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Research Article

THE EFFECT OF MODIFIED CONSTRAINT INDUCED MOVEMENT THERAPY AND DUAL TASK TRAINING ON HAND FUNCTION AND BALANCE IN STROKE PATIENTS- A RANDOMIZED CLINICAL TRIAL

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A B S T R A C T

Background: Following stroke, sensorimotor deficits of the hand are common, restricting both fine and gross motor function of the affected hand, hampering an individual's ability to perform daily activities. Loss of balance in stroke patients and difficulty in coping with distractions reduces the functional ability of stroke patients.
Method and Measures: 14 post stroke individuals were recruited in the study. Written informed consent was obtained from each of the participant. They were randomly allocated into two groups based on the 4 week intervention they received, i.e.; Dual task or mCIMT group. Both the groups received therapy for 60 minutes per session, 5 days a week for a period of 4 weeks
Results: The statistical analysis FMS mCIMT p value was 0.0002 whereas dual task p value was 0.0003 both are significant. TIS For mCIMT p value were 0.0037 whereas for dual task, it was 0.0036 both of which are significant. SSQL For mCIMT p value was 0.0022 whereas for dual task p value was 0.0015 both of which are significant. There was no statistical difference between groups.
Conclusion: Present study concludes that both mCIMT and Dual task training are effective in improving hand function and balance in stroke patients.

INTRODUCTION

The global prevalence of stroke is 518/100,000 worldwide and 2/100,000 in India.1 Post stroke upper extremity paresis and plegia leads to inability to reach, grasp, and manipulate objects and limb activities. The residual sensorimotor deficit is an important challenge 50% of the stroke survivors.2,3 Stability of trunk is an important component of upper limb activities and Stroke patients usually presents with difficulty in maintaining, posture, head and trunk alignment and weight distribution Symmetry.

The learned non-use that develops after Stroke does not allow the patient to use the affected limb to the full extent. However, it is unclear whether these impairments are related to problems in motor learning per se or reflect problems associated with impaired response selection and /or the coordination of movement kinematics (Rush worth *et al* . 1998).4

The initial ninety days following stroke may be critical for the application of behavioral intervention such as mCIMT because this may be the time when the patients are highly receptive to such treatments. mCIMT is considered to have a profound effect on upper limb function in post–stroke population involving repetitive, intense, Functional task oriented practice with the Paretic upper extremity, whereas the Unaffected upper extremity is restrained. Studies[5,6] have shown that mCIMT can increase both motor function and involvement of the paretic arm of adult stroke patients by overcoming the factor of learnt nonuse of the limb affected and these significant improvement help in activation of the brain sensorimotor network. mCIMT not only concentrates on increase in hand dexterity but also covers strengthening, balance and functional tasks which is evident by the alteration in the brain physiology Dual task performance is also another effective therapeutic intervention being widely used in addressing neurological problems. It is also known as concurrent performance, involving execution of a primary task, which is the major focus of attention and the secondary task performed simultaneously.[7]

The capacity to do a second task is required during day to day life because it allows for communication, transportation of object from one place to other.[7] According to task integration hypothesis, single task training has lower demands as compared to Dual task training thus allowing coordination of two tasks. Performing two tasks simultaneously improves the patient's approach towards functional activities.[8] Although there are several best practices advocating the use of mCIMT and Dual task training in the treatment of stroke, there seems to be scarcity of research evidence portraying the comparison between these therapeutic interventions. Thus the need arises

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to compare the effectiveness of mCIMT against that of Dual task on the hand function, balance and quality of life in stroke survivors which is the main objective of the present study.

Methods Design

A comparative randomized control trial was conducted on patients with stroke in Belgavi, Karnataka, India. Patients were randomized to the mCIMT and Dual Task Training group. Both the groups received 4 weeks of home training program for targeting hand function and balance.

Participants, therapist and centers 14 patients with sub-acute and chronic stroke from old age homes and physiotherapy outpatient departments of tertiary healthcare centers underwent recruitment from a sample admission .The therapist screened participants for suitability and then enrolled them in the study. Participants were included if they: were 35- 65 years of age and sustained a motor loss in upper limb, showing at least gross motor function along with a Berg Balance Scale score of 41 to 56 (low fall risk) and Mini Mental State Score of>24(no cognitive impairment).Participants were excluded if they patient had any neurological morbidity other than stroke like Parkinson's or vestibular lesions, unstable cardiovascular orrespiratory condition or seizure activity since past 6 months. All the participants were evaluated for their demographic data. A pre and post intervention value for hand function and balance was obtained by Fugl Meyer Scale (FMS) and Trunk Impairment Scale (TIS) and Quality of Life with Stroke Specific Quality of Life Scale (SSQL) Intervention Intervention was given for a duration of 4 weeks .Each week there were 4 sessions performed by the patient at home and 1follow up session. The therapeutic session lasted for 60 minutes comprising of 45 minutes of training and 15 minutes of rest. mCIMT group The patient's unaffected arm was restrained and the patient was taught to perform the movements with the affected arm. Tasks

Included were

1. Opening and closing cap of the bottle.
2. Donning and doffing of socks.
3. Flipping of 1 card initially for 3 times followed by flipping of 2 cards and progressing flipping 3 cards.

Dual Task training group

Patient was asked to perform the following tasks

1. A balloon in one hand and bouncing another balloon with the other,
2. Transferring pebbles from one bowl to the other bowl.
3. Tapping of fingers on table while reciting multiples of 2.

Outcome measure Fugl Meyer Scale, Stroke Specific Quality of Life and Trunk Impairment Scale were taken pre and post intervention. Fugl Meyer Scale (FMS) FMS evaluates the movement sensation and balance of the trunk and extremities after stroke. In this study, only the arm component of FMS is used. This component evaluates the shoulder, forearm, elbow, wrist, hand and coordination on a 3 point ordinal scale i.e., 0,1,2. Score for the arm component ranges from 0 to 66, out of which the score for the shoulder and elbow component is 36 and hand and wrist component is 30. Higher the score reflects

better upper limb motor function. Trunk impairment scale (TIS) TIS measures motor impairment of the trunk after stroke. It evaluates static, dynamic and sitting balance as well as co-ordination of trunk movement. The reliability, both intra-observer and inter-observer is high.

TIS total score – 0.96 and 0.99.It consists of three subscales: static sitting balance, dynamic sitting balance and co-ordination. Each subscale contains between three and ten items. The TIS scale ranges from a minimum of 0 to a maximum of 23. Higher the score better in the performance.

Stroke Specific Quality of Life

SSQL measures stroke specific changes in quality of life for individuals who have had a stroke. This evaluation consists of 49 items that focus on 12 areas of health-related quality of life. Reliability: Cronbachs 0.73. Validity: Internal consistency showed to be apparent when compared to other quality of life measures such as the Health Related Quality of Life measure (HR-QOL).

RESULTS

FMS (Table I) By independent t test, the mean pretest score of group A was 46.77±18.48 whereas for group B it was 45.15 ± 10.68 with pretest p value was 0.7873. The mean posttest group A score was 52.77±16.55 whereas for group B was 49.69 ± 9.97. The pretest p value was 0.7873 posttest p value was 0.5742. The mean difference between group A and group B was 6.00 ± 4.16 and 4.54 ± 3.31 respectively. The difference between p value of group A and group B was 0.3315. This shows that there was no significant difference between Group A and B.By dependent t test in group A, the mean difference of the participants pretest was 46.77 ± 18.48 which changed to 52.77 ± 16.55 after 4 weeks of intervention. The p value was 0.0002 which is significant. By dependent t test in group B, the mean difference of the participants pretest was 45.15 ± 10.68 which changed to 49.69 ± 9.97 after 4 weeks of intervention. The p value was 0.0003 which is significant.

TIS (TABLE II) By independent t test, the mean pretest score of group A was 11.77 ± 4.21 whereas for group B it was 11.77 ± 3.00 the pretest p value was 1.0000. The posttest group A score was 13.00 ± 4.28 whereas for group B was 12.77 ± 2.95. The posttest p value was 0.8742. The mean difference between group A and group B was 1.23 ± 1.24 and 1.00 ± 1.00 respectively. The difference between p value of group A and group B was 0.6054. This shows that there was no significant difference between group A and B. By dependent t test in group A the mean difference of the participants pretest was 11.77 ± 4.21 which changed to 13.00 ± 4.28 after 4 weeks of intervention. The p value was 0.0037 which is significant.

By dependent t test in group B the mean difference of the participants pretest was 11.77 ± 3.00 which changed to 12.77 ± 2.95 after 4 weeks of intervention. The p value was 0.0036 which is significant. SSQL (Table III) By Mann-Whitney U test the mean pretest score of group A was 127.38 ± 17.03 whereas for group B it was 116.08 ± 30.40 the pretest p value was 0.2486. The posttest group A score was 131.15 ± 18.06 whereas for group B was 119.31 ± 30.54. The posttest p value was 0.3299. The mean difference between group A and group B was 3.77 ± 2.55 and 3.23 ± 1.54 respectively. The difference between p value of group A and group B was 0.6816, showing that there was no significant difference between group A and B. By Wilcoxon Matched pairs test in group A the mean difference of the participants pretest was 127.38 ± 17.03 which changed to 131.15 ± 18.06 after 4 weeks of intervention. The p value was 0.0022 which is significant. By Wilcoxon Matched

pairs test in group B the mean difference of the participants pretest was 116.08 ± 30.40 which changed to 119.31 ± 30.54 after 4 weeks of intervention. The p value was 0.0015 which is significant.

Table I

Fms						
Group	**Pretest**		**Posttest**		**Difference**	
	Mean	Sd	Mean	Sd	Mean	Sd
Group a	46.77	18.48	52.77	16.55	-6.00	4.16
Group b	45.15	10.68	49.69	9.97	-4.54	3.31
% changing in a					-1283%, p=0.0002*.	
% changing in b					-10.05% ,p=0.0003*	
T- test	0.2729		0.5742		0.9911	
P-value	0.7873		0.5712		0.3315	

Table II

Tis						
Group	**Pretest**		**Posttest**		**Difference**	
	Mean	Sd	Mean	Sd	Mean	Sd
Group a	11.77	4.21	13.00	4.28	-1.23	1.24
Group b	11.77	3.00	12.77	2.95	-1.00	1.00
% changing in a					-10.46%, p= 0.0037*	
% changing in b					-8.50%, p= 0.0036*	
T- test	0.0000		0.1601		0.5236	
P-value	1.0000		0.8742		0.6054	

DISCUSSION

The current study was conducted to compare the effect of mCIMT and Dual Task training on hand function, balance and quality of life in stroke patients. This significant improvement in the motor activity of the affected upper limb and hand with regard to FMS was observed with a distinctive increase in the use of stroke affected upper limb in daily activities. mCIMT may not change actual movement potential, but may change the behavior pattern so that individuals are willing to use their limb more, thus achieving the real movement capabilities. A study carried out by Page SJ *et al*., manifested that learned non-use is a type of negative feedback. Individuals are unable to move their affected limb or the movements are inefficient and clumsy. In response to this, suppression of movement occurs. It is this process that mCIMT seeks to reverse.

The improvement in the mCIMT group, thus causing significant increase in FMS scores, may be attributed to two reasons: repetitive practice of functional tasks leading to cortical reorganization also known as Neuroplasticity, thereby causing an increase in movements of the affected hand and repeated use of compensatory strategies during functional use of the impaired limb to facilitate the motor and sensory recovery of the hemiplegic limb.[9] As evident in a study conducted by J D Schechter *et al*., wherein mCIMT showed a shift in motor cortical laterality towards the ipsilateral hemisphere, thus improving motor function of the affected limb. This might have produced a massive use dependent cortical reorganization, thereby increasing the area of cortex involved in innervating movements of the affected limb.[10]

Similarly dual task training also showed significant improvement in the motor activity of the affected upper limb and hand with regard to FMS. Muscle weakness arises primarily from the lesion itself , as a result of a decrease of descending inputs converging on the final motor neuron, and hence a reduction in the number of motor units available for recruitment. Since skeletal muscle adapts to the level of use imposed upon it, secondary sources of weakness arise as a consequence of lack of muscle activity and immobility. Contrary to previous opinion, weakness in the agonist muscle is not due to spasticity (reflex hyperactivity) in an antagonist muscle group, but it is a direct result of reduction of descending motor commands, compounded by disuse and adaptive muscle changes.[11] A relationship exists between cognitive function and motor abilities in normal circumstances, the concomitant execution of motor and cognitive task in day to day life are performed automatically, that is no effort of conscious attention are required. Dual Task training enhances this learning process, thus increasing use of the affected limb with ease. When two different movements are initiated simultaneously as a part of Dual Task training, indicating that both arms are linked together as a co-ordinated unit in the brain. Evidence in support of Dual Task training shows that there is an association between increased use of affected hand and the reorganization of the brain. This improvement of upper limb function can be explained by an increase in cerebral blood flow. It is assumed that repetitive practice of a Dual Task movement strengthens existing pathways and may lead to new functional or structural changes in the motor cortex of the brain. The improvement of hand functionwas exhibited as an obvious increase in the Fugl Meyer scale scores. Studies have shown that learning a motor task with one arm will result in a subsequent bilateral transfer of the same task to the opposite hand. Thus, this increase in motor ability of the affected hand might have led to decreased impairment and increase in the FMS score.[11]

The study by Schubert *et al*., showed that simultaneous performance of two tasks compared to its single component leads to an additional activation in a network of several cortical regions including the lateral and medial pre frontal, temporal, parietal and occipital cortices.[12]

A similar observation was seen in a study performed by Hiyamizu *et al*., Dual Task group had significantly improved performance compared to the single task group.[13] Both mCIMT and Dual Task had a positive impact on increased mobility of the hand concurrently may have increased the balance ability.

Balance involves the ability, not only to maintain the posture without falling over but also to balance the body mass over the base of support while performing different tasks. The trunk played a significant role in transporting the hand to the target in conditions where the objects were located either at arm's length or some distance beyond the arm's length. Performing movement of the upper limb instigates scapular motions in the form of scapular protraction and retraction, this chain triggers trunk motion. Sitting is an inherently stable posture than standing due to the larger base of the support. During reaching, there is a tight coupling between the trunk and arm which reflects the multilinked structure of the body.[14]

A study performed by Catherine D *et al*., stated that placing objects beyond arm's length will enable individuals to practice coordinating motions of the trunk and arm which is effective in stroke patients.[15] In Dual Task and mCIMT the subjects were required to perform activities some distance beyond arm's reach, thus stimulating the coupling between the trunk and arm which in turn might have increased the trunk balance evident with TIS score.

A study done by Nan-Hyang Kim *et al*., showed that gait training conduced with mCIMT improved the dynamic balance of hemiplegic stroke patients bdy 28.6 % and movement distances to the paretic side in the standing position increased by 34.3% after training, indicating improved trunk stability.[16] Seo *et al*., reported that 4weeks of Dual task training program effectively improved the static and dynamic balance and walking abilities of patient in Stroke induced Hemiplegia causing an increase in Trunk Impairment Scale scores.[17] In the current study it was discovered that both the groups showed significant improvement with regard to SSQL, suggesting that an increase in FMS and TIS scores might have in turn led to an increase in functional independence, thus improving their overall day to day quality of life.

In a study conducted by Arlene. A.S *et al*., on subjects with chronic stroke, it was found that, there is a positive association between improved balance and increased quality of life as measured by an increase in the scores of the Stroke Specific Quality of Life Scale.18 In the present study, the results have showed that there was an equally significant increase in the FMS, TIS and SSQL scores when analyzed between the groups. This might be attributed, to the equivalent amount of motor cortical activation, when activities of the affected limb were performed. Tasks involved in both the treatment regimens targeted to improve the functionality of the patient, thus having an identical effect.

CONCLUSION

Hence the present study concluded that both, Modified Constraint Induced Movement Therapy and Dual Task Training given in sub-acute and Chronic Stroke Patients was equally effective in improving hand function significantly and slight increase in balance scores along with increase in quality of life. The treatment protocol is simple, cost effect and can be easily administered at home.

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