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Gaze Stability Exercises Versus Motor Cognitive Dual Task Training On Cognition And Dynamic Postural Ability In Elderly Subjects With Mild Cognitive Impairment

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Ethical Clearance: Obtained from the Institutional Ethical Committee of Padmashree Institute of Physiotherapy.

Abstract: **Introduction: Mild cognitive impairment, a transitional cognitive state has a 10–15% yearly progression to dementia. Along with cognitive deficits, individuals with mild cognitive impairment can experience deficits in postural stability and increased risk of fall. Early diagnosis and intervention can improve the quality of life of these individuals and prevent or delay the progression to dementia.**

Objectives: To compare the effect of gaze stability exercises and motor cognitive dual task training on cognition and dynamic postural ability in elderly subjects with mild cognitive impairment.

Methods: 30 elderly subjects with mild cognitive impairment were recruited for the study and assigned to one of the two groups. Group A received gaze stability exercises while Group B received motor cognitive dual task training. The treatment sessions were scheduled for 45 min/day, 2 times/week for a duration of 4 weeks. Cognition and dynamic postural ability were assessed prior to the treatment and post-intervention using Montreal Cognitive Assessment scale (MoCA) and Timed Up and Go (TUG) test.

Result: Both the groups improved significantly in the MoCA and TUG scores post-intervention ($p<0.001$). But when the scores were compared between the groups, no statistical significance was observed ($p>0.05$).

Conclusion: The study concluded that both gaze stability exercises and motor cognitive dual task training were equally effective in improving cognition and dynamic postural ability in elderly subjects with mild cognitive impairment. The study implies the use of these exercises as a part of geriatric rehabilitation.

Keywords: **Mild cognitive impairment, Gaze Stability Exercises, Motor Cognitive Dual Task Training, Cognition, Dynamic postural ability.**

1. INTRODUCTION

Aging is continuous process of change and can be considered the final stage of human development.[1] World Health Organization defines aging as a course of biological reality starting with conception and ending with death,[2] associated with many degenerative changes.[3] Old age is classified using chronological categories into young old (ages 65 to 74), middle old (ages 75 to 84), and old-old (ages 85 and older).[4]

Cognition is defined as the process that happens in mind producing thought and goal directed movements.[1] Decline in some cognitive abilities like processing speed, memory, language, visuospatial abilities or executive functional skills is seen with normal aging.[5] Mild cognitive impairment can be defined as any decline in an individual's cognitive ability that is greater than that expected for his/her age and education level but which does not interfere much with activities of daily living.[6] Postural control is the position of the body in space for maintaining balance and orientation.[7] Postural control is deteriorated with ageing and manifests with an increased postural sway or a decreased voluntary movement during static and dynamic postural control.[8] Greater than 1/3 of the geriatric population experience a fall due to reduced postural stability. Older individuals with cognitive impairment are at a greater risk for falling compared with healthy population of the same age group. Falls and cognitive impairments can negatively affect the quality of life of older adults.[9] Mild cognitive impairment affects 3% to 19% of the population aged 65 years and over.[10] It is also observed that older adults with mild cognitive impairment develop dementia at a rate of 10% to 15% per year and are at a higher risk for disability that is associated with dementia.[11]

With the existing uncertainty about benefits from pharmacological treatment for the cognition, non-pharmacological methods to delay MCI related decline are considered widely.[12] Cognitive training improved cognitive abilities in the geriatric population and also lead to decrease in fall rates in older individuals with Alzheimer's disease.[13] A treatment approach that could address both cognitive decline and risk of falls can be to combine physical exercise with cognitive training leading to more evident neuroplastic changes in the brain.[7] Simultaneous motor cognitive training or motor dual task training is the training where both motor and cognitive training are performed at same time. Several studies suggest the incorporation of a cognitive task into the motor task combining the advantageous effects of cognitive motor training leading to greater motor-cognitive improvements.[14] Gaze stability exercises are known for improving balance in individuals with vestibular dysfunction.[9] These interventions may provide proactive strategies to prevent falls and cognitive deterioration.[13] Hence, the present study aims to compare the effect of gaze stability exercises and motor cognitive dual task training on cognition and dynamic postural ability among elderly subjects with mild cognitive impairment.

2. METHODS

30 male and female subjects aged ≥65 years with mild cognitive impairment (≤23 on MoCA scale)[15] were included in the study. Subjects were recruited from old age homes and a tertiary care hospital in Bangalore. Individuals with no prior history of falling which could contribute to balance instability and those who were able to understand and follow the commands were included. Unco-operative

subjects, individuals with visual or vestibular impairments, unstable cardiac or respiratory disorders or any other neurological disorders were excluded.

Informed consent was obtained from the participants prior to the study. Ethical clearance was obtained from the Institutional Ethical Committee. Demographic variables like age and gender were documented. Prior to the intervention and post-intervention, all subjects were assessed using the Montreal Cognitive Assessment Scale (MoCA) and Timed Up and Go (TUG) Test. Reliability and validity of both the outcome measures used in the study is well established.[15, 16, 17, 18, 19]

Group A received Gaze stability exercises that comprised of eyeball movements, saccadic eye movements, pursuit eye movements, vergence eye movements and vestibular-ocular reflex exercises.[9] Participants focussed on the card held in their hands as the target or their head moved either left or right at their eye level. The eyeball exercises included moving the eyes slowly to the left and right, up and down and rotation with eyes closed. The saccadic eye movements included moving of the eyes as quickly as possible between stationary targets with no head movements. The pursuit eye movements included tracking the slowly moving target without head movement. The vergence eye movements included tracking the moving target back and forth from 5 cm close at eye level to far as possible. The vestibular-ocular reflex exercise included moving the head from left to right while keeping the eyes on a stationary target.

Participants in Group B received Motor Cognitive Dual Task training. They started with practicing a single-task of walking for 10 meters. When the subjects were able to walk safely without any gait instabilities, the activity was progressed to dual task walking with a simple arithmetic task that is less challenging. Once the participants were able to do the activity without counting errors or stops during walking, it was progressed to a more challenging, complex

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arithmetic task. Arithmetic calculations included 2-forward and 3-backward calculations starting from a randomly chosen 2-digit number (≥30). Subjects were instructed to walk and to calculate as fast as they could without prioritizing one task.[20]

Both the groups received training for 45 minutes per session twice a week for 4 weeks. Rest was given in between as and when the participants required. Both the groups also received another 15 minutes of conventional exercises which included stretching, strengthening and range of motion exercises.[21, 22, 23]

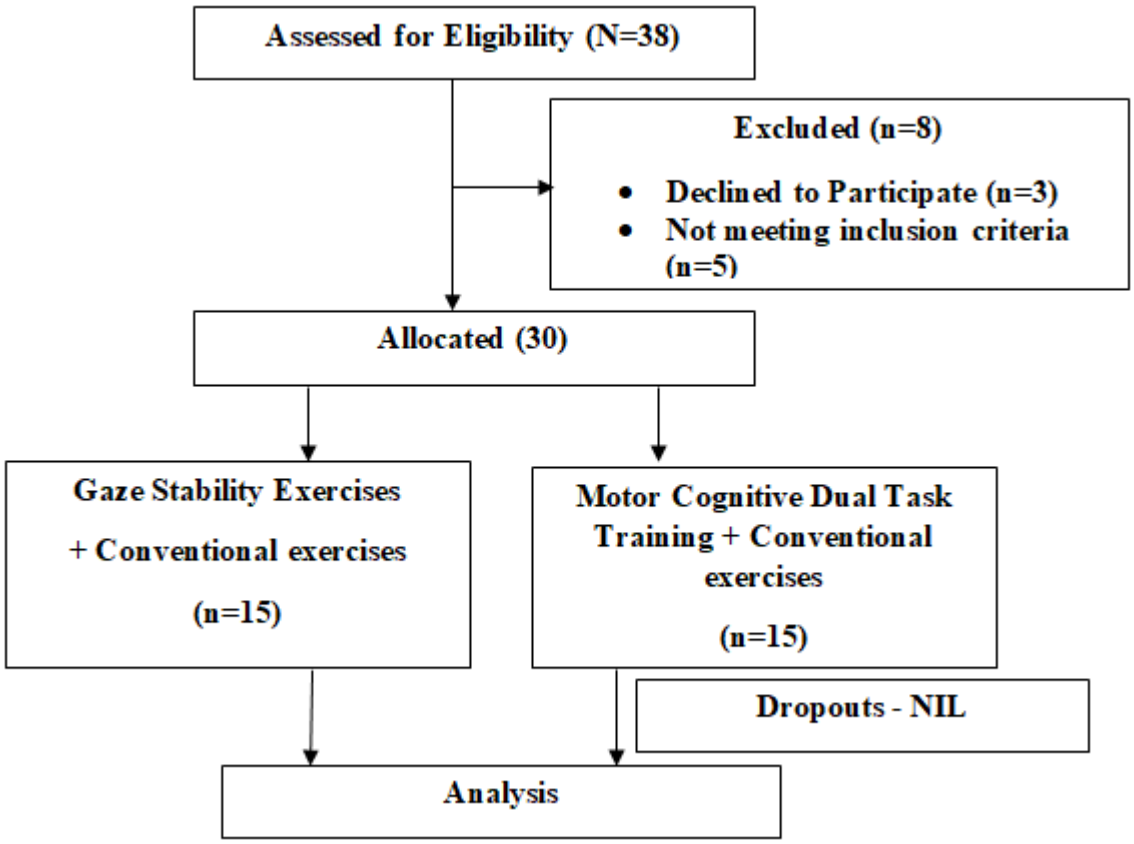

Figure 1: Consort Flow Diagram

3. RESULTS

Table1: Distribution of elderly subjects with mild cognitive impairment according to age and gender in both groups.

S.No.	Variable	Group A	Group B
1	Age in Years	71.07±3.27	71.07±4.71
2	Male / Female	7(46.7%) / 8(57.3%)	5(33.3%) / 10(66.7%)

Table 2: Range, mean and SD of MoCA and TUG scores of elderly subjects with mild cognitive impairment in Group-A.

S. No.	Outcome measures	Group-A				Wilcoxon test/Paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	**MoCA**	11-22	17.27±3.24	18-27	22.13± 2.80	t=3.422*	p<0.001
2	**TUG (sec)**	14-23	17.93±2.91	10-19	15.20±2.51	t=8.657*	p<0.001

Note: * denotes –Significant (p<0.05)

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Table 3: Range, mean and SD of MoCA and TUG scores of elderly subjects with mild cognitive impairment in Group-B.

S. No.	Outcome measures	Group-B				Wilcoxon test/Paired t-test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	**MoCA**	11-23	17.27±3.59	17-28	23.40± 3.81	t=3.414*	p<0.001
2	**TUG(sec)**	14-24	18.40±2.72	12-20	15.67±2.05	t=8.919*	p<0.001

Note: *Significant (p<0.05)

Table 4: Comparison of pre and post-test MoCA and TUG scores of elderly subjects with mild cognitive impairment in between the groups

S No	Outcome measures	Pre-test		Post-test	
		Group-A	Group-B	Group-A	Group-B
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	**MoCA**	17.27±3.24	17.27±3.59	22.13± 2.80	23.40± 3.81
2	**TUG(sec)**	17.93±2.91	18.40±2.72	15.20±2.51	15.67±2.05
Between group comparisons: Mann-Whitney U test / Unpaired t-test		• MoCA: Z=0.146, p>0.05, NS • TUG(sec): t=0.453, p>0.05, NS		• MoCA: Z=1.145 p>0.05, NS • TUG(sec): t=0.159, p>0.05, NS	

Note: S-denotes significant (p<0.05); NS – not significant (p>0.05).

4. DISCUSSION

The objective of this study was to compare the effect of Gaze Stability Exercises and Motor Cognitive Dual Task Training on cognition and dynamic postural ability in elderly subjects with mild cognitive impairment. Balance deteriorates with the severity of cognitive impairment and executive function is important in preserving balance control. Early intervention is vital in geriatric rehabilitation to prevent or delay cognitive impairment and its progression to dementia and thereby reducing the risk of falls.[24]

Gaze stability exercises were given to participants in Group A who showed significant improvement in the post-test scores of MoCA and TUG compared to pre-test scores (p<0.001). The results of this study are in line with a previous study conducted by Miyoung Roh and Eunja Lee in which the authors concluded that gaze stability exercises were beneficial in improving cognitive function and balance ability which affected the quality of life in the elderly. Improvement in balance could be due to the adaptation of the vestibular system through the vestibular-ocular reflex exercise. Vestibular-specific gaze stability exercises would have shown positive results with dynamic visual acuity and postural stability by enhancing the interaction of visual and vestibular system related to postural control.[9] Balance stability can be improved with eye ball exercises by making the image of an object to project at the best portion of the retina trough visual control. In the present study, voluntary saccadic eye movements could have helped in maintaining postural stability through the interaction of visual-vestibular system when moving, by transferring the information through the visual cortex to the connecting portion of parieto-occipital lobe, and fixing the gaze on a point when the head moves.[25] Another study mentioned that visual and vestibular stimulation could improve vestibular function due to neural adaptation at the vestibular nuclei and cerebellum leading to dynamic visual acuity and postural stability.[26] Inter-hemispheric interaction can be enhanced with bilateral eye movements which can help in cognitive improvement. Christman and colleagues observed a link between eye movements and hemispheric activation, with lateral eye movements leading to a sustained increase in activation of the contralateral hemisphere. Thus, bilateral eye movements result in simultaneous activation of both cerebral hemispheres enhancing inter-hemispheric interaction with a better episodic memory. It also generates frontal lobe activity and equalizes the activation levels of both hemispheres.[27]

Participants in Group B received Motor Cognitive Dual Task Training and have shown positive results (p<0.001) which are in line with Fabian Herold, et al., who explains that the “facilitation effect” of physical exercise triggers neuro-physiological mechanisms, which promote neuroplasticity by releasing neurotrophic factors such as the brain-derived neurotrophic factor that is associated with synaptogenesis and neurogenesis which fosters improved cognition. While

physical exercises induce neurophysiological processes that are important for transient neuroplasticity, cognitive stimulation guides these neuroplastic processes. Synapses and neuron activation occur due to the cognitive task execution and enables functional integration of the new neuronal structures in the respective brain circuits.[14] Sensory-motor integrity with dual-task training may reduce postural instability leading to better balance performance and paying attention to motor performance will lead to external attention control. External attention will not interfere with motor control process, resulting in a greater motor performance.[56] Dual-task training can help divided attention and improved balance performance. In the elderly with a history of fall or those at high risk, improved cognition can help prevent falls as the intervention can enhance a dual task processing skill so that they can maintain gait stability while engaging in the complex and distracting environment.[28]

Though both the groups improved with the given interventions, it was observed that there was no statistical difference between the two groups. While Gaze Stability Exercises enhance the interaction of the visual and vestibular systems, these systems play an vital role in gait which was practiced by the subjects in Group B while completing the cognitive task.[9, 29] Furthermore, while executing any musculoskeletal tasks, equilibrium should be maintained by the CNS by integrating the information from visual and vestibular systems. The challenge of completing the concurrent motor and cognitive tasks could have placed a greater stress on these systems, facilitating better performance.[30] As the vestibular and visual systems were profoundly facilitated in both the groups, that could have contributed to the similar results. It was also observed that in Group A, while performing vestibular ocular reflex exercise, the angle of rotation differed for each subject due to the reduced range and flexibility of neck which is usually seen in old age.[2] In Group B, the speed of walking was different for each subject. These differences could have influenced the results. Participants were not advised any home exercises during the study duration. This study included participants with age ≥65 years. It is recommended to study the effect of the interventions on subjects with different age groups.

5. CONCLUSION

Based on the results, both the interventions showed similar improvements. Therefore, it can be concluded that either Gaze Stability Exercises or Motor Cognitive Dual Task Training can be considered as a treatment option while planning the rehabilitation for the elderly subjects with mild cognitive impairment.

CONFLICT OF INTEREST: NIL

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