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Comparison of Sitting Limits of Stability between Young and Old Adults

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Abstract: ***Independent elder in the community is the need of the time. Dynamic sitting balance is crucial for activities of daily living like bathing, dressing etc. However there is limited evidence on sitting balance in the older adults. The Objective of our study was to explore the effect of aging on Sitting Limits of Stability. 30 old and 30 young adults participated in the study. Excursion of centre of pressure in sitting limits of Stability was assessed using force plates and compared between the two groups. Statistical significant difference was seen in composite values of all the parameters viz. reaction time, movement velocity, end point excursion, directional control and maximum excursion between young and old adults. Results are suggestive of affection of sitting Limits of stability in the older adults.***

Keywords: old adults, sitting balance, limits of stability, movement control

1. Introduction

As the geriatric population in India is rising, it is the need of the time to have independent elders in the community, central to the concept of „successful aging‟[1] Aging can be considered the risk factor for various impairments known to us, which reflects accumulation of changes in various systems over a period of time. Falls in elderly and its prevention have been studied extensively by researchers and clinicians[2].Falls is a multifactorial problem affecting quality of life in geriatric population. Although most falls involve multiple factors, it is known that balance impairment is a major contributor[3].Hence balance training has been an important part of fall prevention program.

In geriatric population, most of the evidence is available for the balance function in standing and walking. However sitting control needs equal attention as functional activities using upper extremities like reach and grasp are mostly performed in sitting position. Sitting position has broader base of support where the postural demands are less compared to standing. But dynamic postural control, the ability to maintain balance while reaching, is essential for functional mobility. Trunk contribution cannot be ignored in reach. During eating, anterior weight shift and trunk flexion is required to position mouth over the plate preventing spillage of food. Contralateral or ipsilateral reach with trunk rotation is used for grasping the glass of water or food placed on the table across the midline. Lateral reach may be required to pick up the phone. Lateral weight shift in upper body dressing while anterior weight shift in lower body dressing is required. Thus reaching task, crucial for the activities like feeding, dressing and grooming, requires multidirectional stability in sitting position. This stability is provided by the trunk. It is the midline structure which also provides mobility crucial for movement control of the extremities in sitting position. Trunk control needs to be evaluated as trunk control is correlated with gait and balance function in elderly[4].

The margins of dynamic postural control, or the extremes to which an individual can reach and still maintain balance, defines his/her limits of stability (LOS).Limits of stability is one way to assess balance function. This is the maximum distance a person can lean without losing balance i.e. maintaining centre of mass (COM) within base of support while leaning in all the directions[3].Any base of support places a limit to distance one can lean without either falling or establishing a new base of support. Shape of the base of support decides the limits. The objective of our study was to analyze excursion of centre of pressure in terms of Limits of stability in sitting position in geriatric population.

2. Literature Survey

Shumway Cook and Woollacott state that postural control in seated position has not been studied in depth[3].Aging is known to show effects on the different systems required for maintenance of balance[5]There are changes in sensory system like vision i.e reduction in visual acuity, ability to accommodate and adapt to darkness, contrast sensitivity, depth perception. There is also reduction in somatosensory input due to reduced proprioceptors and vestibular input due to less number of hair cells in vestibular organs[6],[7],[8]Aging has been found to decrease mainly the speed of central processing. It is reflected in the increase in reaction times [9] and movement times [10]. A recent research concluded that CNS may play a major role in mobility decline with aging [11]. Reduction in strength, endurance, flexibility and changes in strategies are motor problems leading to affection of postural response[12], [13]. Movement control in older adults has been extensively discussed by Ketcham et al in his review[14]. Earlier evidence on standing limits of stability suggested that Limits of stability may be a better measure of balance than sway because it provides greater challenge to the postural control system [15]. It may be a sensitive measure of postural control in older subjects and should be used for prediction of risk of falling and measurement of effectiveness of exercise programs designed to improve postural control. Limits of stability is a reliable method of balance assessment in older adults [16],[17] Sitting limits of stability has been studied in chronic stroke patients[18].

3. Methodology

Sixty healthy, asymptomatic individuals participated in the cross sectional study. Group A consisted of thirty adults above 65 years old and group B had thirty adults between 18-30 years old. Adults with neck or back pain, spasm, scoliosis or any other spinal deviation or any known neurological condition including vestibular pathology were excluded from the study. Individuals with Mini mental score less than 24 were excluded. After obtaining the informed consent, they were assessed for limits of stability in sitting. The NeuroCom Basic Balance master has a commercially available system that uses forceplates and computerized software to track Centre of Pressure to assess limits of stability. The participants were made to sit on the seat placed on the forceplates. First practice trial was given and then actual readings were obtained. For each of eight trials, the participant maintained their Centre of gravity centered over the base of support as indicated by a cursor display relative to a center target. On command, the participant moved the cursor as quickly and accurately as possible towards a second target located on the limits of stability perimeter and then held the position as close to the target as possible. The measured parameters were reaction time, movement velocity, directional control, end point excursion, and maximum excursion.

4. Result

Table 1: Demographic Characteristics

	Group A (Old adults)	*Group B (Young adults)*
Number of participants	30	30
Mean Age(years)	68.93 ± 4.60	23.76 ± 3.45
Gender(M/F)	20/10	20/10
Trunk length (cm)	50.71 ± 3.29	50.78 ± 4.64

The difference in trunk length between the two groups was not statistically significant using unpaired t test. (p>0.05)

Table 2: Comparison of Limits of Stability Parameters in forward, backward, right and left directions as well as composite score between old and young adults

Parameters of limits of stability in sitting	Group A (Old) Mean ± SD	Group B (Young) Mean ± SD	P value
Reaction Time(sec)			
Forward	1.02 ± 0.49	0.75 ± 0.21	< 0.001
Backward	0.92 ± 0.60	0.56 ± 0.17	< 0.001
Right	0.94 ± 0.66	0.69 ± 0.25	> 0.05
Left	1.07 ± 0.86	0.61 ± 0.14	< 0.001
Composite	1.09 ± 0.61	0.66 ± 0.15	<0.001
Movement velocity(degree/sec)			
Forward	3.26 ± 1.15	5.90 ± 2.67	<0.001
Backward	2.25 ± 1.20	4.24 ± 1.34	<0.001
Right	4.08 ± 1.77	6.33 ± 2.41	< 0.001
Left	4.09 ± 2.05	6.63 ± 2.38	<0.001
Composite	3.40 ± 1.09	6.16 ± 1.26	<0.001
End point excursion(%)			
Forward	81.43 ± 21.64	96.46 ± 16.65	<0.001
Backward	70.16 ± 24.80	91.83 ± 12.45	<0.001
Right	93.46 ± 12.18	107.16 ± 9.56	<0.001
Left	91.26 ± 15.52	107.16 ± 11.84	<0.001
Composite	82.93 ± 15.32	101.9 ± 6.27	<0.001
Maximum excursion(%)			
Forward	60.56 ± 22.44	87.93 ± 28.85	<0.001
Backward	56.83 ± 21.45	79.53 ± 14.15	<0.001
Right	76.2 ± 23.17	96.23 ± 11.73	<0.001
left	72.2 ± 19.50	99.43 ± 14.81	<0.001
composite	66.6 ± 16	93.43 ± 8.13	<0.001
Directional control(%)			
Forward	77.1 ± 13.02	85.03 ± 6.29	<0.001
Backward	68.34 ± 25.62	81.1 ± 8.94	<0.001
Right	74.83 ± 15.08	78.76 ± 8.88	>0.05
left	73.9 ± 11.32	83.4 ± 7.13	<0.001
composite	76.44 ± 13.76	81.96 ± 6.19	<0.001

When the scores in forward, backward, right and left were compared between young and old adults , difference was statistically significant in all the directions of movement velocity, end point excursion and maximum excursion using unpaired t test. Statistically significant difference was also seen all the directions except right direction of Reaction time and Directional control. When composite scores of all the parameters were compared, there was a statistically significant difference between group A and B.

5. Discussion

We found that excursion of centre of pressure is affected in older adults in terms of increased reaction time, slowing of movement velocity and reduced maximum excursion. There was reduction in end point excursion and directional control indicative of movement control strategy. Our study provides the analysis of sitting balance. Earlier evidence is suggestive of changes in centre of pressure excursion in reaching task in standing in old adults [19],[20]. There are various structural and functional changes associated with aging that can attribute to balance dysfunction. Structural changes include loss of neurons, impaired cellular function, loss of dendrites and deterioration of myelinated structures [21]. Both gray (neurons) and white matter (myelin sheath that insulates neurons, enabling them to respond to stimulus more rapidly) are susceptible to decline with age [22]. Functional changes in the brain include altered patterns of neuronal activation compared to younger adults when completing the same tasks. Neuronal activation patterns also tend to be less specific as adults age, suggesting reduced neural specialization, which in turn may lead to less accurate information transmission, higher levels of distortion, and less distinct mental representation of information[23].

Reaction time is defined as the time required to initiate a movement response following a visual stimulus and is thought to reflect the speed of transmission of the central nervous system [24].In our experiment of sitting limits of stability, the participants were asked to move as soon as they see the target on the screen. We found increased reaction time compared to young. This reaction time includes premotor and motor time. We found difference of 43 msec in composite reaction time between young and old. Previous studies also support approximately 50 msec increase in reaction time with aging [14],[24]-[26].

Another observation was reduced movement velocity. Older adults are known to have slow speed. This speed-accuracy trade off is seen in many tasks where the speed is compromised to complete the movement with accuracy in older adults. Slowing of movements is dependent on the index of difficulty. The index of difficulty (ID) is greater for smaller targets and for longer movements. The reason could be lowered signal to noise ratio in the central nervous system. As age increases, there are changes in neural structure and function. Hence the signal strength reduces and background noise increases. Older adults compensate for the delay by taking extra time to complete the task [14],[27] Our findings were in line with the previous evidence. Earlier study suggested that older adults produce movements with 30-70 percent lower peak velocity compared with young adults. When movement distance increases, older adults do not increase the velocity of their movements to the same degree as young adults [28].

Coordination, the ability to control a number of movement segments or body parts in a refined manner resulting in a well-timed motor output, is affected in older adults. We found reduction in end point excursion and directional control. Both these parameters are indicative of movement control strategy. Deficit could be attributed to inefficient force regulation of trunk or lower extremity muscles required for smooth and accurate movement. Anticipatory adjustments need to be present while completing the leaning task in response to the visual stimulus presented on the screen. It has been shown that younger adults produces a single burst to the targeted force level while the older adults produce multiple bursts of force in tasks when they must achieve targeted force levels approaching maximum [14],[29],[30].The decreased force output may be the reason behind reduction of maximum excursion. Trunk control has been studied and trunk kinematics has shown changes in older adults in many functional activities [19],[20].Granacher U et al conducted a systematic review to explore the role of trunk in old adults. The cross-sectional studies reported small-to-medium correlations between Trunk Muscle Strength/trunk muscle composition and balance, functional performance, and falls in old adults[31].

Results of our study indicated that older adults reacted cautiously and moved slowly Movement control strategy was altered compared to young and the distance covered by centre of pressure was reduced. Sitting limits of stability can provide analysis of the multidirectional stability in sitting position and hence treatment strategies as per the deficit can to be incorporated to improve functional independence of the older adults.

Conclusion

Sitting limits of stability parameters were affected in old adults compared to young adults as there was increase in reaction time and reduction in movement velocity, end point excursion ,directional control and maximum excursion.

6. Future Scope

Effect of training on sitting limits of stability and its effect on functional independence can be studied in older adults. Future studies should include analysis of sitting balance during functional activities.

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