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Original Research Article

Comparison of Conventional Balance Exercises with Auditory Stimuli vs. Conventional Balance Exercises with Visual Stimuli vs. Conventional Balance Exercises with Auditory and Visual Stimuli Both On Balance in Healthy Geriatrics: An Experimental Prospective Study

Roma Raykar[1], Aparna Sadhale[2]

[1]M.P.Th in Neuroscience Physiotherapy, Deccan Education Society's Brijlal Jindal College of Physiotherapy, Pune
[2]Principal, Professor, Deccan Education Society's Brijlal Jindal College of Physiotherapy, Pune

Corresponding Author: Roma Raykar

ABSTRACT

Introduction: Balance is an important aspect of an individual while undertaking various daily activities. It is a dynamic process requiring sensory detection of body motions, integration of sensorimotor information within the CNS, and execution of appropriate musculoskeletal responses in order to establish equilibrium between destabilizing and stabilizing forces. Among geriatric population, impairment in the control of balance under dual-task conditions is a common occurrence. Impaired dual-task balance performance predicts adverse outcomes such as falls and decline in both cognitive and physical function.
Objectives: To assess balance using One Leg Stance Test and Forward Reach Test, To assess level of confidence using Activity Specific Balance Confidence scale, To train healthy geriatrics with conventional balance exercises along with auditory stimulus (group A), visual stimulus (group B) and auditory and visual stimuli combined (group C);To compare the effect on balance post training in three groups.
Methodology: 93 healthy geriatrics between the age group of 65-74 years were randomly allocated into three groups (A, B ,C).Balance assessment was done pre and post one month treatment using OLST and FRT. Treatment sessions were carried out thrice a week for 4 weeks. Each balance training session lasted for 45 minutes. Conventional balance exercises were given for all the three groups along with auditory stimulus (group A), visual stimulus (group B) and auditory and visual stimuli combined (group C).
Result: Results show statistically highly significant improvement in OLST, FRT and ABC scores of three groups when compared pre and post training. Changes in OLST duration, FRT distance and percentage of ABC scores from pre to post between groups was statistically not significant.
Conclusion: The study concludes that there is no significant difference between the three groups post intervention i.e. all the three treatment strategies are equally effective.

Key words: Dual Task Training, Balance, Geriatrics, Postural Control.

INTRODUCTION

Postural stability, also referred to as Balance is considered to be an important aspect of an individual while undertaking various daily activities which is achieved by a complex process involving the function of musculoskeletal and neurological systems.

Balance is defined as the ability to maintain a posture for performing activities and counteract with conflicts (External or internal) and in terms of biomechanics, it is maintaining body mass centre in the domain of base of support.

Postural stability is the ability to sustain the body in equilibrium by maintaining the projected centre of mass within the limits of the Base of support (Shumway-Cook & Woollacott, 2001a).

It is a dynamic process that requires sensory detection of body motions, integration of sensorimotor information within the central nervous system, and execution of appropriate musculoskeletal responses in order to establish equilibrium between destabilizing and stabilizing forces. (Riemann & Guskiewicz, 2000).

The measurement of postural stability is critical to determining predictors of performance (Sell, Tsai, Smoliga, Myers, & Lephart, 2007), evaluating lower extremity musculoskeletal injuries (Ageberg, Roberts, Holmstrom, & Friden, 2005; Herrington, Hatcher, Hatcher, &McNicholas, 2009), determining the efficacy of physical training.

Stability is often described as being static (quiet standing) and dynamic (maintaining a stable position while the subject undertakes a prescribed movement).

Balance is described in terms of static and dynamic. Static balance is defined as the ability to maintain the line of gravity of a body within the base of support with minimal postural sway. (V. Hatzitaki, V. Zisi, et al 2002). Dynamic balance is defined as the ability to maintain equilibrium while moving through space.

Maintaining balance requires co-ordination of input from multiple systems such as vestibular, somatosensory, and visual and an appropriate output from the motor system.

Postural control involves controlling the body's position in space for the dual purposes of stability and orientation. Postural orientation is defined as the ability to maintain an appropriate relationship between the body segments, and between the body and the environment for a task (Horak & Macpherson, 1996).

For most of the functional tasks, we maintain a vertical orientation of the body. In the process of establishing a vertical orientation, we use multiple sensory references, including gravity (the vestibular system), the interrelationship of different body segments, the relationship of our body to support surface (somatosensory system), and the relationship of our body to objects in our environment (visual system).

A properly functioning balance system allows humans to see clearly while moving, identify orientation with respect to gravity, determine direction and speed of movement, and make automatic postural adjustments to maintain posture and stability in various conditions and activities.

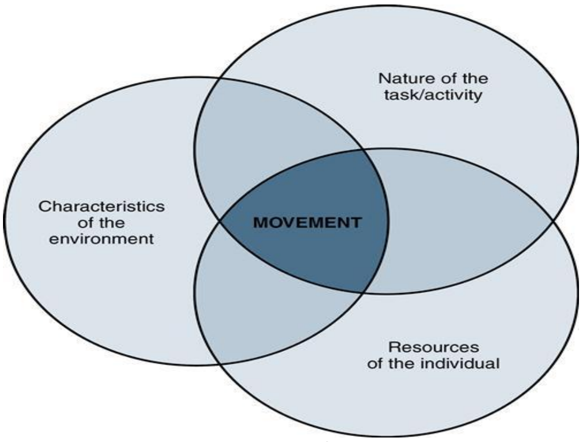
Dynamic postural control often involves compilation of various tasks which also represent the performance of proprioception, range of motion of lower limbs, strength of muscles and also the ability of the subjects to remain steady and upright.

The ability to control our body's position in space is fundamental to everything we do. All tasks require postural control i.e. every task has an orientation component and a stability component and which will vary with the task and the environment.

Some tasks place importance on maintaining an appropriate orientation at the expense of stability e.g.: the successful blocking of a goal in soccer or catching a fly ball in baseball requires that the player remains oriented with respect to ball, sometimes falling to the ground in an effort to block a goal or to catch a ball.

Thus, while postural control is a requirement that most tasks have in common, stability and orientation demand change with each task (Horak & Macpherson, 1996; Shumway-Cook & McCollum, 1990).

Postural control for stability and orientation requires a complex interaction of musculoskeletal, sensory and higher intellectual functions along with environment and task.

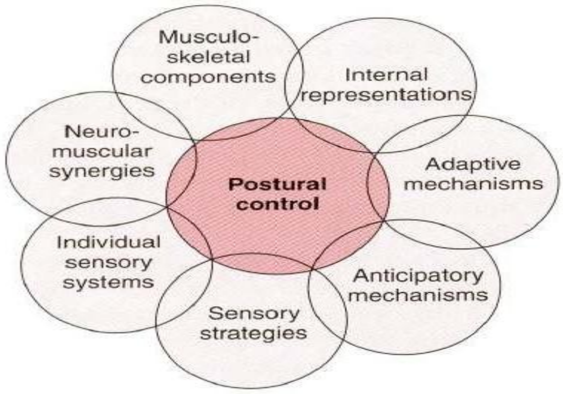


(Figure I: components of Motor Control)

Musculoskeletal components include peripheral joint range of motions, spinal flexibility, muscle properties like muscle tone, muscle strength and biomechanical relationships like muscle length among linked body segments.

Neural components essential to postural control includes:

a) Motor processes, which include organizing muscles throughout the body into neuromuscular synergies,
b) Sensory/perceptual processes , involving the organization and integration of visual , vestibular , and somatosensory systems, and
c) Higher level processes (cognitive influences), essential for mapping sensation to action, and ensuring anticipatory and adaptive aspects of postural control.
d) Adaptive postural control involves modifying sensory and motor systems in response to changing task and environmental demands.
e) Postural movement strategies are used to maintain equilibrium in a number of circumstances. These strategies are the "Feedback control" and the "Feed forward control".



(Figure II: Factors contributing to postural control)

"Feedback control" refers to postural control that occurs in response to sensory feedback (visual, vestibular, or somatosensory) from an external perturbation. For example,

a) In response to external disturbances to equilibrium , such as when the support surface moves ; and
b) During gait and in response in to unexpected disruptions to the gait cycle, such as trip or slip.

"Feed forward control" refers to postural responses that are made in anticipation of a voluntary movement that is potentially destabilizing in order to maintain stability during the movement. For example,

a) Prior to voluntary movement that is potentially destabilizing, such as when lifting a heavy object, or leaning over to pick up a heavy object.

Performing two tasks simultaneously (dual-task) is common in human daily life. Among geriatric population, impairment in the control of balance under dual-task conditions is a common occurrence. Dual-task (DT) performance, the ability to divide one's attention between motor and secondary tasks, is required in daily life.

Elderly population residing in community who usually adopt a sedentary life style making them prone to physical de - conditioning show decline in motor performance when there is a competition for attentional resources for the task to be performed under dual task condition.

There is broad consensus that the control of gait and balance entails attentional capacity as commonly shown using dual-task methodology.

Since normal postural control occurs automatically, without conscious effort, it was traditionally assumed that few attentional resources were needed when controlling balance. However, research examining changes in postural control during performance of another attentionally demanding task, referred to as "dual task" interference has suggested that there are significant attentional requirements.

In addition, it appears that attentional requirements are not constant , but vary depending on the postural task , on age of individual and on individual's balance abilities.(Shumway-Cook & Woollacott , 2002)

There are two primary theories to explain interference between two tasks that are performed at the same time.

The first, "the capacity theory", considers dual task interference to result from the sharing of limited set of information processing (i.e. attentional) resources. In this case, when processing demands of the two combined tasks exceed attentional capacity, reduced performance is observed in one or both tasks.

The second, "the bottleneck theory", hypothesizes the sequential nature of dual task process and proposes that there is competition between tasks for stimulus encoding, identification, or response selection. In this case, it is proposed that the nervous system delays information-processing operations on one task in favour of operations on the prioritized task, which causes impaired performance on the non-prioritized task. (Fraizer&Mitra, 2008; Neumann, 1984; Shumway-Cook &Woolcott, 2000; Wickens, 1989).

Postural control (Balance) plays an important part in daily life activities especially in geriatric population as imbalance results into an increased risk of falls and injury which hampers the quality of living as falls sets in fear and anxiety implying dependency on family members and in their absence can lead to abstinence from participating into social activities ultimately resulting into social isolation.

The standard motor dual-task design involves a comparison of a motor task performed alone versus the same motor task performed with a concurrent cognitive task.

The growing body of literature on motor dual-task effects has inspired a few recent investigations of dual-task training as a means to improve gait and balance.

Pellecchia et al. measured balancing in healthy young to middle-aged adults assigned to dual-task, single-task, or no-training groups. After training, only the dual-task training group was able to reduce their dual-task body sway scores to single-task levels.

Silsupadol and colleagues trained older adults with balance impairment under single-task, dual-task fixed priority (equal task emphasis), or dual-task variable priority (alternating task emphasis between blocks) protocols.

Functional community ambulation requires an ability to perform cognitive tasks while walking and an ability to adapt to extrinsic environmental factors that increase the complexity of mobility, such as obstacle avoidance (e.g., curbs) and time-critical tasks (e.g., crossing the street within the time constraints imposed by traffic signals). A reduced capacity for dual-task walking may limit community mobility.

Research has shown that healthy older adults experience significant decrements in gait speed when cognitive tasks are performed while walking, a phenomenon referred to as dual-task interference or cognitive-motor interference.

Studies of healthy older adults showed a marked reduction in ability to perform a posture and a cognitive task simultaneously compared with young adults and also that the ability to recover stability after an external perturbation is affected by the simultaneous achievement of a secondary task.

This is probably due to interference on the cortical attention resources even in the apparent automatic processes such as walking, contributing to falls in elderly people who already have poor balance. This deficit associated with aging has been attributed to shrinkage of the prefrontal area of the brain, since this area is strongly related to implementation and managing of multiple tasks.

Addition of dual task creates conflict in which brain must divide attention and prioritize between gait function and secondary tasks. (Yogev-Seligmann et al, 2008). However, attentional cognitive dual task is seen to be reduced in older adults. (Ballesteros et al, 2013)

Increasing age is associated with reduced ability to flexibly allocate attention to gait (Yogev-Seligmann et al, 2008). Therefore older adults may demonstrate impaired gait performance with addition of a secondary task.

Balance is the key predictor of recovery and is required in many of our daily life activities and hence is often introduced into treatment plans by physiotherapists and hence having a correct assessment of balance is important.

Functional balance tests focus on the maintenance of static balance, balance during weight shift or dynamic balance, balance responses to perturbations and functional mobility.

Standardised tests of balance are available which allow the physiotherapists and other health care professionals to assess an individual's functional performance. Some of the functional balance tests are – One leg stance test [OLST], Berg balance scale [BBS], Multi directional reach test [MDRT], Dynamic gait index [DGI], Timed up and go [TUG], Star excursion balance test [SEBT] etc.

The one leg stance test is a valid measure considered to assess postural steadiness in a static position by a temporal measurement. (Bohannon,R.W;2006). The forward reach test is a valid tool to measure limits of stability in antero-posterior direction. It assesses the dynamic stability of an individual (Duncan ;1993 , Fisher et al 2009).

The one leg stance test (OLST) and the forward reach test (FRT) are both objective measurements of assessing static and dynamic balance scoresand hence were used in this study.

The activity specific balance confidence (ABC) scale is a 16-item self-report measure in which patients rate their balance confidence for performing activities. As the scale is a self-report measure, it a subjective assessment tool for measuring the confidence of the individual and hence was used in this study (Powell, LE & Myerset al, 1995)

The Mini-Mental State Examination (MMSE) is a brief screening tool to provide a quantitative assessment of cognitive impairment and to record cognitive changes over time (Folstein et al. 1975). In the present study, cognitive stimuli were added as a part of dual task training to individuals. Hence, the MMSE was chosen in this study to assess the cognitive levels of the participants as the use of cognitive stimuli was proposed to be used as a part of training protocol.

Balance impairment is a major contributor to falls in adults over 65 years of age. A growing body of evidence has confirmed the importance of cognitive factors to impaired balance among older adults.

Functional community ambulation requires an ability to perform cognitive tasks while walking and an ability to adapt to extrinsic environmental factors that increase the complexity of mobility, such as obstacle avoidance (e.g., curbs) and time-critical tasks (e.g., crossing the street within the time constraints imposed by traffic signals).

Research has shown that healthy older adults experience significant decrements in gait speed when cognitive tasks are performed while walking, a phenomenon referred to as dual-task interference or cognitive-motor interference.

A reduced capacity for dual-task walking may limit community mobility and thereby increase the dependency on family members.

Very few studies have been conducted in an Indian population to assess the improvement of balance in geriatrics with dual task training.

Thus, the need of the study was to assess the improvement in balance of the geriatrics with a dual task training (motor + cognitive task) with an addition of visual and auditory stimuli which would help the individuals to perform activities of daily living with ease , including community ambulation.

The Aim of the study was to compare the effect of conventional balance exercises with auditory stimulus; conventional balance exercises with visual stimulus and conventional balance exercises given with auditory and visual stimuli together on balance in healthy geriatrics.

The Objectives of the study were (a) To assess balance using One Leg Stance Test (OLST) and Forward Reach Test (FRT) prior to commencement of training protocol, (b) To assess level of confidence using Activity Specific Balance Confidence (ABC) scale prior to commencement of training protocol, (c) To train healthy geriatrics with conventional balance exercises with auditory stimulus (group A) , (d) To train healthy geriatrics with conventional balance exercises with visual stimulus (group B) ,(e) To train healthy geriatrics with conventional balance exercises with auditory and visual stimuli (group C) and (f) To compare the effect on balance post training in group A,B and C.

MATERIALS AND METHODS

The study was conducted on 93 healthy geriatrics between the age group of 65-74 years after obtaining an approval from the ethics committee of the institute. A written informed consent was taken from each participant and the procedure of balance training program was explained in detail. Subjects were screened as per the inclusion and exclusion criteria.

Each participant was randomly allocated into three groups by chit method who were then treated with conventional balance exercises along with auditory stimuli(group A) ; conventional balance exercises along with visual stimuli (group B) and conventional balance exercises along with auditory and visual stimuli together (group C).

Prior to commencement of balance training protocol, each participant was screened for outcome measures (OLST, FRT, and ABC) which were re-assessed after the 4 week training protocol was completed. Balance training protocol was carried out thrice /week for 4 weeks, each session lasting for 45 minutes.

Protocol for group A (auditory) was as follows:

<u>WEEK 1</u>: [mango,banana,pineapple] [3 auditory stimuli]

1) Standing with eyes closed (feet shoulder width apart): 30 sec*10 reps. Repeat words in random order that participant remembers.
2) Tandem standing: 1 minute*10 reps. Repeat words in random order that participant remember.
3) Standing on stability trainer (feet shoulder width apart) (blue stability trainer): 30 sec*10 reps. Repeat words in same order as mentioned.

<u>WEEK 2:</u> [mango, banana, pineapple, orange, apple] [5 auditory stimuli]

1) Standing on stability trainer with rapid bilateral hand movements (feet shoulder width apart) (B/L shoulder flexion):10 sets*10 reps. Repeat words in same order as mentioned.
2) Throwing and catching ball: 10 throws + 10 catch each. Repeat words in same order as mentioned.
3) Tandem standing holding 1kg weight:30 sec*10 reps. Repeat words in same order as mentioned.

<u>WEEK 3:</u> [7 questions challenging memory]

1) Narrowwalking:10 metres*5 laps
2) Backward walking: 10 metres*5 laps
3) Transfer from one chair to another: 5 laps

<u>WEEK 4:</u> [10 questions challenging mathematical abilities & memory]

1) Narrow walking with rapid bilateral hand movements of shoulder flexion: 10 metres * 5 laps
2) Backward walking with rapid bilateral hand movements of shoulder abduction: 10 metres * 5 laps
3) Transfer from one chair to another with rapid bilateral hand movements of horizontal shoulder adduction: 5 laps

Protocol for group B (visual) was as follows:

WEEK 1: [dog, cow, cat] [3 visual stimuli]
1) Standing with eyes closed (feet shoulder width apart):30 sec*10 reps. Recollect pictures shown in random order that participant remember.
2) Tandem standing: 1 minute*10 reps. Recollect pictures shown in random order that participant remember.
3) Standing on stability trainer (feet shoulder width apart) (blue stability trainer):30 sec * 10 reps. Recollect pictures shown in same order as displayed.

WEEK 2: [dog,cow,cat,bus,car] [5 visual stimuli]
1) Standing on stability trainer with rapid bilateral hand movements (feet shoulder width apart) (B/L shoulder flexion): 10 sets*10 reps. Recollect pictures shown in same order as displayed.
2) Throwing and catching ball: 10 throws + 10 catch each. Recollect pictures shown in same order as displayed.
3) Tandem standing holding 1kg weight: 30 sec*10 reps. Recollect pictures shown in same order as displayed.

WEEK 3: [dog,cow,cat,bus,car,horse, 2 wheeler] [7 visual stimuli]
1) Narrow walking: 10 metres*5 laps. Recollect pictures shown in same order as displayed and mention 1 characteristic of any one.
2) Backward walking: 10 metres*5 laps. Recollect pictures shown in same order as displayed and mention 1 characteristic of 3 asked.
3) Transfer from one chair to another: 5 laps. Recollect pictures shown in same order as displayed and mention 1 characteristic of each.

WEEK 4 : [dog , cow , cat , bus , car , horse , 2 wheeler , sheep , cycle , auto rickshaw] [10 visual stimuli]
1) Narrow walking with rapid bilateral hand movements of shoulder flexion: 10 metres*5 laps. Recollect pictures shown in same order as displayed and mention 1 characteristic of any one.
2) Backward walking with rapid bilateral hand movements of shoulder abduction: 10 metres*5 laps. Recollect pictures shown in same order as displayed and mention 1 characteristic of 3 asked.
3) Transfer from one chair to another with rapid bilateral hand movements of horizontal shoulder adduction: 5 laps. Recollect pictures shown in same order as displayed and mention 1 characteristic of each.

Protocol for group C (audio-visual) was as follows:

WEEK 1: [3 stimuli]
1) Standing with eyes closed (feet shoulder width apart): [3 auditory stimuli – aeroplane, chair, and mango]: 30 sec*10 reps. Repeat in random order that participant remembers.
2) Tandem standing: [3 visual stimuli – train, newspaper, lotus]: 1 minute*10 reps. Recollect pictures shown in random order that participant remembers.
3) Standing on stability trainer (feet shoulder width apart) (blue stability trainer) (2 auditory + 1 visual stimuli):30 sec*10 reps. Repeat the words mentioned and picture shown in same order as displayed.

WEEK 2: [5 stimuli]
1) Standing on stability trainer with rapid bilateral hand movements (feet shoulder width apart) (B/L shoulder flexion) [3 visual + 2 auditory stimuli]: 10 sets*10 reps. Repeat the words mentioned and pictures shown in same order as displayed.
2) Throwing and catching ball: [2 visual + 3 auditory]:10 throws + 10 catch each. Repeat the words mentioned and pictures shown in same order as displayed.
3) Tandem standing holding 1kg weight: [3 visual + 2 auditory]: 30 sec*10 reps. Repeat

the words mentioned and pictures shown in same order as displayed.

WEEK 3: [7 stimuli]

1) Narrowwalking: [5 visual + 2 auditory]: 10 metres*5 laps. Repeat the words mentioned and pictures shown in same order as displayed and mention 1 characteristic of any one.

2) Backwardwalking: [5 auditory + 2 visual]:10 metres*5 laps. Repeat the words mentioned and pictures shown in same order as displayed and mention 1 characteristic of 3 asked.

3) Transfer from one chair to another: [5 visual + 2 auditory]: 5 laps. Repeat the words mentioned and pictures shown in same order as displayed and mention 1 characteristic of each.

WEEK 4: [10 stimuli]

1) Narrow walking with rapid bilateral hand movements of shoulder flexion: [7 visual + 3 auditory challenging mathematical skills]:10 metres * 5 laps. Recollect pictures shown in same order and answer questions asked.

2) Backward walking with rapid bilateral hand movements of shoulder abduction: [7 auditory challenging memories + 3 visual]: 10 metres * 5 laps. Recollect pictures shown and words mentioned in same order as displayed.

3) Transfer from one chair to another with rapid bilateral hand movements of horizontal shoulder adduction: [5 auditory challenging memory and mathematical skills + 5 visual]: 5 laps. Recollect pictures shown in same order as displayed and answer the questions asked.

Statistical analysis:

Data was collected and analyzed using SPSS-19.Sample size was estimated to be 93 participants (31 in each group) using the formula: n = $(t^2 * S.D^2) / E^{2;}$where t=constant i.e. 1.96 [S.D=standard deviation= expected change in values (<20%)].

Confidence interval (C.I) was set at 95%; with p value $\leq$0.05.

Comparison between pre and post intervention OLST and FRT scores in A, B, C groups were done using the paired T test.

Comparison between pre and post intervention ABC scores in A, B, C groups were done using the Wilcoxon signed rank test.

Comparison of OLST and FRT scores post intervention was done using the ANNOVA F.

Comparison of ABC scores post intervention was done using the Kruskal Wallis.

RESULTS AND TABLES

For carrying out the following study, statistical analysis was performed for sample size estimation. The sample size estimated for the current study was 93 individuals (31 in each group). Confidence interval (C.I) was set at 95% with p value = 0.05

Table I:Comparison of One Leg Stance Test duration (sec) from Pre toPost in each group.

Group A [Auditory]	Mean	SD	Paired T	P
Pre	6.42	3.344	7.865	<0.001 HS
Post	7.87	3.827		
Group B [Visual]				
Pre	5.42	2.433	8.478	<0.001 HS
Post	6.94	3.010		
Group C [Auditory+Visual]				
Pre	5.68	3.004	7.826	<0.001 HS
Post	7.32	3.544		

Table II: Comparison of Forward Reach Test distance (cms) from Pre to Post in each group.

Group A [Auditory]	Mean	SD	Paired T	P
Pre	26.90	1.904	9.537	<0.001 HS
Post	30.06	2.250		
Group B [Visual]				
Pre	26.45	1.841	8.407	<0.001 HS
Post	30.00	2.098		
Group C [Auditory+Visual]				
Pre	26.32	2.006	9.804	<0.001 HS
Post	29.35	1.836		

Table I shows the comparison of one leg stance test from pre to post in each group. P value of Group A (auditory) is <0.001 which is statistically highly significant. P value of Group B (visual) is <0.001 which is statistically highly significant. P value of

Group C (Auditory+Visual) is <0.001 which is statistically highly significant.

Table II shows the comparison of forward reach test from pre to post in each group.P value of Group A (auditory) is <0.001 which is statistically highly significant. P value of Group B (visual) is <0.001 which is statistically highly significant. P value of Group C (Auditory+Visual) is <0.001 which is statistically highly significant.

Table III:Comparison of ABC % from Pre to Post in each group.

Group A [Auditory]	Mean	SD	Wilcoxon Signed Rank Test Z	P
Pre	83.48	3.325	4.878	<0.001 HS
Post	87.90	3.496		
Group B [Visual]				
Pre	82.55	2.158	4.877	<0.001 HS
Post	88.10	2.561		
Group C [Auditory+Visual]				
Pre	83.45	3.305	4.871	<0.001 HS
Post	88.10	3.320		

Table III shows the comparison of activity specific balance confidence (ABC) scale from pre to post in each group. P value of Group A (auditory) is <0.001 which is statistically highly significant. P value of Group B (visual) is <0.001 which is statistically highly significant.P value of Group C (Auditory+Visual) is <0.001 which is statistically highly significant.

Table IV: Comparison of change in OLST (sec) post training between three groups.

	Mean	SD	ANOVA F	P
Group A [Auditory]	1.55	0.995	0.327	0.722 NS
Group B [Visual]	1.52	0.962		
Group C [Auditory+Visual]	1.71	1.071		

Table IV shows comparison of change in one leg stance test (OLST) post training between three groups. The P value is 0.722 which is statistically not significant.

Table V: Comparison of change in Forward Reach Test distance (cms) post training between groups.

	Mean	SD	ANOVA F	P
Group A [Auditory]	3.13	1.668	0.725	0.487 NS
Group B [Visual]	3.68	2.242		
Group C [Auditory+Visual]	3.26	1.653		

Table V shows comparison of change in forward reach test (FRT) from post training between groups. The P value is 0.487 which is statistically not significant.

Table VI: Comparison of change in ABC % Post training between groups.

	Mean	SD	Kruskal Wallis chi square	P
Group A [Auditory]	4.42	1.689	5.780	0.056 NS
Group B [Visual]	5.55	1.877		
Group C [Auditory+Visual]	4.65	2.332		

Table VI shows comparison of change in activity specific balance confidence (ABC) scale from pre to post between groups. The P value is 0.056 which is statistically not significant.

DISCUSSION

The current study has shown that statistically there was significant improvement in balance scoring and level of confidence post training in all the three groups. Also, study showed that there was no significant difference statistically between any of the three strategies used in the study i.e. clinically all the three balance training strategies were equally effective in improving in balance.

The improved balance post training could probably be due to the effects of neuroplasticity. The term “plasticity” refers, in general, to the capacity of the CNS to adapt to functional demands and therefore to the system’s capacity to reorganize. Plasticity includes the process of learning. (Carr-Shephard ; Weiller , 1998)

Mechanisms of brain plasticity include the capacity for neurochemical, neuroreceptive and neuronal structural changes. Furthermore, the parallel and distributed nature of brain organization appears to play an important role in its capacity for flexibility and adaptation. (Schiber 1992)

Neuronal elements are inherently flexible, responding according to use and experience and the capacity for functional gain for that individual.

Learning is reflected in alterations in the pattern of inter-connections in those sensory and motor systems involved in learning a specific task, in particular changes in the effectiveness of neural connections (Kandel 2000).

Specific motor training can increase the size of different components of motor maps. In acquiring a motor skill, the learner must combine movements of individual segments into the pattern or synergy, in both spatial and temporal domains, that ensures successful performance of the action.

The outcomes suggest that improvement in dual-task performance maybe as a result of the development of improved dual-task processing skills (e.g., the ability to allocate attention) due to neuroplasticity which could have been resulted due to the practice that the individuals performed on regular basis. (Carr-Shephard;Weiller, 1998)

Research studies carried out by Patima Silsupodol , Anne-Shumway Cook showed that According to the Task Integration Hypothesis, practicing 2 tasks together (dual task practice) allows participants to develop task-coordination skills. Thus, a possible explanation of changes obtained in all the outcomes is that the efficient integration and coordination between the 2 tasks acquired during dual-task training is crucial for improving dual-task performance.

Postural control has been closely associated with the ability to correctly perceive the environment through peripheral sensory systems, as well as to centrally process and integrate proprioceptive, visual, and vestibular inputs at the level of CNS.

Since normal postural control occurs automatically, without conscious effort, it was traditionally assumed that few attentional resources were needed when controlling balance. However, research examining changes in postural control during performance of another attentionally demanding task, referred to as “dual task” interference, and has suggested that there are significant attentional requirements.

In addition, it appears that attentional requirements are not constant, but vary depending on the postural task, on age of individual and on individual’s balance abilities. (Shumway-Cook & Woollacott, 2002).

The probable reason for not achieving a significant difference between the balance improvements in three groups could be the interference effect.

There are two primary theories to explain interference between two tasks that are performed at the same time.

The first, “the capacity theory”, considers dual task interference to result from the sharing of limited set of information processing (i.e. attentional) resources. In this case, when processing demands of the two combined tasks exceed attentional capacity, reduced performance is observed in one or both tasks.

The second, “the bottleneck theory”, hypothesizes the sequential nature of dual task process and proposes that there is competition between tasks for stimulus encoding, identification, or response selection. In this case, it is proposed that the nervous system delays information-processing operations on one task in favor of operations on the prioritized task, which causes impaired performance on the non-prioritized task. (Fraizer&Mitra, 2008; Neumann, 1984; Shumway-Cook & Woolcott, 2000; Wickens, 1989).

Addition of dual task creates conflict in which brain must divide attention and prioritize between gait function and secondary tasks. (Yogev-Seligmann et al, 2008).

The limitations of the study are that the study should have been carried out for a longer duration of 12 weeks to observe if it would bring about significant differences in the balance scores due to plasticity between three groups post training. Also , a 4th group should have been added receiving only motor exercises of conventional balance exercises for comparison of effectiveness of treatment strategy.

CONCLUSION

The current study concludes that there is no significant difference between the three groups post intervention i.e. all the three treatment strategies are equally effective.

Clinical Implication of the study is that the clinical therapist can adapt to any one of the strategies used in the treatment plan to train individuals for improvement in balance depending upon the nature of physical and cognitive task that the individuals are expected to perform.

FUTURE SCOPE OF THE STUDY:

1)The Future scope of the study is that further research can be done by replicating the study using a fourth group of individuals receiving only motor exercises of conventional balance training protocol.

2) Further research could be carried out with minimum 12 week intervention program, after which a follow-up study should be conducted to analyze the effects of the achieved improvements in the result.

3) Future research can also be done by carrying out dual task training in virtual reality setting using the cognitive/dual task which the geriatric population has to tackle depending upon the environmental demands.

4) Further research can be conducted to study the Carryover effect of the training provided and the results of the same could be used to decide the minimum duration of treatment required to sustain the effects achieved due to training.

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