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Effect of Dual-Task Training (Fixed Priority-Versus-Variable Priority) for Improving Balance in Older Adults

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Abstract: The purpose of this study was to compare the effect of 2 different instructional sets of dual task training conditions, fixed-priority instruction (FP) versus variable-priority instruction (VP) on dual task performance in older adults with balance impairment. Community dwelling older adults (n=30) with balance impairment who fulfilled the inclusion criteria were included for the study. The subjects were explained about the purpose and nature of the study. All participants received 45-minute training sessions, 3 times a week for 4 weeks. Dependent variables Berg Balance Scale (BBS) and Activities based Confidence Scale (ABC) were measured before and after 4 week training program. Significant interaction and main effects were further explained by paired and unpaired t-test and wilcoxon test. Within groups, analysis showed that there is improvement in BBS and ABC scores after 4 weeks training programs in both groups. Between groups, analysis showed that there is significant improvement ($P \leq 0.05$) of both BBS and ABC scores in VP (variable priority) group when compared to FP (fixed priority) group. Dual task balance training under variable priority is more effective in improving balance of older adults.

Key words: Falls In Elderly · Balance Training · Functional Activities · Berg Balance Scale

INTRODUCTION

The growing evidence that instability and falls increase during the performance of multiple tasks in both neurologic and elderly population suggests the need for training balance under both single and dual task conditions [1-4]. Elderly population residing in community who usually adopt a sedentary life style making them prone to physical de -conditioning and decline in motor performance when there is a competition for attentional resources for the task to be performed under dual task condition. Studies have shown that healthy older adults selectively prioritize sensorimotor performance (walking, balance) over cognitive performance (memory encoding, response selection). Training balance under single-task conditions may not generalize to balance control during dual-task contexts [5]. Pellecchia [6] measured balance 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 [7, 8] 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. 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 [9, 10]. 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 [11, 12]. This deficit associated with aging has been attributed to shrinkage of the prefrontal area of the brain, since this area is strongly

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related to implementation and managing of multiple tasks [13]. Dual task requires the participants to perform a multiple task simultaneously which have been used to investigate the effect of cognitive task on postural control [14-17]. Explicit instruction regarding attentional focus is an important factor contributing to the rate of learning and the retention of the dual-task training effect.

Substantial efforts have been devoted to understanding how and why age-related loss in dual-task performance is observed, but less work was done to understand how such age deficits can be ameliorated. This study aimed to investigate the role of dual task training in improving balance in older adults and hence will result in reducing number of falls experienced.

MATERIALS AND METHODS

Subjects: After receiving ethical committee approval, community dwelling older adults (n=30) of Ambala cantonment area, India were selected by means of simple random sampling and were assigned randomly into 2 group included both male and female above the age of 65 years after meeting the inclusion criteria i.e. ability to walk 10m without assistance of other person and any device, score of more than 41 on BBS scores and history of at least one fall in last six months. Subjects with score less than 27 on Mini Mental Scale, visual or vestibular defects, neurologic or musculoskeletal disorders were excluded.

Procedure: Community dwelling older adults who fulfilled the inclusion criteria were included for the study. Subjects were explained about the purpose and nature of the study and a written informed consent was taken. General assessment regarding the socio-demographic data which included name, gender, age and height, health related information like past medical history; use of assistive device and fall history was recorded. Cognitive status was assessed using Mini mental status examination (MMSE). The subjects were allocated into 2 groups consisted of 15 subjects each. Group I was given dual task training under fixed priority instruction set. Group II were given dual task training under variable priority instruction set.

The subjects were assessed using Berg Balance Scale (BBS) and Activities Based Confidence Scale (ABC) [18]. Prior to testing, each subject was assured of safety to minimize the risk of falls. Each new task was explained and demonstrated. Subject was asked if he or she felt safe performing the task and were reassured that they could attempt to contemplate the task as much as possible with safety. If the subject did not feel safe attempting a specific task, the examiner entered the lowest possible score for that task and continued to the next item. All participants received 45-minute training sessions, 3 times a week for 4 weeks. The participants were instructed to spend 3 minutes on each task with a rest period of 1 min after every task.

Group I (n=15) subjects was trained under dual task balance training under a fixed priority instructional set. During each session, attention was focused on both postural and cognitive task all the time and activities were divided in to stance and gait activities. In stance activities subjects were instructed to perform 1) semi tandem standing with eyes open, arm alteration with cognitive task as spell words forward, 2) semi-tandem standing with eyes closed, arm alteration with spelling words backward and 3) subject has to draw letter with left and right foot and cognitive task was name any word start with letter a-k, l-x, Perturbed standing holding a ball and cognitive task of remembering prices e.g. bills. In gait activity subjects were asked to perform tandem / semi tandem walking while counting backward from 200-90, obstacle crossing while counting backward from 200-90, semi tandem / tandem walking with auditory tone discrimination and obstacle crossing with auditory tone discrimination (low volume vs. high), whereas in other group II (n=15) subjects were given same training as group one but with half training session focusing attention on postural task performance and half training session with attention on cognitive task performance i.e. with variable priority instructional set.

Outcome Measures: Readings on Berg Balance Scale and ABC scale were taken before giving the balance training and then re-administered after four weeks of training to see the effectiveness of treatment protocol and scores were tabulated as data.

Data Analysis: Within and between subject design was used to evaluate the effect of two independent variables (Berg Balance Scale and Activities Specific Balance Confidence Scale). Significant interaction and main effects were further explained by paired and unpaired t-test and wilcoxon test. SPSS software (version 13.0, SPSS Inc Chicago, USA) was used in statistical analysis and level of significance was set at $p<0.05$.

RESULTS AND DISCUSSION

The results showed that there was significant improvement ($p< 0.05$) in balance of older adults who received dual task training with variable priority instruction set. The use of valid tools like Berg Balance Scale (BBS) and Activities Specific Balance Confidence Scale (ABC) [18] on balance allowed clear interpretation of the results. There was improvement in BBS and ABC after 4 week training programs in both groups. Balance is a major contributor to fall in adults over 65 year of age and growing body of evidence has confirmed the importance of cognitive factors to impaired balance among older adults. Previous studies support the benefit of dual task training on balance and also the importance of balance related instructional set on learning. They showed that individualized training program was effective in improving balance. According to task integration hypothesis, practicing 2 tasks together allows participants to develop task co-ordination skill [19].

Dual task training has been used as it suggests that the sensory motor processing essential for motor control requires attention resources. Researchers found that participants in dual task training groups with either fixed-priority or variable priority instructions could learn to co-ordinate the two. However after training the processing demands required to perform the task was less when their attention was shifted between the two tasks, as required in dual task training with variable priority instruction group. This could explain why participants with variable priority instruction group were able to learn task faster and retain it than our dual task training with fixed priority instruction group. Hu and Woollcott [20] reported that improved balance as a result of exercise aimed at optimizing the interaction of visual, vestibular and the somatosensory systems for people aged 65 and above. This shows that deterioration of balance function can be reversed with training. Bherer *et al.* [21] concluded that training can substantially improve dual-task training processing skills in older adults. Karen *et al.* [17] demonstrated the training related benefits to gross motor performance stemming from cognitive dual task training. The results support that motor control in ageing is influenced by executive control and have implications for theories of cognitive training and transfer. Schwenk *et al.* [22] studied the effect on dual task performance in patients with dementia and suggested that specific exercise program is effective to improve dual task performance in patients with dementia. Verghese *et al.* [23] conducted study to see effect of cognitive remediation on gait in sedentary seniors and suggested that cognition remediation improves mobility in older adults. McCulloch *et al.* [24] concluded that patients with Parkinson disease, Alzheimer's and multiple sclerosis have difficulty in performing dual tasks. The cause of dual task difficulties cannot be assumed to be same across these diverse conditions; however it is unclear how

Table 1: Within group analyses for Group I (Dual task training for fixed priority instruction set).

Mean	Pre-Treatment ABC	Post-Treatment ABC	Mean	Pre-Treatment BBS	Post-Treatment BBS
	64.73±3.3	64.73±3.3		48.40±2.3	51.40±1.68
Paired t Test	12.357		Sum of +ve Ranks	0.0	
P value	0.0000		Sum of -ve Ranks	120.0	
Table Value at 0.05 df 14	2.14		Wilcoxon Test Value	0.00	
Result	Significant		Table Value at 5%	25.00	
			Result	Significant	

*Results were found to be significant for within group analysis at $p < 0.05$ in both ABC and BBS scores

Table 2: Within group analyses for Group II (Dual task training for variable priority instruction set).

Mean	Pre-Treatment ABC	Post-Treatment ABC	Mean	Pre-Treatment BBS	Post-Treatment BBS
	62.00±4.209	70.13±3.889		49.00±2.478	53.40±0.507
Paired t Test	29.714		Sum of +ve Ranks	0.0	
P value	0.0000		Sum of-ve Ranks	120.0	
			Table Value at 0.05 df 14	2.14	
Wilcoxon Test Value	0.00				
Result	Significant		Table Value at 5%	25.00	
			Result	Significant	

*Results were found to be significant for within group analysis at $p< 0.05$ in both ABC and BBS scores

Table 3: Between groups analysis for Berg balance scale (BBS)

Group	I	II
Mean	3.00 ± 1.414	4.40 ± 2.063
Sum of + ve Ranks	14.0	
Sum of - ve Ranks	22.0	
Wilcoxon Test Value	14.00	
Table Value at 5%	25.00	
Result	Significant	

*The results showed significant improvement in group II for BBS score at p< 0.05.

Table 4: Between groups' analysis for activities based confidence scale (ABC)

Group	I	II
Mean	3.07±0.961	8.13±1.060
Unpaired Test	13.713	
P value	0.0000	
Result	Significant	

*The results showed significant improvement in group II for ABC score at p< 0.05.

difficulties observed in cognitive psychology experiments relate to balance. Nonetheless, we suggest that multimodality interventions that combine motor and cognitive therapy should, eventually, be incorporated into clinical practice to enable older adults and patients to move safer and with a reduced fall risk. Large-scale, randomized controlled trials are warranted and that additional research is needed to better understand the pathophysiologic mechanisms underlying the interplay between human mobility, fall risk and cognitive function.

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