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Effect of Single Task Training versus Dual Task Training on Balance in Geriatrics

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Abstract: ***Falls in geriatric population is mainly during dual task. This study was carried outto investigate effect of single task training versus dual task training on balance in geriatrics. Eleven males and 10 females in age group of 66-70 year of age and 4 males and 5 females of 71-75 year of age were randomly divided in three groups, 10 participants each (i) single task group, (ii) motor-motor group, (iii) motor-cognitive group. Balance training was given thrice a week for 2 weeks; duration of each session of training was 20 minutes. The outcome measures were functional reach test, Tinneti score, Berg's balance scale. There was a significant improvement in balance in all three training groups. Motor cognitive dual task training was found to be the most effective as compared to single task and motor-motor dual task training.***

Keywords: Single task, Dual task, Motor - motor training, Motor - cognitive training, Geriatric, Balance

1. Introduction

Balance or equilibrium is defined as the ability to maintain the body's centre of mass (COM) within the stability limit. Postural stability is an integral component of the motor control and coordination process of the body, which is required for preserving steadiness during static and dynamic activities.[1]

Balance involves the complex interaction of (i) the sensory (afferent) system responsible for the detection of body position and motion, (ii)motor(efferent) system responsible for the execution of motor responses, and (iii) integrated CNS control processes.[2]

Human beings move about as they perform their activities of daily living and are often exposed to destabilizing environmental forces. As a result, the relationship between the COM and BOS is continually changing, thus requiring that balance be considered in a dynamic context.[2] Rather than collapse when line of gravity through the COM falls outside the BOS, human beings are able to take the corrective actions. Failure to regain balance after destabilization results in falls.

As age advances many physiological changes start taking place in the musculoskeletal, neurological, cognitive and sensory system. All these changes hamper the balance control of the individual. Balance impairment leads to falls in elderly. Magnitude of this problem significantly increases with advancing age, cognitive and sensory impairment, poor psychological and environmental factors (extrinsic causes).[3,4] Falls are costly and have potentially devastating physical, psychological, and social consequences. Nonfatal falls often lead to physical Injury, reduced levels of activity, loss of confidence and changes in llifestyle.[3] The control of balance, whether in static or dynamic conditions, is an essential requirement for daily activities.

The activities performed in our daily life are usually single task or a combination of different tasks and the falls occurring in this population are mainly during dual tasks. Among older adults, impairments in the control of balance under dual task conditions is a common occurrence.[5] Because impaired dual task balance performance predicts adverse outcomes such as falls and declines in both cognitive and physical function, interventions that improve dual task performance are critical health care need.[6] Dual tasks are tasks that require divided attention. These tasks are a combination of 2 motor tasks or a cognitive task paired with a motor task (e.g.: walking while talking). Typically this type of performance is contrasted with single-task performance in which the individual only has to perform one task at a time.

Training of balance done under single as well as dual task conditions showed to improve balance and overall functioning in geriatrics and stroke patients.[6,7,8] However some studies have shown dual task interference and training increases the risks of falls.[9]

According to the study done by Karen Li etal dual task training had positive effects on executive control and balance in geriatrics.Training of balance done under single as well as dual task conditions might improve balance and overall functioning. So the purpose of this study is to study the effects of single task training and dual task training on balance in older adults.

2. Methodology

The type of study used was intervention study on 30 subjects which were selected according to the inclusion and Individuals suffering from- Any neurological condition-stroke, Parkinson's disease, TIA, diabetic neuropathy etc, Any musculoskeletal pathology of the lower limbs or having undergone joint replacements, Cardiac problems, Significant visual or auditory impairment, Individuals exercising regularly were excluded. A written consent was taken. The subjects were randomly divided into 3 groups, 10 participants each group:
Group i: single task group

Group ii: motor-motor group
Group iii: motor-cognitive group

All the subjects were evaluated pre and post treatment on the basis of the outcome measures. Outcome measure: Functional reach test[10], Tinetti score[11], Berg's balance scale[12]. Balance training was given thrice a week for 2 weeks. Duration of each session of training was 20mins.[13]

Group 1: Single Task Group
1) Standing with narrow BOS for 3 mins
2) Tandem standing for 2 mins on each side
3) Tandem walking a distance of 25m

Group 2: Motor-Motor dual task training
1) Standing with narrow BOS and throwing-catching ball for 3 mins
2) Tandem standing for 2 mins on each side and performing upper limb movements (e.g. Flexion, abduction)
3) Tandem walking a distance of 25m while carrying a glass of water

Group 3: Motor –Cognitive dual task training
1) Standing with narrow BOS and naming things starting from a given letter for 3 mins
2) Tandem standing for 2 mins on each side and performing stroop task (naming the color of the ink while ignoring the meaning of the word)
3) Tandem walking a distance of 25m while counting multiples of 3(3,6,9, …)

3. Results and Analysis

The results were analyzed using the following tests:Paired t-test, Wilcoxon matched pairs test, Unpaired t-test, Mann-whitney test .

Age wise gender distribution

	66-70	*71-75*
Males	11	4
Females	10	5
Total	21	9

Result: There were 11 males and 10 females in the age group of 66-70 years of age. And 4 males and 5 females in the age group of 71-75 years of age.

Group	*FRT*	*Mean Difference*	*Standard deviation*	*P value*	*Significance*	*Test used*
Single	13.3	1.1	1.494	<0.0032	Very significant	Paired t test
	14.4		1.174			
Motor-motor	13.3	2.2	1.494	<0.0001	Extremely significant	Paired t test
	15.5		0.9718			
Motor-cognitive	13.3	2.5	1.494	<0.0007	Extremely significant	Paired t test
	15.8		1.135			

Group	*Tinetti*	*Mean Difference*	*Standard deviation*	*P value*	*Significance*	*Test used*
Single	19.9	2.6	1.853	<0.0001	Extremely significant	Paired t test
	22.5		1.596			
Motor-motor	19.9	2.4	1.853	<0.0001	Extremely significant	Paired t test
	22.3		1.636			
Motor-cognitive	19.9	3.0	1.853	<0.0001	Extremely significant	Paired t test
	22.9		1.853			

Group	*BBS*	*Mean Difference*	*Standard deviation*	*P value*	*Significance*	*Test used*
Single	42.1	3.2	6.136	<0.0001	Extremely significant	Paired t test
	45.3		5.964			
Motor-motor	42.1	3.3	6.136	<0.0001	Extremely significant	Paired t test
	45.4		5.873			
Motor-cognitive	42.1	4.2	6.136	<0.0001	Extremely significant	Paired t test
	46.3		6.056			

4. Discussion

This study was undertaken to compare the effects of single task, motor-motor dual task and motor-cognitive dual task balance training.

It is evident from the results that there was significant improvement in balance in all three training groups, i.e. Single task training, motor-motor and motor-cognitive dual task training groups. This shows that single task balance training as well as dual task balance training both are effective in improving balance performance.

In FRT, within group comparison in the single task training group, showed significant improvements in balance due to training (p=0.0032) with an increase in score of 1.1. Within group comparison in the motor-motor dual task training group, showed significant improvements (p<0.0001) with an increase of 2.2 in the FRT score. Within group comparison in the motor cognitive dual task training group, showed significant improvements (p=0007) with an increase of 2.5 in the FRT score.

In bergs balance scale, within group comparison in the single task training group, showed significant improvements in balance due to training (p<0.0001) with an increase in score of 3.2. Within group comparison in the motor-motor dual task training group, showed significant improvements (p<0.0001) with an increase of 3.2 in theBBS score. Within group comparison in the motor cognitive dual task training group, showed significant improvements (p<0.0001) with an increase of 4.2 in the BBS score.

The improvement in the FRT and BBS score can be due to tasks like tandem standing and standing with feet close to each other in which the base of support is reduced, and hence the visual system, somato-sensory system and the proprioception are stimulated. Stimulation of these systems help in improving the static balance. Also practice and repetitions further enhances the performance.

In Tinetti score, within group comparison in the single task training group, showed significant improvements in balance due to training (p<0.0001) with an increase in score of 2.6. Within group Comparison in the motor-motor dual task training group, showed significant improvements (p<0.0001) with an increase of 2.4 in the Tinetti score. Within group Comparison in the motor cognitive dual task training group, showed significant improvements (p<0.0001) with an increase of 3.0 in the Tinetti score.

The improvement in Tinetti score, similar to static balance training, is due to activation of the three systems i.e. the visual system, somato-sensory system and the

proprioception. Along with these, there is also stimulation of the vestibular apparatus. In these tasks, there is also change in COG. Due to more number of repetitions & practice, there is further enhancement in performance.

In single task training, tasks like standing with feet close, reduce the base of support and limits of stability. This helps in improving static balance whereas tasks like tandem walking recruit lateral hip strategies which contributes to improving dynamic balance. Also practice and repetitions further enhances the performance. Hence single task balance training showed improvement in balance.

In motor motor dual task balance training, as the secondary motor tasks were explained to the samples well in advance, predictive control and anticipatory pro-active and reactive strategies help to maintain and improve balance. Also, practice and repetitions of performing tasks with reduced base of support and reduced limits of stability enhanced further performance. Hence motor motor dual task training showed improvement in balance.

The continuous practice of a new motor skill results in progressive improvement of performance. During the initial learning phase, performance increases rapidly and attentional demands are high, whereas in an advanced(automatization) phase, a performance plateau is reached and attention is diminished (Fitts& Posner, 1967; Magill, 2007; Nissen&Bullemer, 1987; Schmidt & Lee, 1999). This increasing level of automaticity has been tested in behavioral studies using dual-task paradigms. When the motor task is performed at the same time as another task, interference between both tasks is high in early learning, resulting in deterioration of motor performance. Once the motor task has been overlearned, interference is low or inexistent, indicating high automaticity.[13,14]

Under the dual task conditions, variable priority training strategy was more effective in improving balance performance. Training balance under single task conditions may not generalize to balance control during dual task contexts. Explicit instructions regarding attentional focus is an important factor contributing to the rate of learning and retention of dual task training effect.[5,7]

The motor-cognitive dual task training group showed more significant improvement than single task and motor-motor dual task training group.

In a study done on young and old adults, it was seen that there is a reduction in the area of COP displacements found in all dual-task experimental conditions.[12]

Compared to a situation in which standing still was the only task to perform (single task), adding a simple perceptual task (standing and viewing digits) reduced COP displacements in both young and old adults. In older adults, however, the beneficial effect of a secondary cognitive task on postural control performance diminished as the cognitive demand of the secondary task increased.

Firstly, cognitive activities improve postural performance by shifting the focus of attention away from a highly automatized activity. Beneficial effects are more easily observed at low levels of cognitive task difficulty because such levels are sufficient to shift attention away from the postural domain without causing resource competition. Secondly, cognitive activities hinder postural control through cross-domain resource competition. Thus, detrimental effects are found only at higher levels of cognitive task difficulty, when resource competition actually sets in. Accordingly, the transition from beneficial to detrimental effects occurs at lower levels of nominal task difficulty for individuals with lower task-relevant resources such as older adults than for individuals with higher task-relevant resources such as young adults.

Several neuroimaging studies have shown that the cognitive task leads to increased activity in the pre-frontal cortex (PFC) which is concerned with memory, attention, executive function and emotions. D'esposito et al. compared single-task performance with a concurrent performance of both tasks and discovered that activation of the PFC occurred only during the dual-task condition whereas this area was not active during either single-task. Thus cognitive functioning was more active in the motor-cognitive group. Hence improvement in balance was more significant in this training group.

Thus, as per the results, it was seen that although there was significant increase in all outcome measures for all three training groups, motor-cognitive dual task balance training is more effective in improving balance in geriatric individuals.

5. Conclusion

- Single task training programs as well as dual task training programs were effective in improving balance
- Motor-cognitive dual task training was found to be the most effective as compared to single task training and motor-motor dual task training.
- Motor-motor dual task training was found to be more effective as compared to single task training.

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