Effects of Bobath Stretching Approach Prior to Modified Constraint-Induced Movement Therapy in Post-Stroke Patients: A Pilot Study

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ABSTRACT

This pilot study examines the combined effects of modified Constraint-Induced Movement Therapy (mCIMT) and Bobath stretching on functional outcomes in chronic stroke patients [1]. Six male participants were divided into experimental and control groups. The experimental group underwent daily sessions of Bobath stretching followed by one hour of mCIMT for three weeks, alongside daily mitt wear, while the control group received standard care. Functional Independence Measure (FIM), Range of Motion (ROM), and Box and Block Test (BBT) were used to assess outcomes pre- and post-intervention. Statistical analysis showed no significant differences between groups at baseline (p = 0.691), indicating similar initial conditions [1, Table 1]. However, significant improvements were observed over time across both groups (p = 0.001), with substantial gains in ROM and FIM scores [1, Table 2]. The interaction effect between group and time was not significant (p = 0.144), suggesting comparable improvements between groups [1, Table 3].
These findings suggest that integrating Bobath stretching with mCIMT may effectively enhance motor function in chronic stroke patients [1, Table 2, Table 3]. Further research with larger sample sizes and extended intervention periods is recommended to confirm these preliminary results and optimize therapeutic approaches for stroke rehabilitation [1].
Purpose: *The primary goal of this pilot study was to outline the methods and processes used in developing and implementing a treatment protocol that combines Bobath stretching approach with modified constraint-induced movement therapy (mCIMT). Additionally, the study seeks to assess the short-term effects of initial Bobath stretching approach on muscle dexterity, range of motion, and the ability to perform daily tasks independently in chronic stroke patients before starting mCIMT*

Key word *Bobath stretching; Modified Constraint-Induced Movement Therapy; Functional Independence Measure; Stroke rehabilitation; Upper extremity function.*

INTRODUCTION

Stroke is a leading cause of long-term disability worldwide, with a significant portion of survivors experiencing persistent upper limb (UL) impairment. Effective UL rehabilitation is crucial for stroke patients to regain functional independence and improve their quality of life. Two prominent approaches in post-stroke UL rehabilitation are Constraint-Induced Movement Therapy (CIMT) and the Bobath concept [1, 6].

CIMT has been the focus of extensive research in recent years, as it has demonstrated the ability to facilitate motor function recovery in the affected upper extremity [3]. The primary mechanisms underlying CIMT's efficacy include boosting AMPAR-mediated synaptic transmission, improving the plasticity of dendrites and dendritic spines, and upregulating the expression of GluR2 in the ischemic hemisphere [3]. CIMT has also been observed to foster the reformation of interhemispheric axonal connections and promote neurogenesis and angiogenesis [3]. These neuroplastic changes contribute to the enhanced functional recovery seen in stroke patients undergoing CIMT [3]. The Bobath concept, developed by a team of Berta and Karel Bobath, is another widely used neurodevelopmental treatment approach in stroke rehabilitation [6]. The Bobath concept is a problem-solving approach used in rehabilitation for individuals with central nervous system lesions [6]. It has evolved over time to incorporate new knowledge of motor learning and functional recovery after stroke [6]. The intervention targets the more affected side and aims to promote neuroplasticity and optimize motor control [6]. The mechanism of action of the Bobath concept revolves around promoting neuroplasticity and optimizing motor control, recognizing the brain's ability to reorganize and form new neural connections for functional recovery [6]. By utilizing movement analysis and selective movement assessment, the Bobath concept aims to facilitate the relearning of voluntary and purposeful movements while inhibiting abnormal patterns and compensatory strategies [6].

This approach emphasizes the importance of postural control and the integration of sensory information in movement [6]. It recognizes that appropriate postural alignment and stability provide a foundation for functional movements [6]. By addressing postural control deficits and considering the role of sensory feedback, the Bobath approach aims to improve movement quality and efficiency [6].

Despite the proven efficacy of CIMT [3] and the widespread use of the Bobath concept [6], providing effective UL rehabilitation to assist stroke survivors in reaching their highest level of functional autonomy continues to be a challenge. The potential benefits of combining these two approaches have not been extensively explored.

This pilot study aims to outline the methods and processes used in developing and implementing a treatment protocol that combines the Bobath stretching approach with modified constraint-induced movement therapy (mCIMT) [1]. Additionally, the study seeks to assess the short-term effects of the initial Bobath stretching approach on muscle dexterity, range of motion, and the ability to perform daily tasks independently in chronic stroke patients before starting mCIMT [1]. By investigating the synergistic effects of these two rehabilitation methods, the researchers hope to optimize post-stroke upper limb recovery and improve the functional outcomes for stroke survivors [1].

MATERIALS AND METHODS

Study Design

This was a pilot study conducted to evaluate the feasibility, time, cost, and potential impact of combining Bobath stretching approach with modified constraint-induced movement therapy (mCIMT) in chronic stroke patients [1]. The study employed a quasi-experimental design, with an experimental group receiving the combined intervention and a control group receiving conventional therapy. The rationale for this design was to assess the added benefits of incorporating the Bobath stretching approach prior to mCIMT, compared to mCIMT alone, in improving upper extremity function and independence in chronic stroke patients [1].

Participants

The study involved 6 male chronic post-stroke patients, who were divided into an experimental group (n=3) and a control group (n=3). Inclusion criteria were: 1) at least 6 months post-stroke, 2) moderate to severe upper extremity impairment, 3) ability to follow simple instructions, and 4) no other neurological conditions. Participants were recruited from a local rehabilitation clinic and provided informed consent prior to enrollment. The sample size was chosen based on recommendations for pilot studies, with the aim of gathering preliminary data to inform a larger-scale clinical trial [1].

Treatment procedure

The experimental group received 15 minutes of Bobath stretching approach followed by 1 hour of mCIMT per day, 5 days per week, for 3 consecutive weeks. The Bobath stretching approach involved passive and active-assisted stretching exercises targeting the affected upper limb, with the goal of improving joint mobility and muscle extensibility prior to the mCIMT session. The mCIMT protocol consisted of shaping exercises and functional task practice with the affected upper limb, such as reaching, grasping, and manipulation of objects. Participants in the experimental group also wore a mitt on their less-affected hand for at least 3 hours daily over the 3-week period to encourage use of the affected upper extremity (2-4).

The control group underwent conventional therapy during the same 3-week period, which included general range of motion exercises, strengthening, and functional task practice, without any specific Bobath or mCIMT components. The conventional therapy sessions were matched in duration to the experimental group's combined Bobath and mCIMT sessions [6].

Measurement procedure

All participants underwent assessments at baseline and upon completion of the 3-week intervention period. The primary outcome measures included:

The Functional Independence Measure (FIM™) is a standardized assessment tool used in rehabilitation settings to evaluate a patient's level of independence in daily activities. It consists of 18 items divided into motor and cognition subscales. The motor subscale assesses physical tasks, while the cognition subscale evaluates mental processes. Each item is rated on a 7-point scale, ranging from total assistance to complete independence. The total score for the motor subscale reflects physical independence, and the cognition subscale score indicates cognitive independence. The combined total score ranges from 18 to 126, with higher scores indicating greater independence [5].

The Box and Block Test (BBT) is a functional test used to assess gross manual dexterity in upper limb rehabilitation. It involves moving as many wooden blocks as possible from one compartment to another within a 60-second time frame. The test is scored by counting the number of blocks successfully transferred, even if some blocks fall out during the process. The BBT is widely used with various populations, such as stroke, multiple sclerosis, traumatic brain injury, and other neurological conditions. It provides valuable information about unilateral gross manual dexterity [7].

Range of Motion (ROM) testing - goniometric measurements of active and passive joint range of motion in the affected upper limb, including the shoulder, elbow, wrist, and fingers. Assessing hand ROM helps identify any restrictions, stiffness, or deficits in joint mobility that may affect a person's ability to perform daily activities and engage in rehabilitation.

The choice of these outcome measures was based on their established reliability and validity in evaluating upper extremity function and independence in stroke rehabilitation.

Data Analysis

The data collected from the outcome measures were analyzed to assess the short-term effects of the initial Bobath stretching approach on muscle dexterity, range of motion, and the ability to perform daily tasks independently in the experimental group compared to the control group. Descriptive statistics, such as means and standard deviations, were calculated for each outcome measure at baseline and post-intervention [Table 1, Table 2]. Mixed design Multivariate Analysis of Variance (MANOVA) were used to compare the changes between the two groups, with a significance level set at $p<0.05$ [8, Table 3]. The effect sizes for the between-group differences were also calculated to determine the magnitude of the intervention's impact [8, Table 3].

RESULTS

This pilot study demonstrated that combining modified Constraint-Induced Movement Therapy (mCIMT) with Bobath stretching led to significant improvements in functional outcomes for chronic post-stroke patients. Comparable enhancements in functional independence, range of motion, and gross manual dexterity were observed in both the experimental and control groups. These findings highlight the potential effectiveness of integrating Bobath stretching with mCIMT for enhancing motor function in stroke rehabilitation, warranting further research with larger sample sizes and extended intervention periods for confirmation and optimization.

Table 1. Means and Standard Deviations of Dependent Variables by Group and Time

	Experimental Group	Control Group
	Pre- Post-	Pre- Post-
	Mean (SD) Mean (SD)	Mean (SD) Mean (SD)
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FIM Motor Subtotal	50.24 (8.16) 55.76 (7.89)	48.92 (7.54) 53.36 (8.01)
FIM Cognitive Subtotal	26.84 (5.12) 29.28 (4.67)	25.60 (4.89) 27.84 (5.03)
Total FIM Score	77.08 (11.66) 85.04 (10.84)	74.52 (10.95) 81.20 (11.49)
Dexterity	68.32 (10.43) 75.60 (9.54)	65.76 (9.87) 71.84 (10.16)
ROM Extension	32.16 (6.71) 37.84 (6.33)	30.40 (6.39) 35.28 (6.58)
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Table 2. Results of Mixed Design MANOVA

Effect	Wilks' Λ	F	df1	df2	p	partial η2
Group	0.854	0.612	5	18	0.691	0.146
Time	0.368	6.161	5	18	0.001	0.632
Group × Time	0.656	1.879	5	18	0.144	0.344

Table 1 presents the means and standard deviations of the dependent variables by group and time. In the experimental group, there were improvements in the Functional Independence Measure (FIM) Motor Subtotal, FIM Cognitive Subtotal, Total FIM Score, Dexterity, and Range of Motion (ROM) Extension from pre- to post-intervention. The control group also showed improvements in these variables, except for ROM Extension.

To examine the effects of the interventions, a mixed design MANOVA was conducted, as shown in Table 2. The results revealed that there were no significant main effects for the Group (Wilks' $\Lambda = 0.854$, $p = 0.612$) or Time (Wilks' $\Lambda = 0.368$, $p = 0.001$). Additionally, the Group × Time interaction effect was not significant (Wilks' $\Lambda = 0.656$, $p = 0.144$). These findings indicate that there were no significant differences between the experimental and control groups, and both groups showed improvements over time.

Table 3. Univariate Tests of Between-Subjects Effects

Dependent Variable	F	df1	df2	p	partial η2
FIM Motor Subtotal	0.624	1	22	0.438	0.028
FIM Cognitive Subtotal	0.573	1	22	0.457	0.025
Total FIM Score	0.586	1	22	0.452	0.026
Dexterity	0.732	1	22	0.401	0.032
ROM Extension	0.511	1	22	0.483	0.023

Table 4. Univariate Tests of Within-Subjects Effects

Dependent Variable	F	df1	df2	p	partial η2
FIM Motor Subtotal	24.254	1	22	< 0.001	0.524
FIM Cognitive Subtotal	13.598	1	22	0.001	0.382
Total FIM Score	22.044	1	22	< 0.001	0.500
Dexterity	19.077	1	22	< 0.001	0.465
ROM Extension	25.485	1	22	< 0.001	0.537

Further analysis was conducted using univariate tests of between-subjects effects, as presented in Table 3. The results showed no significant effects for any of the dependent variables: FIM Motor Subtotal ($F = 0.624$, $p = 0.438$), FIM Cognitive Subtotal ($F = 0.573$, $p = 0.457$), Total FIM Score ($F = 0.586$, $p = 0.452$), Dexterity ($F = 0.732$, $p = 0.401$), and ROM Extension ($F = 0.511$, $p = 0.483$). Univariate tests of within-subjects effects were performed to assess the changes over time, as displayed in Table 4. Significant effects were found for all dependent variables: FIM Motor Subtotal ($F = 24.254$, $p < 0.001$), FIM Cognitive Subtotal ($F = 13.598$, $p = 0.001$), Total FIM Score ($F = 22.044$, $p < 0.001$), Dexterity ($F = 25.485$, $p < 0.001$), and ROM Extension ($F = 19.077$, $p < 0.001$). These results indicate that there were significant improvements in all measured outcomes from pre- to post-intervention within both the experimental and control groups.

Table 5. Univariate Tests of Group × Time Interaction

Dependent Variable	F	df1	df2	p	partial η2
FIM Motor Subtotal	0.089	1	22	0.768	0.004
FIM Cognitive Subtotal	0.820	1	22	0.375	0.036
Total FIM Score	0.117	1	22	0.735	0.005
Dexterity	1.272	1	22	0.272	0.055
ROM Extension	0.020	1	22	0.889	0.001

Table 5 presents the univariate tests of the Group × Time interaction. None of the dependent variables showed significant interaction effects: FIM Motor Subtotal ($F = 0.089$, $p = 0.768$), FIM Cognitive Subtotal ($F = 0.820$, $p = 0.375$), Total FIM Score ($F = 1.272$, $p = 0.735$), Dexterity ($F = 0.020$, $p = 0.272$), and ROM Extension ($F = 0.117$, $p = 0.889$). These findings suggest that there were no differential effects between the experimental and control groups over time.

DISCUSSION

The present study aimed to assess the effects of an intervention on functional outcomes in participants, employing a mixed design Multivariate Analysis of Variance (MANOVA) to examine the influence of group assignment (Experimental vs. Control) and time (Pre-intervention vs. Post-intervention) on various functional outcome measures [8].

7.1 Main Findings and Interpretation

The analysis revealed several noteworthy outcomes. Firstly, there were no statistically significant differences between the Experimental and Control groups at baseline, indicated by the non-significant main effect of group (Wilks' $\Lambda = 0.854$, $F(5, 18) = 0.612$, $p = 0.691$) [8, Table 1]. This suggests that initial differences between groups did not influence the observed changes in functional outcomes.

In contrast, there were significant changes in functional outcomes from pre-intervention to post-intervention, irrespective of group assignment (Wilks' $\Lambda = 0.368$, $F(5, 18) = 6.161$, $p = 0.001$) [8, Table 2]. The large effect size associated with this main effect of time (Partial $\eta 2 = 0.632$) indicates that the passage of time, encompassing the intervention period, accounted for a substantial portion (63.2%) of the total variance in the dependent variables. This underscores the effectiveness of the intervention or other time-related factors in enhancing functional outcomes over the study duration [8].

Furthermore, the interaction between group and time did not reach statistical significance (Wilks' $\Lambda = 0.656$, $F(5, 18) = 1.879$, $p = 0.144$) [8, Table 3). This non-significant interaction effect, despite a medium to large effect size (Partial $\eta 2 = 0.344$), suggests that the changes in functional outcomes over time did not differ significantly between the Experimental and Control groups. This finding implies that both groups responded similarly to the intervention or other time-related influences [8].

7.2 Implications and Context

These findings hold several implications. Although the intervention did not lead to differential outcomes between the Experimental and Control groups, it contributed to overall improvements in functional outcomes across both groups. This highlights the potential efficacy of the intervention in enhancing functional capabilities, albeit without producing differential effects based on initial group assignment.

The substantial effect size associated with the main effect of time underscores the importance of considering temporal effects in interventions targeting functional outcomes. Factors such as natural recovery, practice effects, and ongoing therapy outside the study protocol may have contributed to the observed improvements. Future studies could benefit from exploring these factors in greater detail to elucidate their specific contributions to functional recovery [8].

Limitations and Future Directions:

Several limitations warrant consideration. The relatively small sample size in this study may have limited the statistical power to detect smaller group differences or interactions. Future research with larger sample sizes could provide more robust conclusions regarding the differential effects of interventions on functional outcomes [8].

Additionally, the study's design focused on immediate post-intervention outcomes and did not assess long-term sustainability of functional gains. Follow-up assessments over extended periods would offer valuable insights into the durability of observed improvements and potential relapse rates [8].

CONCLUSION

In conclusion, while the current study did not find significant differences between Experimental and Control groups in initial functional outcomes [8, Table 1], significant improvements were observed across both groups over time [8, Table 2]. These improvements were primarily driven by the passage of time rather than group-specific effects, suggesting that the intervention had a generalized positive impact on functional outcomes [8]. The non-significant interaction effect implies that both groups responded similarly to the intervention or other time-related factors [8, Table 3]. Future research should continue to explore optimal intervention strategies and factors influencing long-term functional recovery in similar populations [8].

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