when intervention duration exceeds two weeks and training sessions are performed regularly. *BMJ Open* (S. Bastos et al., 2025)

The current findings support previous research demonstrating positive effects of m-CIMT on upper-limb recovery. Studies have reported improvements in motor function, hand dexterity, and functional use of the affected limb following m-CIMT interventions. Similarly, recent meta-analytic evidence suggests that CIMT-based interventions improve arm motor function and upper-limb impairment compared with conventional therapy. *BNR* (Ramirez-Nava et al., 2023)

The present study found that m-CIMT produced significantly greater improvements across wrist, MCP, PIP, and DIP joint ROM. This finding is consistent with Abdel Ghafar et al. (2025), who reported superior improvement in hand strength and dexterity following m-CIMT compared with alternative rehabilitation approaches. (Hung et al., 2025)

However, an important finding of the present study was that TST demonstrated greater reduction in spasticity. The lower MAS scores observed in the TST group may be related to the functional, repetitive, and controlled nature of task-oriented activities. Unlike repetitive isolated movements, TST requires purposeful motor planning, coordinated activation, and controlled execution, which may contribute to improved muscle regulation. (Surya & Srivastavat, 2020)

Previous studies have demonstrated that task-oriented training improves upper-limb function after stroke by encouraging meaningful and repeated activities. Rozevink et al. (2023) reported that task-specific training improves upper-limb performance, particularly through repeated functional practice. The current study extends previous evidence by showing that TST may have a specific advantage in reducing abnormal muscle tone.

The difference between interventions highlights that stroke rehabilitation should not focus on a single outcome. While m-CIMT may be preferred when the primary goal is improving joint mobility and active movement, TST may be particularly useful when spasticity management and movement control are priorities. (Sun et al., 2024) Therefore, a combined rehabilitation approach incorporating both interventions may provide comprehensive benefits by addressing both ROM limitations and abnormal muscle tone. (Fodor et al., 2023)

5. Conclusion

The present randomized controlled trial demonstrated that both Task-Specific Training (TST) and Modified Constraint-Induced Movement Therapy (m-CIMT) contribute positively to upper-limb recovery among hemiplegic stroke patients. However, the

effectiveness of the interventions differed according to the targeted outcome. m-CIMT produced significantly greater improvements in wrist and hand range of motion across wrist, MCP, PIP, and DIP joints, indicating its potential role in enhancing joint mobility and active limb use. In contrast, TST demonstrated greater reduction in spasticity, reflected by lower Modified Ashworth Scale scores across wrist, finger, and thumb movements.

These findings suggest that rehabilitation selection should be based on individual patient needs. Patients requiring improvement in joint mobility and active movement may benefit more from m-CIMT, whereas individuals with prominent spasticity may gain greater benefit from TST. Rather than considering one intervention universally superior, both approaches appear to provide complementary therapeutic advantages. Future rehabilitation programs may consider integrating both approaches to achieve comprehensive improvements in movement, muscle tone regulation, and functional independence.

6. Limitations

The present study has several limitations:

- **Limited sample size:** Although the sample size was statistically adequate, the inclusion of a larger number of participants may improve the generalizability of findings to broader stroke populations.
- **Short intervention duration:** The intervention period was limited to six weeks; therefore, long-term sustainability of improvements could not be evaluated.
- **Absence of long-term follow-up:** Post-treatment assessments were performed immediately after intervention, without evaluation of whether improvements were maintained over time.
- **Restricted participant characteristics:** Only hemiplegic stroke patients aged 40–60 years were included; therefore, findings may not be applicable to younger patients, older adults, or individuals with different stroke severity levels.
- **Measurement limitations:** ROM and spasticity assessments were based on clinical tools such as

goniometry and the Modified Ashworth Scale, which may not capture all aspects of motor recovery.

- **Supervised rehabilitation setting:** Interventions were performed under therapist supervision, and treatment adherence may differ in home-based or community settings.

7. Recommendations

Based on the findings of this study, the following recommendations are proposed:

- Future studies should include **larger multicenter randomized controlled trials** to improve external validity and confirm the effectiveness of both interventions.
- Longer intervention periods and follow-up assessments should be conducted to determine whether improvements in ROM and spasticity are maintained over time.
- Future research should investigate the **combined application of TST and m-CIMT**, as both interventions demonstrated different therapeutic strengths.
- Additional outcome measures such as **Fugl-Meyer Assessment, Action Research Arm Test, Wolf Motor Function Test, hand dexterity tests, and activities of daily living measures** should be incorporated to evaluate functional recovery more comprehensively.
- Objective technologies such as motion analysis systems, robotic assessment tools, or instrumented spasticity measurement devices may be considered alongside clinical assessments.
- Future studies should examine patient-related factors such as motivation, adherence, cognitive status, and psychosocial factors that may influence rehabilitation outcomes.

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