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# Effect of Cognitive Dual Task Training versus Motor Dual Task Training on Balance in Post Stroke Patients

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## Abstract

**OBJECTIVE:** This study aims to compare the effects of cognitive dual task training and motor dual task training on balance in post stroke patients.
**INTRODUCTION:** Stroke is a disease caused by lack of blood supply to the brain following ischemia or haemorrhage. The reduced motility following stroke results in a body imbalance that appears as asymmetric posture, proprioception disorder and abnormal muscle tone that lead to the degeneration of balancing ability. Dual tasks training is a training in which two or more tasks are performed at the same time continuously. The motor dual tasks requires performance of a motor task and a postural control task at the same time and cognition dual tasks requires performance of a cognition task and postural control task simultaneously.
**MATERIALS AND METHODS:** Thirty participants fulfilling the inclusion criteria were selected and divided into 2 groups with 15 participants each. Participants in CDTT or MDTT practiced the cognitive and motor dual tasks respectively while standing on wobble board. The intervention was for 45 minute / session, 5 days/week for 4 weeks Participants were tested before and after the intervention for balance function under cognitive and motor dual task conditions using berg balance scale, stroop test and standing balance test.
**RESULTS:** Mean values of Group A and Group B on berg balance scale, were (49.47) and (47.40) respectively. Mean values of Group A and Group B on standing balance test were (30.07) and (28.80), and the mean values of Group A and Group B on stroop test were (16.73) and (11.47). On comparing pre test and post test values within Group A and Group B on berg balance scale, standing balance test and stroop test shows highly significant difference in mean values at $p \leq 0.001$.
**CONCLUSION:** This study concluded that cognitive dual task training is more effective in improving balance in acute stroke patients with balance impairment, when compared to motor dual task training.

## Keywords

Stroke, balance, cognitive dual task, motor dual task.

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## Introduction

World health organisation defines stroke as an acute, focal or diffuse dysfunction of the brain, which arises from the blood vessels and lasts for a period longer than a day. Stroke is characterised as a neurological deficit ascribed to an acute focal injury of the central nervous system by a vascular cause, including cerebral infarction, intracerebral haemorrhage, and subarachnoid haemorrhage and is a major cause of disability and death worldwide (Sacco et al., 2013). According to world health organization (WHO) stroke accounts for 10.8% mortality and 3.1% of disease burden worldwide (Muratova et al., 2020). The global diseases burden of stroke increased by 19 percentage between 1990 and 2010 and current projections estimate the number of death worldwide will rise to 6.5 million in 2015 and7.8 million in 2030 (Donker, 2018). Prevalence rate scales from 84-262/100000 in rural and 343-424/100000 in urban areas (Kamalakannan et al., 2017).Stroke classification would be based on risk factor profile such as diabetes mellitus, hypertension and cardiac diseases. The national institute of neurological disorders and stroke (NINDS) recognized 5 major groups: brain infarctions, brain haemorrhages, atherothrombotic stroke, cardioembolic stroke, lacunar stroke and stroke from rare causes or undetermined etiology. Cerebral accidents can be grouped into ischemic strokes, which comprises 87% of the cases and are caused by thrombotic occlusion of arteries and veins or intracerebral haemorrhagic strokes, which comprise 13% of the cases and are caused by rupture of vessels by hypertension or aneurysm, trauma and penetrating cerebral injuries (Katan, & Luft, 2018). One of the main deficit caused by stroke is motor impairment can be defined as loss or limitation of motor control function or reduction in mobility. It commonly affects the control of the face, arm and leg on one side of the body and is present in 80% of patients with stroke (Walker et al., 2017). The survivors of the stroke present with a combination of muscle weakness, muscle spasticity, reduced postural control, lack of voluntary control and body misalignments (Hatem et al., 2016). These factors implicate the poor recovery of functional ability and an increased risk of falls (Baer et al., 2014).

Among the survivors of stroke two thirds, have initial mobility deficits, and six months after stroke more than thirty percentage of the survivors find it difficult to walk independently (Corbetta et al., 2015). The consequences of stroke are related to type, location in the brain and its severity. Various clinical features following stroke such as loss of sensation, spatial neglect, perceptual problems, ataxia, concentration problems, muscle weakness, together contributes to balance impairment. It is much astonishing that more than 83 percent of the stroke survivors suffer from balance impairment and therefore is characterized by short supporting time and differences between two sides of the body and slow walking speed, which may increase the risk of fall as well. Fear of fall among individuals following stroke can lead to sedentary life style and increased disability that together contributing to lower quality of life among stroke patients. Prognosis of the patient is dependent on baseline characteristics like age, stroke severity and gender (Rhoda et al., 2014). Motor deficits are common in patients with stroke and often have a great impact on the performance of activities of daily living (Jung & Choi, 2017). Among various motor functions, gait and balance are essential in regaining independent ADL performance (Cho et al., 2014). Therefore, it is expected that improvement of balance is the utmost priority in patients with brain lesions and as a result restoration of balance and gait is considered as the main concern of stroke rehabilitation to enhance the independence of patients in activities of daily living and to increase participation in the society (Kristensen et al., 2016). Mobility and cognition impairments are common in most of the neurologic conditions making previously automatic movements more attention demanding (Seligmann et al., 2008). Divided attention, the ability to respond to multiple stimuli simultaneously is frequently affected than other domains (Mateer et al., 1996). Divided attention is essential to successfully perform two

tasks concurrently such as cognitive and motor tasks. Patients with stroke may have difficulty in performing single activity or dual activities at same time. Dual task training is a type of training in which two or more tasks are performed simultaneously. The cognitive dual task exercises given in this study include standing on a wobble board and counting number forwards and backward (1- 20 and 20 -1), mentioning names of the places or objects starting with the given alphabet, image description, memorizing the names of the object shown, repeating the sequences of words given, approximation and estimation exercises, mental mapping of the recently visited place/drawing or illustration of given picture in mind. The motor dual task exercises given in the study include standing on a wobble board and performing catching or throwing a ball, bouncing a ball, squeezing the exercise ball, holding a cup of water without spilling, coin transfer, buttoning and unbuttoning, transferring a cup from one hand to another hand.

Both the cognitive and motor dual tasks are noted as ways of training patients with neurological damage to recover their motor control ability (Liu et al., 2017).Thus the purpose of this study was to find the effect of cognitive dual task training and motor dual task training on balance in stroke patients

## Materials and Methods

This is an experimental study of comparative (pre and post) type that was conducted in the outpatient physiotherapy department of ACS medical college and hospital Chennai, Tamil Nadu, India and it took nearly 4 weeks to complete the study. Thirty samples were selected and participants were screened to ensure that they followed following inclusion criteria: acute hemiplegic stroke patients with age group between 40 to 60 years, mini mental state examination score of greater than or equal to 24, able to follow 3 step commands, able to walk at least 10 meter without assistance rather than assistive devices, having obvious balance deficits. Both genders are equally preferred and the patients should be medically stable. The thirty participants included in this study were then randomly allocated either into cognitive dual task training group or to motor dual task training group using lottery method with fifteen participants in each group. The participants of the cognitive dual task training group ( GROUP A – CDTT) and motor dual task training group (GROUP B-MDTT) received exercises for 45 minutes , once in a day, five days per week for four weeks. Participants were tested before and after the intervention for balance function under cognitive and motor dual task conditions using berg balance scale, stroop test and standing balance test.

Berg balance scale is most commonly used clinical test to assess a person's static and dynamic balance. It is a performance dependent measure of standing balance commonly used by clinicians dealing with post stroke individuals. The scale comprises of a set of 14 simple balance related tasks, ranging from standing up from a sitting position, to standing on one foot. The degree of ability in achieving each task is given a score of zero (unable) to four (independent) and the final score is obtained by sum up of all the scores. The berg balance scale has excellent inter rater reliability of (0.98) and intra-rater relative reliability of (0.97) (Kudlac et al., 2019). Superior BBS performance can be due to compensatory strategies used by the stroke patients, but indicate continued underlying impairment. Four-stage balance test or standing balance test is a clinical tool to assess a person's mobility and risk of falls, based on their ability to hold four progressively more challenging positions (Hill, 1996). Standing balance test primarily evaluates static balance. Four positions that are used are standing with feet side by side, placing the instep of one foot touching the big toe of other foot, tandem stance,

Stand on one foot. Participants who fail in semi tandem stand is asked to stand for 10 second feet side by side. Participants whose semi tandem stand is successful is asked to stand for 10 sec with one foot behind the other so that big toe of one foot is touching heel of other foot. If the patient can hold a position for 10 seconds without moving their feet or requiring support, can move on to next position. Inability to hold the tandem stance for 10 seconds is an indication of increased risk of fall. The reliability of 4-stage balance test is (0.66). Stroop colour and word test is a neuropsychological test widely used to evaluate the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a second stimulus attribute known as stroop effect. Stroop effect is defined as the delay in reaction time between congruent and incongruent stimuli. Stroop effect works based on the principle of processing speed theory which states that people can read words much faster than they can name colour word processing is much faster than colour processing (Gregory et al., 2005).

The collected data were tabulated and analyzed using both descriptive and inferential statistics. All the parameters were assessed using statistical package for social science (SPSS). Paired t-test was adopted to find the statistical difference within the groups & Independent t-test was adopted to find the statistical difference between the groups.

Table 1. Comparison of the berg balance score between group – a and group – b in pre-test and post-test

| BERG BALANCE SCALE | GROUP A | | GROUP B | | t-TEST | SIGNIFICANCE |
|---|---|---|---|---|---|---|
| | MEAN | SD | MEAN | SD | | |
| PRE TEST | 44.47 | 3.44 | 43.53 | 3.29 | 0.759 | .454* |
| POST TEST | 49.47 | 3.39 | 47.40 | 3.35 | 1.676 | .105* |

**(*- $p > 0.05$)**

Table 2. Comparison of standing balance test score between group – a and group – b in pre-test and post-test

| STANDING BALANCE TEST | GROUP A | | GROUP B | | t-TEST | SIGNIFICANCE |
|---|---|---|---|---|---|---|
| | MEAN | SD | MEAN | SD | | |
| PRE TEST | 25.27 | 5.63 | 25.13 | 4.38 | 0.072 | .943* |
| POST TEST | 30.07 | 5.39 | 28.80 | 4.32 | 0.709 | .484* |

**(*- $p > 0.05$)**

Table 3. Comparison of stroop test score between group - a and group - b in pre-test and post-test

| STROOP TEST | GROUP A | | GROUP B | | t-TEST | SIGNIFICANCE |
|---|---|---|---|---|---|---|
| | MEAN | SD | MEAN | SD | | |
| PRE TEST | 11.93 | 2.78 | 10.60 | 2.29 | 1.446 | .159* |
| POST TEST | 16.73 | 2.68 | 11.47 | 2.38 | 5.678 | .000** |

**(*- $p > 0.05$, **- $p \leq 0.001$)**

Table 4. Comparison of berg balance scale, standing balance test and stroop test score between pre-test and post-test within group-a

| GROUP – A | PRE-TEST | | POST-TEST | | t-TEST | SIGNIFICANCE |
|---|---|---|---|---|---|---|
| | MEAN | SD | MEAN | SD | | |
| BERG BALANCE SCALE | 44.47 | 3.44 | 49.47 | 3.39 | 18.114 | .000* |
| STANDING BALANCE TEST | 25.27 | 5.63 | 30.07 | 5.39 | 44.900 | .000* |
| STOOP TEST | 11.93 | 2.78 | 16.73 | 2.68 | 21.569 | .000* |

**(*- $p \leq 0.001$)**

Table 5. Comparison of berg balance scale, standing balance test and stroop test score between pre-test and post-test within group-b.

| GROUP – B | PRE-TEST | | POST-TEST | | t-TEST | SIGNIFICANCE |
|---|---|---|---|---|---|---|
| | MEAN | SD | MEAN | SD | | |
| BERG BALANCE SCALE | 43.53 | 3.29 | 47.40 | 3.35 | 29.000 | .000 |
| STANDING BALANCE TEST | 25.13 | 4.38 | 28.80 | 4.32 | 15.783 | .000 |
| STOOP TEST | 10.60 | 2.29 | 11.47 | 2.38 | 2.476 | .000 |

**(*- $p \leq 0.001$)**

## Results

On comparing the mean values of Group A and Group B on berg balance scale, both the group shows significant increase in the post test means but (GROUP-A) which has the higher mean value 49.47 is more effective than (GROUP-B) with a mean value of 47.40. Comparing the mean values of Group A and Group B on standing balance test, both the group shows significant increase in the post test means but (GROUP-A) which has the higher mean value 30.07 is more effective than (GROUP-B) with a mean score of 28.80. Comparing the mean values of Group A and Group B on stroop test both the group shows significant increase in the post test means but (GROUP-A) which has the higher mean value 16.73 is more effective than (GROUP-B) with a mean score of 11.47. The null hypothesis of this study for berg balance scale, standing balance test and stroop test was rejected. On comparing pre-test and post-test within Group A and Group B on berg balance scale, standing balance test and stroop test shows highly significant difference in mean values at $p \leq 0.001$.

## Discussion

This experimental study aimed to provide an overview of dual task training approaches for balance in patients with acute stroke. The functional recovery of stroke patients is more effective when interventions include high intensity treatment and practices that will allow voluntary use of specific motions and functions that are similar to functional tasks. Jiejiao et al. (2012) in the study on effects of cognitive dual task training on balance in stroke patients states that integration of cognitive dual task training and balance program could produce more beneficial effect on balance function than balance exercise alone. Yeop et al. (2014) found that dual task training improves cognitive and walking abilities of patients with stroke. Bin and Cho (2015) found that dual task training is more effective for improving balance ability. Ru et al. (2019) when conducted studies on patients with Parkinson's disease found that 12 sessions of cognitive dual task training reduced double support time during cognitive dual task walking and in addition, it improved stride length, speed under motor dual task walking and single walking. Brauer and Morris (2010) found that 20 minutes of cognitive dual task training improved cognitive dual task walking speed and stride length in Parkinson's disease patients. In the present study, we found CDTT could be more effective in improving balance in acute stroke patients than MDTT. Baer and colleagues defined balance or postural stability as the "act of maintaining, achieving or restoring state of balance during any posture or activity. It is the lack of ability to carry out dual task, which is one of the reason for stumble, and fall as well. Recent researches indicated the lack of ability to perform two or more tasks simultaneously is regarded as an indicator for a higher fall risk. Simultaneous training of motor dual task during conventional treatment has already regarded as beneficial for various groups of individuals. Dual task training includes a primary task and a secondary task. The primary task of treatment aims to improve the balance. There are three hypothesis of how dual task training might work.

First, the individual learn to integrate two tasks efficiently. Second dual task training can enhance the automatization of the primary task. Finally, dual task training results in faster information processing. The exact cause for the improvement of balance in cognitive dual task balance training group is not immediately known. On the other hand, cognitive function may be improved by cognitive dual task balance training to result in better walking, balance or postural stability performances, since cognitive function is necessary for gait and balance performance especially during dual tasking as per the capacity sharing theory. In recent years, dual task training has evolved in to an emerging approach for balance and gait training in people

experiencing neurological conditions such as stroke. Balance training with a dual task has been hypothesized to be beneficial for enhancing balance and walking impairments in individuals with stroke.

## Conclusion

This four weeks study results showed improvement in cognitive dual task training group in comparison with motor dual task training group. Balance was improved after training sessions in the acute stroke patients in both the groups. However, the group, which had cognitive dual task training, showed significantly better performance in balance rather than the group, which received motor dual task training. Thus, this study concludes that cognitive dual task training is effective in improving balance in acute stroke patients with balance impairment, when compared to motor dual task training.

## Limitation of the Study

This was a short duration study, with less number of subjects that was limited to acute stroke patients with balance impairment.

## Recommendation

A study in future can be conducted with larger number of subjects for longer duration and in variety of other neurologic conditions other than stroke. This protocol in future can be recommended for chronic neurological conditions as well as in other determinants like gait.

## Conflict of Interest

Authors declare no conflict of interest.

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