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Effect of 2 Weeks of Dual Task Training on Balance and Gait in Patients with Stroke: Single Group Experimental Study

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ABSTRACT

Background: Performing two or more tasks continuously and simultaneously or performing one task while simultaneously performing another task is referred to as "Dual-Task performance. People, whose cognitive or physical functions are not smooth, such as stroke patients and the aged, lose their physical abilities or experience physical injuries, such as falls when put into a situation of dual-task performance. Therefore, in this study, the effects of 2 weeks of dual- task training on balance and gait ability of stroke patients were investigated.
Objective: To evaluate the effect of 2 week of Dual task training on Balance and Gait in patients with Stroke.
Method: After getting the ethical approval, patients were screened and informed consent form was taken from them. At baseline and post intervention (after 2 weeks) balance and gait was assessed by using Berg Balance Scale (BBS) and Functional Gait Assessment Scale (FGAS). Dual Task Training was given to the patient for 5 days a week for 2 weeks. All the patients received 30 min (3min x 10 tasks) of dual task training.
Results: There was improvement in balance and gait which included scores of Berg Balance Scale and Functional Gait Assessment Scale. The results were similar to alternate hypothesis which state that there is difference between pre and post exercise score.
Conclusion: The 2 week of Dual Task Training help in improving balance and gait in stroke patient.
Trial registration: Clinical Trials Registry-India (CTRI) CTRI/2018/04/013535

Keywords: Stroke, Dual Task Training, Balance and Gait.

INTRODUCTION

A "Stroke" is a condition which results in a injured state of the peripheral external nervous system which arising from the necrosis of nerve cells particular in areas of brain, due to which there is disruption of blood supply to brain cells which results in the obstacle or rupture of blood vessels that transports oxygen and glucose to the brain. Stroke is the condition which is the most common cause of ambulatory disability and impaired activities of daily living (ADL). Many neurological deficits resulting from the stroke lead to determined functional impairment and physical problems caused by brain damage. All the neurological symptoms after stroke which are reported commonly differ according to the position and level of the brain lesion, motor weakness and sensory and cognitive impairments[1]. Out of this 40% are left with functional deficits and 15-30% becomes strictly handicapped among the patients who survive. Abnormal muscle tone that guide to the deterioration of balancing ability and body imbalance that appears as asymmetric posture, proprioception disorder results in reduced motility subsequent in stroke[2].

Stroke is a universal cause of morbidity and mortality that affects health-related quality of life (QoL) (Talabi 2003; Strong et al., 2007). As a result, the importance of quality of life (QoL) in stroke survivors existing longer with stroke sequelae and long-term disability has been emphasized[3].

Balance is an additional element that seems to be affected in patients with stroke. For the people to guide normal daily lives and execute intended activities they should have the capability to maintain balance which is one of the most important component that is required. On the other hand, every stroke patients has difficulty with balance and postural control that leads to imperfect movement ability which interferes with activities of upper limb functions, impaired balance and disables walking and activities of daily living. Thus, to prevent falling, undertake the activities of daily living, and preserve an independent life balance is the most essential requirement in stroke patients[3]. Additionally, functional movements that are necessary for actual living should include more approach to balance training and task-oriented training [4]. The motor functions of stroke patients should be focused first rather than focusing on recurring functional tasks helps to get better [4].

Most important physical functions that are highly affected by stroke are walking. Stroke patients present decreased dynamic balance ability, as well as decreased musculoskeletal and cardiovascular function, and use an important amount of force compensating for this deficiency and this is all because of ineffective walking. Stroke patients have lesser walking speeds and shorter length of walking when compared with healthy individuals. They also have difficulties in performing their daily functions and also conversing while walking becomes difficult when they have to complete certain immediate tasks[2]. They also experience difficulty returning to their productive roles in culture due to gait disturbances. Recovery of walking to recover independence in daily life is one of the key goals of stroke rehabilitation. So in recovery of gait and balance in patients with stroke many methods have been in work for gait training [5]. While performing other tasks in daily living we require balance and walking ability. Motor skills and cognitive function necessary in daily living dual tasks should be imitate along with balancing and gait training for hemiplegic stroke patients. Increased gait ability can recover an individual's independence, participation in society, and quality of life as well as decrease the supporting expenses of caregivers [6].

The improvement of walking ability has been known as a major goal of stroke rehabilitation, and 60-80% of stroke patients can walk independently after discharge from the hospital. However, according to earlier studies on community ambulation, only 7% of stroke survivors continue valued activities in the home and community[7]. In addition, therapeutic interventions performed in clinical or hospital settings are not easy to provide various environmental factors, such as ambient conditions, terrain characteristics, and traffic level or a complex external environment for stroke patients [8]. Since environmental factors perform as serious determinants for the point of community ambulation of stroke patients, environmental factors must be measured while designing stroke rehabilitation programs aimed at improving community ambulation. Therefore, various previous studies have integrated environmental factors in the therapeutic intervention and have established that training that combines environmental factors with walking is helpful in the recovery of community ambulation [9].

Walking while talking, using a mobile phone, carrying a bag or watching traffic in which cognitive-motor and motor dual tasks play significant roles in daily life. Performing two tasks simultaneously may negatively force gait performance which has been reported in earlier studies. It has been observed that not only in healthy subjects there is Dual task interfering impacting gait

performance, but it is also seen in subjects with neurological disorders [10]. Performing two or more tasks constantly and simultaneously or performing one task while simultaneously performing another task is referred to as "Dual-task performance" [11].People whose cognitive or physical functions are not smooth, such as stroke patients and the elderly individuals, lose their physical abilities or experience physical injuries, such as falls when put into a situation of dual-task performance. Because of this studies are being carried out for subjects such as stroke patients and aged people on the application of dual-task performance. Yang et al. conducted a study in which he observed patients with neurological injuries has decrease of actual movements due to a variety of tasks and this emphasized the significance of performing dual tasks through behavior development by performing two exercise tasks simultaneously in a complex environment [15]. In addition, Canning et.al argued that activities of daily living that involves two exercise tasks must be performed simultaneously to effectively bring out complex tasks [20].

Cognitive-motor interference (CMI) is generated by the intense concentration when cognitive and motor tasks are simultaneously performed. CMI changes by age group and is more increased in stroke patients. A cognitive task such as language or calculation may be further difficult for an individual with low education level. The increased CMI in stroke patients is caused by cognitive motor function damage[6]. The dual task-related increase in CMI is considerably correlated with activities of daily living in stroke patients. To decrease CMI, automatization should be enhanced through repetitive gait training, whereas the coordination capability of dual tasks should be better through task-oriented training. In a study done by Yang et al. which evaluated "the purpose exercises based on dual tasks to chronic stroke patients, enhanced their gait ability [15]. Development of the ability to incorporate multiple exercise tasks into complex environment of daily living was brought about by results of previous studies. And this can be achieved by performing exercise tasks at the same time as performing another task. More studies are to be needed on the effects of dual-task training on improvement of balance and gait ability because most of the studies on dual-task training have focused on improvement of task performance abilities. Therefore, in this study, we investigated the effects of dual-task training on balance and gait of stroke patients

MATERIAL AND METHODS

Participants: The present study included 39 patients of stroke who consented to participate in the study. Sample size was calculated by formula $n = \frac{Z\ (1-\alpha/2)^2 \times p(1-p)}{d^2}$

n = sample size

p = Expected prevalence or proportion (179/6886) = 0.02

(Total no of Medicine department IPD patient in the year 2017 = 6886 out of which 179 was stroke patients)

α (level of significance) = 0.05%

Z (Confidence level) = 1.96

d (absolute value)= 0.05

$n= \frac{(1.96)^2 \times 0.02\ (1-0.02)}{(0.05)^2}$

Therefore n= 39

The study was performed at Padmashree Dr. Vitthalrao Vikhe Patil Memorial Hospital; Physiotherapy OPD Ahmednagar, India began in March 2018 to May 2019. The present study is an Experimental study with Purposive sampling method. All the subjects voluntarily consented to participate in this study prior to its initiation. Data collection was carried out after approval had been granted by the Institutional Review Board. Inclusion criteria were age 20-60 years, both male and female, first incidence of stroke, able to walk 10m independently with or without any assistive device, able to hold an object to complete the task using the non-affected upper extremity, a score of greater

than 24 on the MMSE, Brunnstrom stage of recovery for LL 2 or above. Exclusion criteria were aphasia, hearing impairment or visual impairment, seizures disorder, any other significant neurological or orthopedic disorder of gait including amputation.

Method: After getting the ethical approval, patients with stroke of age group 20-60 years were screened as subjects for the study according to the inclusion and the exclusion criteria. The brief written consent was taken from the subjects. The demographic data including name, age and gender was collected.

Outcome Measures: Gait and balance was assessed by using Berg Balance Scale (BBS) and Functional Gait Assessment Scale (FGAS) at baseline and after 2 weeks.

Intervention: The study was conducted for 5 days a week for 2 weeks. All the patients received intervention of Dual Task Training for 30 min (3min x 10 tasks).

Dual task training that was given includes the following:

1. Backward counting while walking.
2. Mathematical subtraction while walking.
3. Category naming while walking.
4. Recitation a sentence backwards while walking.
5. Naming words starting with a particular letter while walking.
6. Object transfer during walking.
7. Holding of glass of water without spilling during walking.
8. Tossing up and catching a ball while walking.
9. Receiving and returning rings from a ring holder while walking.
10. Picking objects and transfer to a fixed point while walking.

DATA ANALYSIS

Statistical analysis was performed by using GraphPad InStat software version 3 with following statistical test.

- Parametric Paired t test was used for comparing the scores of Berg Balance Scale and Functional Gait Assessment Scale pre and post (after 2 weeks) exercise.
- P <0.05 was considered as level of statistical significant for the entire statistical test which was incorporated in this study.

Figure 1: patient performing backward counting while walking.

Figure 2: patient performing a task of holding of glass of water without spilling during walking.

Figure 3: patient performing a task of tossing up and catching a ball while walking.

Figure 4: patient performing a task of picking objects and transfer to a fixed point while walking.

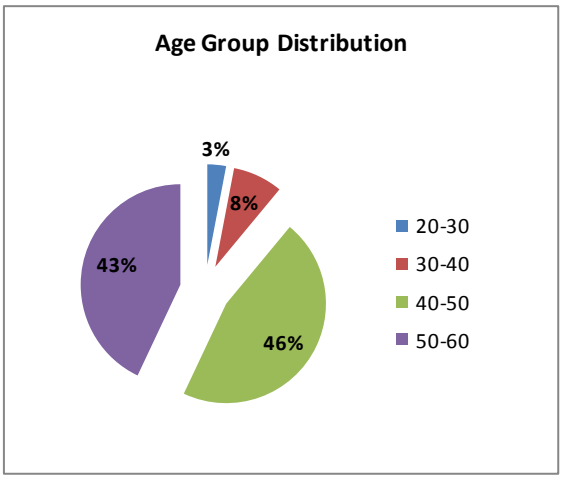
RESULTS

Table 1: Subject Characteristics

Age, years	49.53±8.73
Gender	
Male (%)	72%
Female (%)	28%
Dominance	
Right (%)	85%
Left (%)	15%
Months , since stroke	4.90±4.54
Ambulatory status	
Independent (%)	79%
Dependent (%)	21%

Table 2: Age Group wise Distribution of Subjects

Age group	20-30	30-40	40-50	50-60	Total
No. of subjects	1	3	18	17	39
Percentage	3%	8%	46%	43%	100%

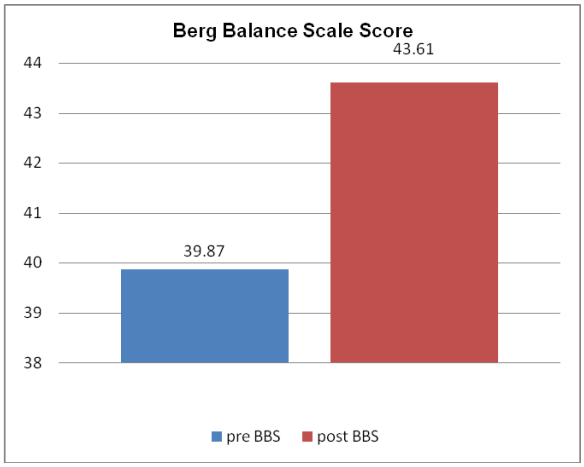


Graph 1: Age Group wise Distribution of Subjects

Table 3: Paired t-Test Results for Pre and Post Berg Balance Scale (BBS) Scores

	Pre BBS	Post BBS
Mean	39.87	43.61
SD	11.72	10.55
P value	<0.0001	
t value	7.71	
Significant	Yes	

Data are expressed as mean±SD; MD: mean difference; SD: standard deviation



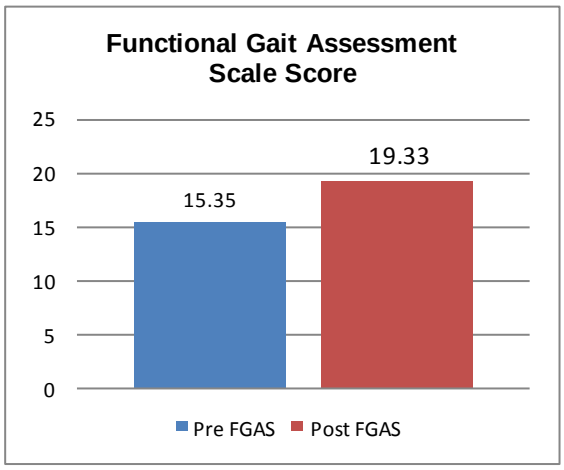
Graph 2: Graphical Representations of Paired t Test Analysis for Pre and Post BBS

Result: The pre and post value of BBS was compared using paired t test and the p value was found to be less than 0.0001 which is extremely significant.

Table 4: Paired t-Test Results for Pre and Post Functional Gait Assessment Scale (FGAS) Scores

	Pre FGAS	Post FGAS
Mean	15.35	19.33
SD	6.68	6.21
P value	<0.0001	
t value	6.57	
Significant	Yes	

Data are expressed as mean±SD; MD: mean difference; SD: standard deviation



Graph 3: Graphical Representations of Paired t Test Analysis for Pre and Post FGAS

Result: The pre and post value of FGAS was compared using paired t test and the p value was found to be less than 0.0001 which is extremely significant.

DISCUSSION

This study concluded that Dual task training was effective in improving balance and gait in subject with stroke. The total number of 41 patients participated in this study out of which 39 completed the study. Our study was having more number of male subjects (72%) as compare to female (28%). Dropout rate was 2 (one patient death and other did not continue for 2 weeks). The results of the study were similar to alternate hypothesis which states that 2 week of dual task training improve balance and gait in patients with stroke, hence it was accepted.

The findings of our study shows that there is improvement in balance and gait according to score of Berg Balance Scale and Functional Gait Assessment Scale which was used as outcome measure in this study. The reason for this is the weight shifting and dynamic balance movements which are increased and efficiently restore dynamic balance; as a result subject performed a variety of training methods [7].

Similar results were obtained by Neeraj Mishra (2015) who performed a study on "Effect 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". Fifteen eligible participants after being tested for ability for motor imagery were randomly divided into 3 groups (MI, CDTT and MDTT) of 5 each. Findings from this and related studies have lead to an understanding that mental imagery can trigger the neural activations of relevant motor areas of brain which then can be used to practice motor skills even in absence of actual implementation of movements by mere imagination. They concluded that Gait and Balance in stroke patients can be significantly enhanced by using Mental Imagery and Dual task training in course of rehabilitation along with conventional rehabilitation. This would help in better community mobility [4].

Sim and Oh (2015) conducted a study on 14 chronic stroke patients, who were randomly divided into the experimental group (EG) and the control group (CG), each with 7 patients. They reported that subjects exhibited improved gait velocity, endurance, static and dynamic balance abilities after training and significant differences in gait velocity with cognitive-motor dual-task training compared with single-task training was noticed. Other physical, cognitive, and emotional factors should be considered as gait speed is not the only reason that determines one's ability to walk within the community[12].

The Dual task exercise performed in our study is to transfer object while walking, holding a glass of water without spilling while walking, tossing a ball and catching while walking and to picking object and transfer to a fixed point while walking. Because the therapist give practice environment to recover the performance of the patient's in a different way[13], depending on the characteristics of all phase of the learning process, this study conducted task training that required attention[14], which is based on earlier studies. Hence, once provided dual tasks to maneuver objects and

maintain directionality, which is used to progress the cognitive effort through the exercise task. There was also additional further concentration to task performance by asking the subjects not to spill the water from the glass while walking, and to move the object while walking[15]. So to carry out difficult tasks in everyday life and to return efficiently to the local circuits, it is essential to possess the capability to properly distribute and regulate the concentration for problem solving rather than simple concentration, which can be accomplished more appropriately through dual task training[16]. The dual task training is thought to play a significant role in the learning process of movement tasks and activities by allowing cognitive coordination of various tasks during training by performing more than two tasks at the same time [17]. In addition, it is likely to improve the accuracy of the task learning by adapting to changes in attention and concentration during the dual task, and it may lead to the evolution effect on the performance of other tasks that are not directly trained. Participants who received dual-task training established greater improvements in balance and gait. Hence, a potential clarification is that for improving dual-task performance the well-organized integration and coordination between the two tasks acquired during dual-task training is important.

A study done by Silsupadol et.al.(2009) on twenty-five older adult with balance impairment. Results of the study shows that BBS and walked considerably quicker after training was improved in all the groups of participants. Major enhancement in gait was observed only in participants who received dual-task training with fixed-priority instructions and dual-task training with variable-priority instructions after addition of cognitive task. They concluded that for improving gait speed under dual-task conditions in older adults with balance impairment dual task training is useful. Single-task conditions may not simplify to balance control during dual-task contexts under training balance. An important factor contributing to the speed of learning is clear instruction regarding attention focus and therefore the retention of the dual-task training effect. They reported that impaired balance and reduced gait speeds after performing dual-task training there was improved balance and gait in older subject with hand movements while standing, eyes closed, and different physical activities in addition to performing cognitive tasks, like trying to recall object names or numbers [18].

Earlier studies show that because of the ability to integrate the challenges efficiently improvements with dual-task training will increases task-coordination skills. For this specific study, it is thought that because of the coordination and integration of motor and cognitive tasks as given in previous studies subjects who underwent gait training which include counting backwards, mathematical subtraction, category naming, recitation sentence backwards, naming words starting with a particular letter while walking showed improvements in balance and gait abilities. Therefore, for the persons with stroke to exercise while inducing their memory or to perform motor tasks while talking it is believed that an environment should be provided to them.

The correlation between cognition and motor functions has been the center of research on dual task, because it is important for understanding how the recovery of motor control happens after injury to the central nervous system. Morioka et al. (2015) conducted a study to determine if the postural sway of a subject required to grasp a tray (motor task) holding a cup filled with water and prevent spilling (mental task), would be reduced by consciously redirecting attention to keep the tray in a horizontal position. Results of this study specify that postural sway was considerably shrivelled throughout a mental task as compared to no mental task. Most potential the addition of a mental task “try not to spill the water” forced the subject to purposely concentrate attention on

maintaining the tray in a horizontal position, so reducing postural sway. Thus, they concluded that higher brain functions like attention and consciousness exerted a significant influence over the management of standing posture [14].

These findings were confirmed in our present study within which walking was combined with the mental task of "holding a glass of water while not spilling it". Results of this study show that postural sway was considerably decreased during a mental task. Most likely the adding from a mental task "try to not spill the water" forced the subject to consciously concentrate attention on maintaining the glass in position, as a result reducing postural sway. Therefore, this mental task significantly reduced right and left sway. These findings suggest that cognitive function, specifically conscious attention, includes an important impact on postural control. Due to the promotion of changes in concentration and attention levels, facilitate the accuracy of learning various tasks with dual-task training a positive effect on the patient's walking performance was given in this study. In addition, results show that posture control was more able with use of an external focus compared to an internal focus for concentration for subjects with balance impairments due to neurological diseases. Therefore, it's thought-about that the balance and gait abilities of subjects had improved throughout the combination of an external focus on a target and cognitive tasks.

Another study conducted by Audrey Bowen (2001) which aimed to verify whether or not performing a verbal cognitive task while walking adversely affected patients balance and velocity. The results of the study show that eleven people with stroke participated. During this study the cognitive activity involved giving a verbal response to a non-verbal auditory signal (i.e. a tone). As response to verbal auditory stimuli is a more realistic life-like activity, words were used rather than a tone. They concluded that performing a verbal cognitive task while walking adversely affected stroke patients balance and gait velocity [19].

In the present study subjects was given cognitive task like backward counting, mathematical subtraction, category naming, recitation a sentence backwards and naming words beginning with a particular letter the whole task was performed while walking. Real life interactions are also probably more difficult, involving many higher level cognitive processes (such as sustained attention, language processing, remembering and sequencing). Understanding the therapist's instructions and communicating with each other is a basic element in improving the effectiveness of gait training for stroke patients and learning gait tasks, which should be possible with adequate cognitive abilities. Therefore, gait training performed with cognitive tasks helps to decrease errors that may occur during task performance, and enhances cognitive abilities and enhances gait function. In this study, we found that the cognitive exercise program, including the cognitive exercise task, can be used in stroke rehabilitation as a way to progress the ability of stroke patients to adapt to various and speedily changing environments. And can be modified to suit the characteristics of the clinical field. So the improvement in subject of this study was because of more practice at talking while walking which help them to improve the ability to do both in real life settings.

In our day to day routine task we are most often performing dual motor task like carrying object while walking or transferring object from one hand to other. Analyzing the results it is clear that the dual task training shows the most significant improvement in balance and gait, similar findings have been reported in previous study. This is all possibility could be accredited to the direct nature of dual task training which approximates best to the day to day functional activity of the patients. Hence, in our study the scores of Berg Balance Scale and Functional Gait

Assessment Scale after 2 week of dual task training exercise shows that there was functional improvement in balance and gait.

CONCLUSION

The most important goal of treatment in stroke patients is to return the patients to society. For this cause, a very essential goal of physical therapy in stroke patient has been the recovery of balance and gait ability and it has been regarded as having a high research value. Moreover, Dual tasks have clinical significance in a number of areas in enhancement of the balance and gait ability of patients. As patients show various reactions to the level of dual tasks, it can be very important to assess dual tasks for stroke patients and can contribute to the individual therapy strategy of patients.

It can be concluded from the results of this study that for improve balance and gait in stroke patients dual task training is useful intervention and can be included in conventional stroke rehabilitation program. Furthermore, compared with the traditional single-task exercise task, dual tasks are performed in activities of daily living and as a result, they can be a better indicator of functional daily living in the stroke patient.

Clinical Implication

In persons with stroke the exercise endurance and cognitive function are both reduced the two elements that combines dual-task training is necessary, and by distribution of their attention while walking and performing a dual-task will be enhanced through physical function.

So in stroke patients to improve their balance and gait Dual task training should be a part of regular physiotherapy exercise program.

Scope of Study

In this study the dual task gait training protocols given may be simple and easily implemented as a part of stroke rehabilitation therapy. Thus to improve different dual task gait performance in individuals with stroke, different types of dual task gait training can be adopted.

Further research using a gait-training program with additional various training components would help to identify a broader rehabilitation approach for clinical use.

Limitations

This study has some limitations in interpreting the results. First, it is hard to generalize the results of the study to the stroke patients because the study was conducted on few patients. Second, since the training period is short it is not well-known how long the actual training effect lasts in the long-term. Third absence of a control group. Fourth, as the sample size was not homogeneous it was difficult to divide the patients into groups according to their age, gender and duration to analyze the results.

Disclosures: None.

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