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Effects of Modified Constraint-Induced Movement Therapy with Trunk Restraint versus Bobath Approach on Motor Function and Activities of Daily Living in Hemiplegic Upper Extremity after Stroke

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DECLARATIONS

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ABSTRACT

Background: Stroke has been known as the leading cause of disability globally, resulting in significant morbidity and mortality despite early interventions. Difficulties in the functions of the upper limbs are common after stroke. These impairments commonly comprise difficulty in moving and coordinating hands, arms, and fingers. This eventually results in difficulty in performing activities of daily living. **Objective:** To compare the effectiveness and the efficiency of modified constraint movement therapy combined with trunk restraint with the Bobath approach on the improvement of motor function and activities of daily living in hemiplegic upper extremity after stroke. **Methodology:** A randomised trial was conducted at the General Hospital and the University Physical Therapy and Rehabilitation Clinic. Diagnosed participants who had an episode of 1st stroke between 2 to 12 weeks of the sub-acute stage, both males and females aged between 40 to 70 years, with a mini-mental state exam of greater than or equal to 7, were recruited in our study. Those patients were excluded from the current study who had shoulder pain or neurological or orthopaedic conditions, patients with hemi-spatial neglect or apraxia, comorbidity, any disability, or psychosocial issues. One group was given the Bobath Approach, and the other was given the modified constraint-induced movement therapy with trunk restraint. Repeated measure ANOVA was employed to compare the motor function and activities of daily living at baseline, 4th, and 8th week follow-ups. **Results:** Between-group comparison of mean scores of the Motor Assessment Scale shows that the group receiving the constraint-induced movement therapy with restraint trunk showed more improvement in score at the 8th week when compared with the Bobath therapy. **Conclusion:** The results showed that modified constraint-induced therapy with trunk restraint yielded better outcomes compared to the Bobath concept in refining motor function of the hemiplegic upper extremity and activities of daily living.

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INTRODUCTION

Stroke has been recognised as one of the chief causes of disability globally. The World Health Organisation well-defined stroke as a speedily developing consisting of clinical signs of focal or global disruption of cerebral function, which tends to last for more than 24 hours or might become fatal, with apparently no cause of vascular origin. Almost more than half of the patients after suffering from a stroke are left with disability.[1] Difficulties with the functioning of the upper extremities are very common after suffering from a stroke. These impairments tend to include common difficulties in moving and coordinating the hands, arms, and fingers. This commonly results in difficulty in performing activities of daily living such as dressing, washing, and eating. The majority of patients with upper extremity impairment after the stroke tend to have problems many months to years after their stroke.[1,2]

These are the Brunnstrom stages of arm recovery, which have been considered ideal for arm recovery. Stage 1 is when the limb is in the flaccid stage, and no movements can be initiated. Stage 2 is when the basic synergies components of the limb might appear as associated reactions, and this stage consists of negligible voluntary movement responses. At stage 3, patients tend to gain control over their movement synergies, even though the full range of all synergy components may not have developed. At this stage, the spasticity has developed and might become severe. At stage 4, the spasticity starts to decrease. It includes, raising the arm forward to a horizontal position, raising the arm towards the rear of the body and pronation and supination of forearm with elbow flexed also can be performed. Components that comprise stage 5 are the arm raised to the side horizontal position, raising the arm overhead, and moving the palm up and down with the elbow extended. At stage 7, the last stage, normal motor functioning is restored.[1]

Improving the functioning of the upper extremity is a major part of stroke rehabilitation, which tends to maximise the outcomes of the patients and reduce the disability. Numerous interventions have been established, which tend to include various exercises and training methods, equipment, or techniques, and they might have taken the form of a medicine (injection or a pill) given to aid in the movement of the arm.[2] The Bobath concept is known as one of the most popular neurophysiological approaches in the field of neuro-rehabilitation, which is based on neurodevelopmental treatment. The objective of this concept is to enhance the patient's functional capacity after suffering from a stroke by improving the control of posture with the aid of selective facilitating movements.[3] The Bobath approach firmly believes that patients must be active while the physical therapist aids the patient to learn by using the key points of reflex and control inhibition. The concept also comprises assessing the functional deficits, their causes, and analysing the disability.[4]

The task-specific training was developed by Carr and Shepherd in 1987. It is an interventional approach of neurological rehabilitation which was based on motor re-learning. It is firmly believed that a rehabilitation plan should begin soon after the injury and must focus on functional tasks rather than routine exercises, where the patient practices the background-specific motor task and receives some form of feedback. It also tends to involve the functional task of everyday life. There has been growing evidence on the benefits of effects of task-specific training in rehabilitation following stroke.[5] Even though a large number of patients who have suffered a stroke tend to recover and recuperate their ability to walk. Still, more than 85% of them are not able to use the most affected arm in the acute stage and the following phases; this number tends to remain high, almost between 45 and 75%.[6] The repossession of the affected upper extremity is usually slower than that of the lower extremities, as the functioning of the upper extremities necessitates better-quality movements and greater dexterity. Additionally, the unaffected upper extremity tends to assume the role of manipulating objects, reaching, which generates a larger abandonment or erudite non-use phenomenon of the affected upper extremity [6,7]

Non-use starts when the acute phase following the stroke persists, depending on the relentlessness of the symptoms and the lack of rehabilitation.[8] The upper extremity is involved in an extensive range of tasks, which involve various positions, settings, temporal adjustments, and sequences of movements of the joints that tend to perform a particular task and function. The actions of the upper extremities are essentially the ability to

reach, which is defined as placing the hand voluntarily in space towards an object or location to accomplish a specific goal.[9] For stimulating the use of the affected upper extremity, various studies have shown that employing the constraint-induced movement therapy has been deliberated to be the most encouraging therapy for improving the function of the affected upper extremity.[10] A large number of research studies, which involved systematic reviews and clinical trials, tend to provide evidence regarding the advantages of constraint-induced movement therapy on survivors of chronic stroke.[11-13] When the affected limb is restrained, the other one will be automatically stimulated to supply the notable functions, which leads to greater plasticity in the musculoskeletal and neural systems. Normally, these interventions are always carried out in clinical settings. This tends to contribute less to direct adaptations in the patients' home setting, where they live for most of the time.

Constraint-induced movement therapy is carried out in home settings, for it is the patients' real world, it will aid in learning and will contribute to greater behavioural changes, which is a substantial function of the therapy. To perform the movements of grasping and reaching, various motion analysis studies have determined that, generally, patients with stroke use the trunk excessively, and compensatory movements of the shoulder are performed in order to accomplish their tasks. Compensations like these can be observed as positive adaptations of the body to the new condition and situation. Nevertheless, performing the movements of the trunk excessively is not always appropriate for the reacquisition of the performance of the skilled movements.[14,15]

The compensations that tend to result from the incapability to produce movements and regulate them might be because of weaknesses in the muscles, deficits of the sensory systems, spasticity, and pain in the shoulders.[16,17] Some studies have determined the effects of trunk restraints during reach-to-grasp tasks, constraint-induced movement therapy, and task-related training.[18,19] Despite promising results, there is still inadequate and insufficient evidence considering the benefits of constraint-induced movement therapy with trunk restraint and then comparing them to the benefits provided by Bobath alone. Especially in underdeveloped countries like Pakistan, there is a dire need to find out the best intervention for patients of stroke to treat them in the best way economically and beneficially. Consequently, the overall objectives of our current study are to determine which treatment is more beneficial or just to compare them roughly for the sake of determining the better one, focusing on improvements in the motor function and activities of daily living in the hemiplegic upper extremity after stroke. Our current study focuses on comparing the effects of the neurophysiological approach of Bobath with modified constraint-induced movement therapy with trunk restraint on the functioning of the upper extremities of stroke patients. This might aid healthcare providers in selecting interventions for patients more effectively and efficiently.

METHODOLOGY

Our current study is a randomised controlled trial. The data for our study was collected from the Department of Physiotherapy, General Hospital, Lahore, and the University Physical Therapy and Rehabilitation Clinic, University of Lahore, Lahore, Pakistan. Our study was completed in nine months after the agreement of its synopsis. A sample size of 50 participants was recruited in this study, and then they were allocated into 2 groups of 25 participants each. The sample size for this study was calculated by employing the following formula, keeping the power of the study equal to 95% and the level of significance was kept at 5% with a drop off of 20% which made 30 participants in each group.

$$n = \frac{2\sigma^2(z_{1-\alpha/2} + z_{1-\beta})^2}{(\mu_1 - \mu_2)^2}$$

- Level of significance: $\alpha = 5\%$
- Power of test: $1 - \beta = 80\%$
- Anticipated population mean: $\mu a = 35.13$
- Test value for population mean: $\mu o = 38.71$
- Standard Deviation in experimental Group A and Group B = $\delta = 4.475$
- Sample size in each group: n = 25

The sampling technique employed was the non-probability purposive sample technique. Those patients were recruited in our study who had an episode of 1st stroke between 2 to 12 weeks of the sub-acute stage. Both males and females aged between 40 to 70 years were recruited in our study. All the recruited patients' condition was confirmed by a performed CT scan, MRI, or were diagnosed clinically by a neurophysician. Only

those patients were recruited in this study who had a mini mental state exam of greater than or equal to 7.[20] Those patients were excluded from our current study who had shoulder pain or any type of neurological or orthopedic condition which tend to affect the reaching movement ability or trunk, patients with hemi- spatial neglect or apraxia. Those patients with any sort of comorbidity or any disability other than stroke that could have unacceptable their training in upper limb training were excluded from our current study. Patients with any sort of any uncontrolled health condition for which exercise was contraindicated were also excluded from our study. Patients with psychosocial issues were also excluded from our study.[20] The equipment employed in our study was trunk stabilisation and a mitt for the unaffected hand.[21] The instructions and protocols which were set by the ethical committee of the University of Lahore were followed while conducting our research. The rights of the research participants were treasured at all times. Written informed consents in Urdu and English were taken from the recruited participants.

The recruited participants were assured that all their evidence and statistics would be kept confidential. Participants remained unidentified throughout the study. All the participants of our current study were informed that there were no disadvantages to this study and no risks were involved. They were also knowledgeable that they would have the freedom to withdraw at any time during the conduct of this study. After getting the knowledgeable consent form, the participants went through a comprehensive neurological examination and were assessed for their eligibility as mentioned in the inclusion and exclusion criteria. In order to assess the eligibility, the participants underwent a thorough examination. After this, a pre-test was conducted. The motor impairment levels and the functioning of the upper extremity were assessed by employing the Motor Assessment Scale (MAS). .[22]

The activities of daily living and the assessment scale were assessed by employing the Barthel index.[23] The experiment started one day after the randomisation. For both groups, the interventions tend to progress during the routinely scheduled therapy sessions, and all other routine interdisciplinary stroke rehabilitation ensued as per routine. In Group 1, the participants received modified constraint-induced movement therapy.[24] With trunk restraint as intervention, the participants in Group 2 received physiotherapy, which was based on the Bobath concept as intervention.[25,26] The recruited patients were reassessed on the outcome scales after four weeks of the treatment, and follow-up was performed after one month. After assessing the participants, they were randomly assigned to either of the two groups by employing a lottery method.[27] The random numbers were generated from one to thirty by employing an online random number generator in 2 sets.[28] Set 1 was assigned as modified constraint-induced movement therapy, and Set 2 was the physical therapy based on the Bobath concept. The sealed envelope method was employed to allocate the participants into both groups.[29] The assessor was blinded to the treatment provided to each group.

Group A received the modified constraint-induced movement therapy with trunk restraint group for a one-hour session at the rehabilitation clinic, on 5 days per week, for four weeks, a total of twenty sessions. The training provided was grounded in repetitive and task-specific practice. The participants were asked to perform tasks with the paretic arm only, while the less-paretic arm was restrained in a mitt. During the 4th week period, the participants with less paretic hands and wrists

Table 1: Descriptive statistics

Variables		Control Group f(%)	Experimental Group f(%)	Total f(%)
Types of Stroke	Ischemic	16(53.3)	15(50)	31(51.7)
	Hemorrhagic	14(46.7)	15(50)	29(48.3)
Affected Side	Right	15(50.0)	15(50.0)	30(50.0)
	Left	15(50.0)	15(50.0)	30(50.0)
Total		30(100)		

Table 2: Between-group comparison of the motor assessment scale and the Barthel index scale

Groups		Motor Assessment Scale Mean(S.D)	Barthel index scale Mean(S.D)
Control Group	Baseline	7.23(2.73)	39.5(10.26)
	4th week	15.53(2.88)	67.03(4.27)
	8th week	23.57(2.19)	78.63(5.61)
Experimental Group	Baseline	10.77(2.3)	39.63(10.2)
	4th week	22.3(2.42)	71.17(6.91)
	8th week	46.67(3.94)	94.9(2.21)

were placed in mittens by using self-adhesive straps. Patients in this group were restrained at the trunk by a non-elastic strap during the intervention, limiting the compensatory movements of the trunk. Pelvic motion and arm movement were not restricted. The physical therapist provided unwavering verbal feedback to increase the effectiveness of the training. The more affected arm restraint was completed by employing a padded mitt that hindered the use of the fingers of the less-affected arm.

Group B was treated by the Bobath approach, which takes about one hour per day in a twenty-session plan. This intervention will be grouped into five main items: mobilisation, assisted movement, practising an activity component and the entire task, and teaching patients. Individually programmed all the interventions, aimed at improving postural control of the trunk and shoulder girdle which tend to enable more selective movement of the arm and to increase strength and functioning, aiming at recovering full range of motion and its
patterns, to improve and augment effectiveness and maximizing functioning and tumbling the relentlessness of impairments where they tend to influence functioning. Statistical Package for Social Sciences version 23 was employed for data analysis. Frequency and percentage were employed to represent the qualitative variables like occupation, gender, and for quantitative variables like age and time etc. Mean and standard deviation were also calculated. Repeated measure ANOVA was employed to compare motor functions and activities of daily living at baseline, 4th, and 8th week follow-up. The p-value less than 0.05 or equal to was taken as significant.

RESULTS

Table 1 represents the types of stroke count of patients recruited in this study. In our current study, two types of strokes were included, ischemic and hemorrhagic. 53.3% patients were of ischemic stroke within the control group and 46.7% hemorrhagic stroke in the control group, while the experimental group had 50% ischemic and 50% hemorrhagic stroke patients. It also represents the descriptive statistics of the affected side involved. The results showed that within the control group 50% was the right side involved and Fifty percent the left side, while in the experimental group 50% was the right side affected and 50% was the left side.

Table 2 represents a between-group comparison of mean scores of the Motor Assessment Scale. It shows that the experimental group, which is Group A, the constraint-induced movement therapy with restraint trunk, showed more improvement in score at the 8th week when compared with the control group, which was the Bobath concept group. Although the mean score of the motor assessment scale tends to improve in both groups. Table 4 represents the between-group comparison of the mean scores of the Barthel index scale. The results show improvement of scores in both groups till the 8th week follow up but the experimental group showed more improvement. Figure 1 represents the mean age of participants in the control group. The mean age was 53.83 years in the control group. Figure 2 represents the mean age of participants in the experimental group. The mean age of participants in the experimental group was 59.5 years.

DISCUSSION

The results of our study show that modified constraint-induced therapy with trunk restraint shows better results when compared to the Bobath concept in refining the motor functioning of the hemiplegic upper extremity and activities of daily living. Our study concludes that modified constraint-induced movement therapy combined. With trunk restraint might be customised according to the strength of the affected upper extremity; it must be employed to improve the functioning of the upper extremity and performance of the activities of daily living in patients after suffering from stroke.

Figure 1: Age of participants in the control group

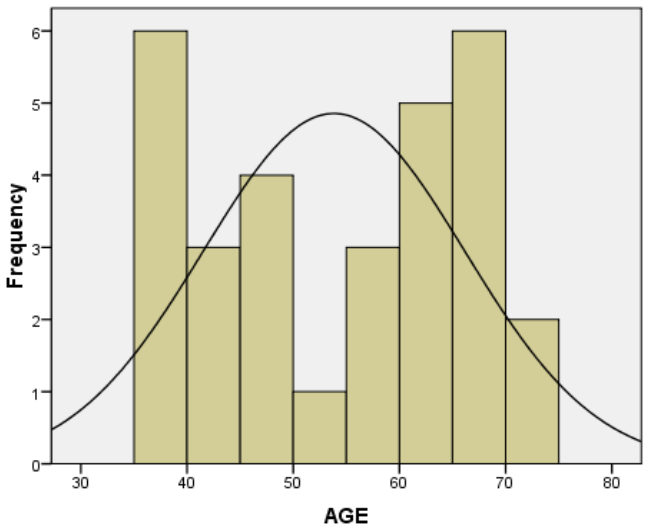
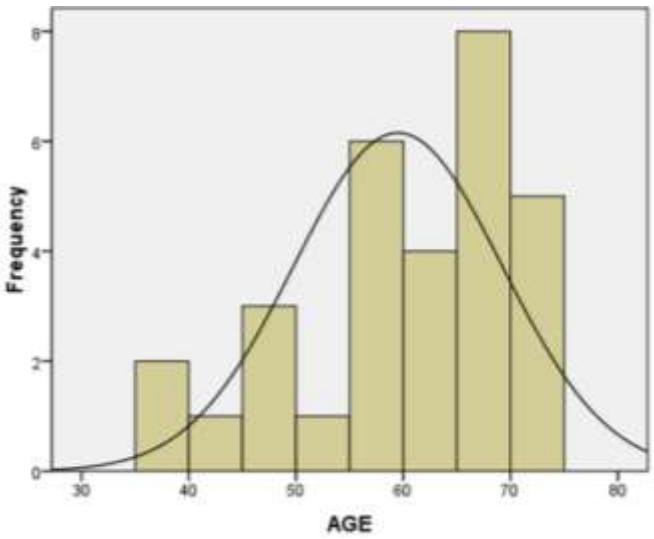


Figure 2: Age of participants in the experimental group



Radwa S. Abdul Rehman and co-workers conducted a study to compare the efficacy of modified constraint-induced movement therapy with neuro-developmental therapy on the reaching capacity of children with hemiplegic cerebral palsy. In the United States, the Bobath concept is commonly referred to as Neurodevelopmental Therapy (NDT).[30] Their study tends to compare the effects of modified constraint-induced movement therapy and the approach of Bobath on reaching capacity in children with cerebral Their results showed substantial improvement in all the pre-treatment and post-treatment outcomes, which was seen in both groups by employing a two-way mixed MANOVA. The modified Constraint-induced movement therapy group showed more significant improvement when compared with the post-treatment outcomes of the other group. The results of our current study coincide with their results. Our study also showed more improvement in the constraint-induced movement therapy group.[31]

Hyoseon Choi and co-workers conducted a study to determine the effects of constraint-induced movement therapy on the function of the arm and activities of daily living in post-stroke patients. Their work was a systematic review and meta-analysis. Their results concluded that constraint-induced movement therapy might be tailored to the strength of the affected upper limb, and it should be used to augment the function of the upper limb and activities of daily living in post-stroke patients with hemiplegia. The health care providers should implement constraint-induced movement therapy focusing on the exclusive values and preferences of the patients.[11] Our study completely agrees with their conclusion and represents the same conclusion. Burcu Ersoz and co-workers conducted a randomised controlled trial to compare the Bobath approach with constraint-induced movement therapy to improve the functional recovery of the affected arm in patients with stroke. Their results clearly showed that the constraint-induced movement therapy turned out to be slightly more competent than the Bobath approach for refining the quality of activities performed by the affected arm.[32] Our current study completely agrees with their result. Our current study and their study both agree on the fact that both approaches, the constraint-induced movement therapy and the Bobath approach, tend to have comparable efficacies for improving the speed and quality of movement of the hemiplegic arm and functional capability of the affected arm of the stroke patients.

In underdeveloped countries like Pakistan, future researchers are advised to carry on such comparative studies in order to conclude which intervention is best in every way for stroke patients. Future researchers are also advised to carry out trials to compare these interventions to determine which intervention is more economical for stroke patients in countries like Pakistan. So that both stroke patients and health care providers would benefit. Future researchers are recommended to work on a larger sample size of stroke patients for more generalised, reliable, and accurate results. More randomised control trials for interventions for stroke patients should be performed on patients in rural areas, especially in countries of Pakistan, so that the most economical, effective, and efficient treatment can be chosen for them, considering the increasing rate of stroke.

CONCLUSION

Modified constraint-induced therapy with trunk restraint yields better outcomes compared to the Bobath concept in enhancing motor function of the hemiplegic upper extremity and activities of daily living. Both interventions tend to have similar efficiencies in improving the quality of movement and functional ability in the affected arm amongst the stroke patients. However, constraint-induced movement therapy appears to be slightly more effective than the Bobath concept in improving the motor function of the hemiplegic upper extremity.

DECLARATIONS

Consent to participate: Written consent had been obtained from patients. All methods were performed following the relevant guidelines and regulations.

Availability of Data and Materials: Data will be made available upon request. The corresponding author will submit all dataset files.

Competing interests: None

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Authors' contributions: All authors had read and approved the final manuscript.

CONSORT Guidelines: All methods were performed following the relevant guidelines.

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