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Effects of Modified Constraint-Induced Movement Therapy Versus Proprioceptive Neuromuscular Facilitation on Upper Limb Motor Function in Chronic Ischemic Stroke Patients

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Author`s Contribution

[1 2 3 4 5] Substantial contributions to the conception or design of the work for the acquisition, analysis or interpretation of data for the work, [1 2 3] Drafting the work or reviewing it critically for important intellectual content, [2 3] Final approval of the version to be published, [1 2 3 4 5] Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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A B S T R A C T

Background: Motor function is the most important long term consideration for conservative management for post stroke patients. Modified constraint induced therapy is a promising treatment to improve functionality of limbs. PNF combines the use of spirals and diagonals in specific directions with techniques that cause muscle pain, relaxation and muscle contraction, and overlapping techniques.

Objective: To assess effects of modified constraint induced movement therapy versus proprioceptive neuromuscular facilitation on upper limb motor function in chronic ischemic stroke patients.

Methodology: It was a randomized control trial. Total number of participants was 72 (66 after dropout) of chronic stroke patients.it was a single blinded study.one group was given conventional physical therapy with PNF and other group was given conventional physical therapy with MCIMT. This study was conducted by the ethical approval of research and ethics committee of University of Lahore. Study Design was a randomized controlled trial. Patients were recruited from Social Security Hospital Lahore.

Results: the participants mean age was 58.1818(PNF) and 58.3939 (MCIMT). We used the Motor activity log 30 and Fugl Meyer motor assessment scale. There was not seen a significant difference in between the groups pretreatment ($p>0.05$). A significant difference was noted post intervention ($p<0.05$) in both the groups. However the MCIMT group showed better scoring for both FMA and MAL .

Conclusion: The study showed that both techniques are effective improving upper limb function but MCIMT shows more favorable results.

Key Words: Hemiplegia, Motor Activity, Proprioceptive Neuromuscular Facilitation, Stroke, Stretching.

Introduction

Stroke is a huge contributor to the population of disabled individuals worldwide. [1] on every four individual suffers for the debilitating condition that is stroke, at least once in our lifetimes Neurorehabilitation is extremely important in dealing with the aftereffects of stroke.[1] Physical therapy is important to increase the range of motion and strengthen and to increase the mobility of the patient[2] as 70-80% of stroke survivors reportedly have persisted upper limb impairment.[3] Structured rehabilitation not

only increases the mobility and strength but also decreases the chances of stroke reoccurrence. There are several approaches to rehabilitation after stroke for example; PNF (proprioceptive neuromuscular facilitation), Bobath, mobilization and stimulations.[4] and constraint induced movement therapy.

Constraint Induced Movement Therapy is a behavioral approach that can be used in both acute and chronic stages of stroke and is convenient in a sense that it can be applied in both clinical and home settings. Constraint induced therapy is based on the principle of 'learned non-use'.[5] This technique discourages the phenomenon of learned non-use by forcing the effected extremity to perform tasks while the unaffected extremity is constrained. This is achieved by wearing constraint devices on the unaffected extremity. 10 to 15 tasks are performed by the patient in sets of 10 to 30seconds trials.[6] Repetitive exercise thus enable the brain in generation of new neural pathways. Constraint induced movement therapy also enhances the homeostasis in the neuronal cell.[7] Classic constraint induced movement therapy requires the constraintment of the patient's unaffected extremity to be constrained 80-90% of the time, but this may result in problems for the patient in his daily life henceforth the modified CIMT (mCIMT) protocol with varying intensities and durations of exercise has been developed Modified constraint induced therapy is a promising new treatment to improve functionality of limbs in chronic stroke patients.

Proprioceptive neuromuscular facilitation (PNF) is a neurophysiological process the stimulates the neurons from the peripheries to transmit impulses to the central nervous system by stimulating sensory neurons around muscles and joints to extend, resist, contract, approach, and audible and visual commands to the patient .[8] PNF combines the use of spirals and diagonals in specific directions (antagonist and agonist muscles) with techniques that cause muscle pain, relaxation and muscle contraction, and overlapping techniques. Proprioceptive Neuromuscular Facilitation combines the use of the sensory system and motor system through neurological and neurophysical techniques to do evaluation and treatment of the neurological and muscular system. PNF provides physicians with an effective way to evaluate and treat musculoskeletal and neuromuscular diseases.

This particular study was carried out to recognize which technique plays a more superior role in improving the upper limb function and mobility in post stroke hemiparetic patients. Two scales will be used to measure effect of modified constraint induced movement therapy versus the effect of PNF that are the fugl meyer assessment and motor activity log 30.

Methodology

This study was conducted by the ethical approval of research and ethics committee of University of Lahore with ref no. (REC-UOL-559-10-2023). Study Design was a randomized controlled trial. Patients were recruited from Social Security Hospital Lahore. Duration of Study: was 9 months after approval of synopsis Total sample size was be 72 patients with 36 patients in each group. After drop out only 66 remained with 33 in each group. Post stroke patients aged between 40 to 70 years.[9] Pain level less than 4 on numeric rating scale.[9] Both males and females were included .Chronic hemiplegic stroke patients with mild spasticity (score of 2 or less on Modified Ashworth scale. [4] Patients having 25 degree extension in wrist and 10 degree in interphalangeal joints[(9)].Screening was done according to the above given criteria. Patients were divided into two groups randomly. There was group A and group B divided by fish Bowl method.[10] The participants were asked to pick from a bowl containing two papers that had either MCIMT or PNF written on it. The papers were mixed together and the participants had no idea what was written on the papers. The study was single blinded. The assessor was unaware of treatment given to both groups. Data was collected at baseline and at the end of 8th week.

Group A was the PNF group that received the conventional therapy 4 days a week for 8 weeks for 90 minutes per day. This included hot pack and TENS for 20 minutes then range of motion exercises(ROM), strengthening exercises, motor skills training.[1] For PNF context specific tasks were performed in D1 pattern (first diagonal) extension and flexion directions([4])We used the technique of Timing For Emphasis along with Rhythmic Initiation, Combination of Isotonics and Dynamic Reversals.[11] Physiotherapy was done keeping in mind the basic concepts of PNF which consisted of different movement patterns . The patient for example was asked to sit upright and perform D1 flexion on unaffected limb and the therapist performed it passively on the patient's effected limb. As the patient progressed more context specific tasks were gent such as extending arm to close the door and applying resistance on the distal forearm and asking patient to flex wrist to put an apple in their mouth.

Group B was the MCIMT group that received the conventional therapy explained above as well as modified constraint induced movement therapy by wearing a sling in the normal hand and limiting its motion and giving a series of functional tasks were performed by the effected hand while the patient was sat up right with their arm on a table. We started off with mere grasping of objects such as an apple or a spoon and the with time advanced into different repetitive movements whilst

grasping the object[4] the patients in this group were taught how to wear a sling and were encouraged to wear it 6 hours a day[1] Fugl Meyer motor assessment scale(9) and Motor activity Log (MAL)[1] were used before and after the treatment i.e. at baseline and 2 months after baseline.

Kolmogorov Smirnov test for normality was applied on different parameters among both PNF and MCIMT group. As the value of p is not greater than 0.05 which shows the data is not normal hence we applied the Friedman test for within group comparison and the Mann Whitney U test for between group comparisons.

Results

The total number of participants was 72(66 after dropout).There were 19 female and 14 males in the PNF group and 17 females and 16 males in the MCIMT group respectively. The participants mean age was 58.1818(PNF) and 58.3939 (MCIMT)

Friedman test a non-parametric test was applied for with in group comparison of outcome variables and as u can see the p value is less than 0.05 which shows significant improvement in both PNF and MCIMT groups. (Table I)

Wilcoxon test a non-parametric test was applied for with in group comparison of outcome variables and as you can see the p value is less than 0.05 which shows significant improvement in both PNF and MCIMT groups. Fugl meyer score median before and after PNF was 20.00and 49.00 respectively whereas fugl meyer score median before and after MCIMT was 21.00 and 56.00 respectively. In motor activity log amount of movement scale the median values are 38 pretreatment in PNF group and 78.00 after treatments in PNF group. Whereas the pre and post values for MCIMT group motor activity log amount scale were 36.00 and 85.00 respectively. In motor activity log quality of movement scale the values for pretreatment PNF group median was 39.00 and values for post PNF treatment was 79.00 whereas the values for MCIMT group on pretreatment and post treatment were 40.00 and 86.00 respectively. These show that more improvement in the MCIMT group compared to the PNF group. (Table II)

These tables represent the values of Mann Whitney U test used to compare the outcome parameters between groups of fugl meyer score. Where the pretreatment p value of PNF and MCIMT group for FMA is .656 the post treatment p value is .000 this tells us that although there is no significant difference between both pretreatment values there is a significant difference between the post values of PNF and MCIMT group. pretreatment p value of PNF and MCIMT group is .686 the post treatment p value is .002 for motor activity log amount of movement score. Pretreatment p value of PNF and MCIMT group is .931 the post treatment p value is .000 this tells us that although there is no significant difference between both pretreatment values there is a significant difference between the post values of PNF and MCIMT group for motor activity log quality of movement score. (Table III)

Table I: Shows the Friedman's test within group

		Friedmans test within group		
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	

Table II: Shows the Wilcoxon Ranks in within group comparison

	Median	**IQR**	**Mean Rank**	**P-Value**
Pre PNF FMA score	20.00	12.00	17.00	0.000
Post PNF FMA score	49.00	5.00	.00	
Pre MCIMT FMA Score	21.00	11.00	17.00	0.000
Post MCIMT FMA score	56.00	10.00	.00	
Pre PNF MAL (amount)score	38.00	15.00	17.00	0.000
Post PNF MAL (amount)score	78.00	13.00	.00	
Pre MCIMT MAL (amount)score	36.00	8.50	17.00	0.000
Post MCIMT MAL (amount)score	85.00	13.00	.00	
Pre PNF MAL (quality)score	39.00	16.00	17.00	0.000
Post PNF MAL (quality)score	79.00	14.50	.00	
Pre MCIMT MAL (quality)score	40.00	17.00	17.00	0.000
Post MCIMT MAL (quality)score	86.00	10.50	.00	

Table III: shows Mann Whitney U test between the Groups		
	Pretreatment FMA score	**Post treatment FMA score**
Mann-Whitney U	510.000	178.500
Wilcoxon W	1071.000	739.500
Z	-.446	-4.707
Asymp. Sig. (2-tailed)	.656	0.000
IQR	11.00	8.25
	Pretreatment mal (amount)	**Post treatment mal (amount)**
Mann-Whitney U	513.000	300.000
Wilcoxon W	1074.000	861.000
Z	-.405	-3.144
Asymp. Sig. (2-tailed)	.686	0.002
IQR	13.00	12.25
	Pretreatment mal (quality)	**Post treatment mal (quality)**
Mann-Whitney U	536.000	223.000
Wilcoxon W	1097.000	784.000
Z	-.109	-4.133
Asymp. Sig. (2-tailed)	.913	.000
IQR	16.00	13.00

Discussion

This study compared the effects of proprioceptive neuromuscular facilitation with the modified constraint induced movement therapy on chronic patients of ischemic stroke. In this particular study we studied the effects on the upper extremity. We observed no difference between the pretreatment fugl meyer and motor activity log of the patients which told us that both the groups were comparable and thus we concluded that any difference in the fugl meyer and motor activity log score can be attributed to the difference in the effects of the intervention.

This study showed a significant difference between the effects of modified constraint induced movement therapy and the proprioceptive neuromuscular facilitation. With the study group receiving the modified constraint induced movement therapy scoring significantly higher than the PNF group, post intervention. Although it is notable that both the groups i.e., the

group receiving MCIMT and the group receiving PNF have shown significant improvement from their initial scoring before intervention.

Fred Smedes and Leandro Giacometti da Silva[11] conducted a case study to use PNF as an alternative to CIMT in a post stroke patient with right arm and hand effected (decreased strength and range of motion). They found that significant improvements and success in changing in the patients abilities to carry out activities of daily living. They came to the conclusion that PNF is a good alternative to CIMT. However in this study we found that although PNF bring about positive change in the motor function of the patients, MCIMT effects are far greater in comparison.

Shaheen Noor and Sayeda Nida Bukhari [9] conducted a study to see the effects of MCIMT on hand function. Their control group received conventional treatment. This study concluded that compared to the control group the MCIMT group showed significantly better results in terms of hand function. This study however only had patients' ranging from ages 40 to 60 in our study however the ages were much higher up to 67, we also gave conventional therapy to both PNF and MCIMT group. Yet still it was in accordance to our current study as the MCIMT group showed much more significant results.

Emre Sahin[12] conducted a study with 40 chronic stroke patients and to check if there was a difference between the effects of regular physical therapy and MCIMT with regular physical therapy and found no significant difference between the two. This is in contrast with our current study as we saw a significant improvement with group receiving the MCIMT with conventional physical therapy. This might be due to the difference in sample size as our current study has a greater sample size.

Cansın Medin Ceylan[13] evaluated the effects of MCIMT on hemiparetic upper limb and found that the group receiving MCIMT showed significantly better results in terms of motor function as compared to a conventional rehab program. These results were in accordance with our current study.

Amelia Patching, Rachel Weis,conducted a study on the comparison of CIMT with mirror box therapy for adults who have experienced hemiplegia following a stroke. The evidence review was based on 3 systematic reviews and 5 randomized controlled trials. Various outcome measures were uses to check the effect on motor function. They came to the conclusion that CIMT showed a far greater effect than regular conventional therapy, comparing CIMT and Mirror box therapy alongside each other, they found that CIMT produced much greater results in terms of treatment in post stroke patients. This is in accordance with our study. The current study gives information on the effects of 2 interventions on upper limb chronic stroke patient's motor function. MCIMT showed much more favorable results.

Conclusion

The study concluded that both interventions were effective in improving the upper limb motor function in chronic ischemic stroke patients. However MCIMT showed greater results compared to PNF in improving the overall motor function of upper limb.

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