Comparison of effects of Motor Imagery, Cognitive and Motor Dual Task training methods on Gait and Balance of Stroke Survivors

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Abstract

Objectives of Study: This study examined the effects of various interventions (Mental Imagery (MI), Cognitive Dual Task Training (CDTT) and Motor Dual Task Training (MDTT)) on the Gait and Balance of Stroke survivors.

Method: 15 eligible participants after being tested for ability for motor imagery were randomly divided into three groups (MI, CDTT, MDTT) of 5 each . Each group received 15 min. of training each day for 10 sessions (5 sessions per week). Pre and post intervention Berg balance Scale (BBS) and Functional Gait Assessment Scale (FGAS) was measured to record changes in Balance and Gait abilities

Results: Within group analysis using Paired t-test indicated that there was significant difference in both BBS and FGAS scores in all the three groups. Between Group analysis using Kruskal –Wallis test showed that post intervention median of the three groups were different (á = 0.05). Follow up Pair wise comparisons showed that MDTT group performed significantly better.

Conclusion: Gait and Balance in stroke patients can be significantly improved by using Mental Imagery and Dual task training in course of rehabilitation along with conventional rehabilitation. This would help in better community mobility.

Introduction

Hemiplegia is one of the most common impairments after stroke and contributes significantly to reduce gait performance. . Although the majority of stroke patients achieve an independent gait, many do not reach a walking level that enable them to perform all their daily activities [1,2] Balance is another component that seems to be affected in patients with stroke [3]

Balance consists of mainly three aspects: steadiness, symmetry, and dynamic stability. All of these components of balance (steadiness, symmetry, and dynamic stability) have been found to be disturbed following stroke. [4] Balance testing of patients with hemi paresis secondary to stroke has revealed a greater amount of postural sway during static stance asymmetry with greater weight on the non paretic leg and a decreased ability to move within a weight bearing posture without loss of balance. [5]

Recovery of walking to regain independence in daily life is one of the main goals of stroke rehabilitation. Traditionally many methods of Gait training have been employed to improve gait and balance in patients with stroke. [6]

One of the recent developments in past few years for Gait rehabilitation in Patients with stroke is the use of Dual task training. The dual task is defined by the simultaneous production of two tasks, one called "primary" and the other called "secondary", where performance changes are measured. The dual-task paradigms are based on the assumption that two tasks performed simultaneously interfere if they use functional subsystems and / or identical brain. The interferences are observed changes in performance of one or two tasks that are measured by comparing the performance of conditional single and dual task. [7]

Dual tasks are mainly divided into two types: motor dual tasks which require simultaneous performance of a motor task and a postural control task at the same time; and cognition dual task which require simultaneous performance of a cognition task and postural control task . Effects on Gait Speed, Double limb support duration and step length have been reported in earlier studies during dual task conditions.

It has been observed that even if single task gait parameters recover to near normal after gait rehabilitation following stroke still the capacity for dual task remains considerably decreased as indicated in earlier studies [8,9]

Another intervention called Mental Imagery (MI) which can be defined as "the process of imaging and rehearsing the performance of a skill with no related overt actions" [10] have been used for gait interventions in Patients with stroke.

Capacity of Motor Imagery is not dependent on the actual ability of being able to do a movement so it can be used at a very early stage of rehabilitation to train for motor preparation. Recent imaging studies have proved that MI leads to excitation of similar areas of brain which are involved in actual performance of the movements. *Decety and colleagues (1996).* Also it has been demonstrated that even simple passive observation of motor movements activates the cortical motor areas. *(Grezes and Decety, 2001).).*These and similar studies have led to an understanding that mental imagery can trigger the neural activations of relevant motor areas of brain which therefore can be used to practice motor skills even in absence of actual execution of movements .[11,12]

Hall et al. have used Movement Imagery Questionnaire (MIQ) to classify subjects as high or low imagers based on their scores and demonstrated that individual differences in motor imagery ability can influence performance of motor tasks . [13]

Studies in the past have indicated that MI may be useful for the enhancement of walking ability, mainly in temporal-distance gait variables [14,15] and task specific gait functions [16]

In light of the current evidences in support of the efficacy of Dual task training and MI it is evident that both have been found to be helpful in Gait rehabilitation of patients with stroke however till date few studies have tried to analyze the relative merits of different types of dual task training in both Gait and balance of stroke survivors. Also effects of MI on balance in stroke survivors still remains unexplored. The current study therefore tries to compare the effectiveness of three different types of interventions (two Different types of Dual Task training and MI) on Gait and Balance in stroke survivors.

Aims and Objectives

AIMS

1. To assess the Gait and Balance abilities of Stroke Survivors
2. To study the effects of Motor Dual Task Training (MDTT) on Gait and Balance in Stroke survivors
3. To study the effects of Cognitive Dual Task Training (CDTT) on Gait and Balance in Stroke survivors
4. To study the effects of Motor Imagery (MI) on Gait and Balance in Stroke survivors

OBJECTIVES

1. Gait abilities will be assessed by using the Functional Gait Assessment scale.(FGA)
2. Balance abilities will be assessed by using Berg Balance Scale (BBS)
3. Pre and post intervention scores of the above two scales will be used to analyze the effectiveness of MDTT, CDTT and MI on Gait and Balance in Stroke survivors.

Hypothesis

H0: There will be no significant effects of either MDTT. CDTT and MI on Gait and Balance in Stroke Survivors.

H1: There will be a significant effect of MDTT on Gait and Balance in Stroke survivors.

H2: There will be a significant effect of CDTT on Gait and Balance in Stroke survivors.

H3: There will be a significant effect of MI on Gait and Balance in Stroke survivors.

Methodolgy

SETTINGS

Occupational Therapy Unit of Neurology Department of G. B. Pant Hospital, New Delhi, India

PARTICIPANTS

A total of 23 eligible participants were invited for participation in the study. After getting an informed consent all of them were initially screened for inclusion criteria including ability for Motor Imagery using the MIQ-RS (Movement imagery questionnaire – revised for stroke.) 15 participants who fulfilled the inclusion criteria were finally included for the study. All 15 (Five in each group) were randomly assigned into either of three treatment groups namely Motor Dual Task Training Group (MDTT), Cognitive Dual Task Training Group (MDTT) and Mental Imagery (MI) group.

INCLUSION CRITERIA

At least one incidence of stroke in past

Ability to ambulate at least 10 meter without any external support

No incidence of any other significant Neurological disorders

Ability to understand and follow three step commands

Ability to communicate verbally

Age : 25- 75

Both Male and Female

EXCLUSION CRITERIA

Aphasia

Hearing Impairment or Visual Impairment

Seizure Disorders

Any other significant Neurological or Orthopedic Disorders of gait including amputation.

WITHDRAWL CRITERIA

Any subsequent incidence of another episode of stroke

Any other medical condition that would prevent regular participation in study

OUTCOME MEASURES

BERG BALANCE SCALE (BBS)

The BBS is a 14-item scale that quantitatively assesses balance and risk for falls in older community-dwelling adults through direct observation of their performance. The scale requires 10

to 20 minutes to complete and measures the patient's ability to maintain balance—either statically or while performing various functional movements—for a specified duration of time. The items are scored from 0 to 4, with a score of 0 representing an inability to complete the task and a score of 4 representing independent item completion. A global score is calculated out of 56 possible points. Scores of 0 to 20 represent balance impairment, 21 to 40 represent acceptable balance, and 41 to 56 represent good balance. The BBS measures both static and dynamic aspects of balance. The ease with which the BBS can be administered makes it an attractive measure for clinicians; it involves minimal equipment (chair, stopwatch, ruler, step) and space and requires no specialized training. It is noted, however, that the BBS should only be administered by health care professionals with knowledge of how to safely mobilize patients with stroke.

Functional Gait Assessment Scale (FGAS)

The Functional Gait Assessment (FGA) is a modification of the DGI19 that was developed to improve the reliability of the DGI and to reduce the ceiling effect seen with the DGI in patients with vestibular disorders. The FGA is a 10-item clinical gait test during which participants are asked to perform the following gait activities: walk at normal speeds, at fast and slow speeds, with vertical and horizontal head turns, with eyes closed, over obstacles, in tandem, backward, and while ascending and descending stairs. The FGA is scored on a 4-level (0 –3) ordinal scale; scores range from 0 to30, with lower scores indicating greater impairment. In adults with vestibular disorders, the interrater reliability of the FGA was reported as r.86 (intraclass correlation coefficient [ICC (2,1)]) and intrarater reliability as r.74 (ICC [2,1]).28 Individual FGA item interrater and intrarater reliability ranged from r.16 to r.83 (kappa). Walker et al found the interrater reliability of the FGA to be r.93 (ICC [2,1]) in community-dwelling adults following a training session of the raters. In case of Stroke it shows Excellent test-retest reliability (ICC = 0.95, 95%CI)

Movement Imagery Questionnaire-Revised for stroke (MIQ-RS)

Movement Imagery Questionnaire - revised. The MIQ-R is a self-report questionnaire developed and validated by Hall & Buckholtz (9) in order to assess visual and kinesthetic modalities of movement imagery. A revised version, the MIQ-RS was developed and validated by Gregg et al. (22). The MIQ-RS is composed of 2 sub-scales of 7 relatively movements (e.g. bending forward, or pulling a door handle) for use with people with limited mobility. For each item, 4 steps are required. First, the starting position of the movement is described by the examiner and the subject is asked to assume this position. Secondly, the movement is described and the subject is asked to perform it. Thirdly, the subject is asked to reassume the starting position and imagine producing the movement (no actual movement is made). Finally, the subject is instructed to rate the ease/difficulty with which he or she imagined the movement on a 7-point scale, where 1 is very difficult and 7 is very easy to picture (visual sub-scale, MIQ-RSvis) and feel (kinesthetic sub-scale, MIQ-RSkin).

STUDY DEISGN

Single centre randomized trial.

SAMPLING: Convenience sampling with random assignment

PROCEDURE

All participants who fulfilled the inclusion criteria were enrolled into the study after getting prior informed consent. Following this all participants were assessed for ability for Motor Imagery using the MIQ-RS (Movement imagery questionnaire –revised for stroke.) Only those participants who showed adequate

MDTT Group (Each task for 3 min.) 3 min. x 5 tasks = 15 min. session	**CDTT Group** (Each task for 3 min.) 3 min. x 5 tasks = 15 min. session	**MI Group** (Each task for 3 min.) 3 min. x 5 tasks = 15 min. session
Object transfer during walking.	Backward Counting while walking	Targeting specific impairments
Holding of glass of water without spilling during walking	Mathematical Subtraction while walking	Loading of affected limb and stepping forward backward
Buttoning upwards after unbuttoning while walking	Category naming while walking	Practice walking at variable speeds
Receiving and returning rings from a ring holder while walking	Backward Recitation while walking	Obstacle crossing, bending and direction change
Picking objects and transfer to a fixed point while walking	Naming words starting with a particular letter while walking	Walking in real life situations. Uneven surface, confined space

imagery abilities were finally selected for the study. 15 participants who fulfilled the inclusion criteria were finally included for the study. All 15 (Five in each group) were randomly assigned into either of three treatment groups namely Motor Dual Task Training Group (MDTT), Cognitive Dual Task Training Group (MDTT) and Mental Imagery (MI) group.

Following this a baseline assessment of Balance using the BBS and Gait using the FGAS was done at the beginning of the study. All participants continued to receive conventional rehabilitation throughout the entire duration of study.

Participants received an additional specific intervention as per their intervention group for 15 min. each day for 10 sessions (5 sessions a week).

The total duration of each intervention session was 15 min. in which the patient was made to do five different tasks and each component was practiced for 3 min.

The Intervention protocol for each group was as enlisted in the table:

Protocol of MDTT and CDTT consisted of doing the secondary motor or cognitive tasks under either of the following circumstances:

- Level surface walking : 4 sessions
- Obstacle crossing: 2 sessions
- Walking at different speeds : Fast and Slow 2 sessions
- Walking with frequent changes of directions 2 sessions

Each session of MI (Motor Imagery) Training consisted of the following components:

- Information on task characteristics and walking environment
- Imagining movement/ walking from an external perspective.
- Imagining movement/ walking from an internal perspective.
- Feedback on the imagined movement patterns.

Throughout the MI training patient participation was monitored using Mental Chronometry. Mental chronometry is based on the assumption that time taken for actual performance and that on mental imagery are comparable. Therefore the patient is asked to signal the beginning and end of the tasks and engagement is checked at various unequal intervals by taking patient feedback during the imagery process.

All participants were reassessed at the end of 10 sessions for their balance abilities using the Berg Balance Scale (BBS) and Gait abilities using the Functional gait analysis scale (FGAS).

Statistical analysis

All data was analyzed using Graph pad prism 5 software.

Pre and post within group analysis for changes in BBS and FGA scores was done using he paired t-test.

Shapiro –Wilk test was conducted to check for normality of data prior to the use of paired t-test. Data was found to be normally distributed for observations across all the three groups.(calculated value of W was greater than the critical value of W and p value > 0.05 for $N = 5$) This meant that paired t-test could safely be applied to compare the mean difference between the two data (Pre and Post) .

Within group analysis to compare the difference of medians of the three groups was done using Kruskal Wallis test due to small sample size in each group. Dunns test was used for Post hoc. Significance level for each analysis was set at 0.05 .

Results

A paired sample t-test was conducted to compare the pre and post BBS and FGA scores. There was a significant difference in the scores for pre and post BBS and FGA scores.as indicated in Table 1 and Table 2 respectively.

Between group analysis of BBS and FGA score for significance of difference in median of three groups was done using the Kruskal Wallis test.

There was a statistically significant difference between the post intervention FGA scores of three groups $H(2) = 7.433$ and $p = 0.0149$ and there was significant difference between the MDTT group and CDTT groups and MI groups.

There was no statistically significant difference between the

Table 1: Paired t –test results for Pre and Post Berg Balance Scale (BBS) Scores

GROUPS	MDTT		CDTT		MI	
	Pre	Post	Pre	Post	Pre	Post
MEAN	32.20	40.60	33	43.40	32.60	42.20
SD	8.075	8.562	10.86	9.529	6.229	6.261
t (df= 4)	7.799		11.21		14.15	
p	0.0015		0.0004		0.0001	
Significant	YES		YES		YES	

Table 2: Paired t –test results of Pre and post Function al Gait Assessment (FGA) scores

GROUPS	MDTT		CDTT		MI	
	Pre	Post	Pre	Post	Pre	Post
MEAN	14.20	25	15.20	17.80	15.80	18.40
SD	2.387	1.581	3.962	3.564	4.324	3.507
t (df= 4)	6.249		10.61		5.099	
p	0.0033		0.0004		0.007	
Significant	YES		YES		YES	

Graphical representations of paired t test analysis for pre and post BBS and FGA scores is represented in Graph no, 1-6 respectively

Fig. 1 : T Test Results for BBS score in CDTT group

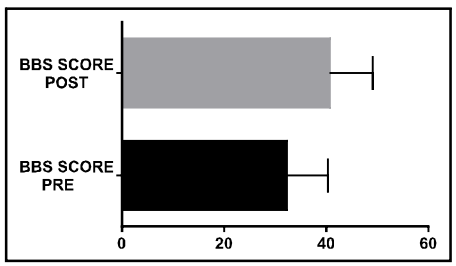


Fig.2: T Test Results for BBS score in MDTT group

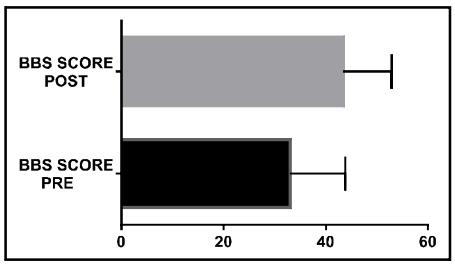


Fig 3: T Test Results for BBS score in MI group

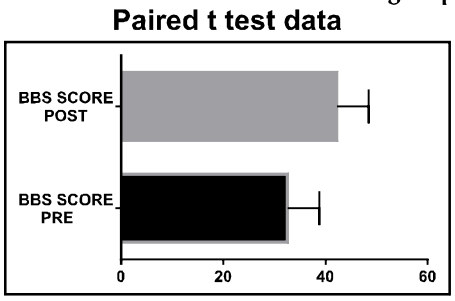


Fig: 4 T Test Results for FGA score in MDTT group

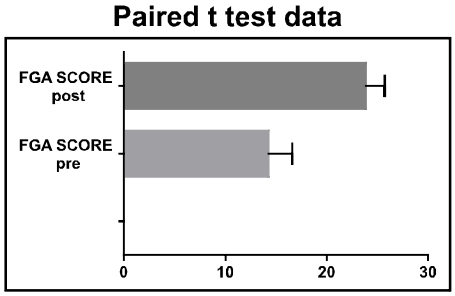


Fig 5: T Test Results for FGA score in CDTT group

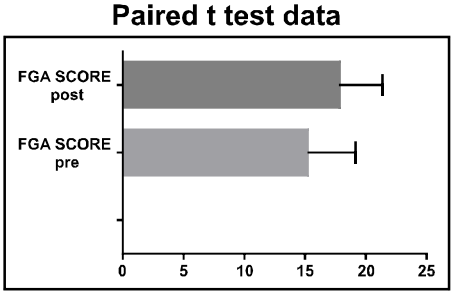
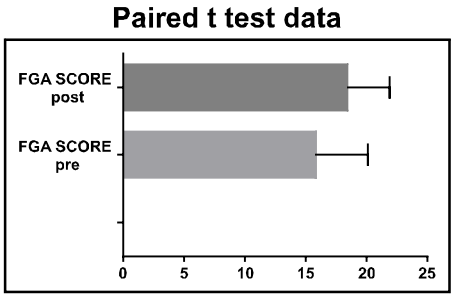


Fig.6: T Test Results for BBS score in MI group



post intervention BBS scores of three groups H (2)= 0.3184 and p = 0.8680.

Discussion

Results of the study indicated that there was significant effect of all MDTT CDTT and MI interventions on GAIT on balance in stroke survival. This signifies that all three interventions are effective in changing the gait and balance of patients with stroke.

Effectivenes of dual tasks have been reported in earlier studies done by Plummer et al. [7,8,9] This can probably be explained to the inherent nature of the dual tasks which tend to simulate actual day to day performances . Community mobility most often requires the individuals to simultaneously perform motor and cognitive tasks while walking and also maintain their balance during these tasks. Training of similar nature tends to stimulate similar responses at the neurological levels which is thus manifested as improvements in performance following such

interventions[8] The nature of selective attention to more than one tasks at the same time tends to reduce the postural sway as reported in earlier studies which again can be a contributing factor in improvement of Gait and Balance in stroke survivors.[7,8,9]

Patients in the Motor Imagery Intervention group also showed significant improvements in Gait and balance. Similar findings have been reported in clients with stroke [10,11]. Findings from this and similar studies have led to an understanding that mental imagery can trigger the neural activations of relevant motor areas of brain which therefore can be used to practice motor skills even in absence of actual execution of movements by mere imagination.

Evidences form last to decades have strongly pointed out that brain plasticity has an intrinsic role to play in recovery following brain damage. Specifically recovery of motor functions after stroke is accompanied by a redistribution of activity within a network of parallel-acting multiple cortical motor areas and reinforcement of the spared area adjacent to the lesion .Neurophysiologically stating the possible benefits of MI in motor function recovery might be related to stimulation of restitution and redistribution of brain activity occurring due to imagining movements. [10]

Patients can be trained to perform MI after some giving some instructions followed by familiarization. It is also important to assess the MI imagery abilities of the patients before initiating any kind of MI training however it is still not clearly known whether a high level of MI ability is specifically required before initiation of MI training. [12]

Analyzing the results it is evident that the MDTT group showed the most significant changes as compared to the other groups, similar findings have been reported in previous study [8]. This in all possibility could be attributed to the direct nature of dual task training which approximates best to the day to day functional activity of the patients.

In our day to day routine task we are most often performing dual motor tasks like carrying objects while walking or transferring objects from one hand to other.

Conclusion

It can be concluded from the results of these studies that MDTT, CDTT, MI are useful interventions to improve balance and Gait in Stroke survivors and can be included in the conventional stroke rehabilitation programs.

Limitations

Small sample size

Short Duration of Intervention

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