Original Article

The relation between Balance and Sustained Attention in Elderly

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Objectives: Researchers have focused their attention on balance in the elderly because there is a significant correlation between balance and fall. Therefore, it is very important to identify the factors that can affect elderly balance. The aim of this study was to investigate relation between sustained attention and balance in elderly.

Method: This cross sectional study was conducted in 2013 in Semnan city. Convenience sampling was used to enroll 50 old people according to inclusion and exclusion criteria. Sustained attention was measured by continued performance test and static and dynamic balance was evaluated by biodex system. Data was analyzed using SPSS 16 software. Having a normal distribution via Kolmogorov smirnov test, the relationship between each characteristic was assessed through using Pearson correlation coefficient and independent t test.

Results: The participants' mean (±SD) age was 65.48±4.36 years, static balance with eyes open 3.64±2.69, eyes closed 4.10±2.47, dynamic balance with eyes open 4.55±2, eyes closed 6.65±1.98 and omission error was 2.56±4.11. Among the four balance indexes and Sustained attention, Pearson correlation was only significant in dynamic balance with eyes closed and sustained attention.

Discussion: Considering the significant correlation between sustained attention and dynamic balance with eyes closed, it can be said that this correlation will become significant by increasing the difficulty level of the balance task.

Keywords: balance, sustained attention and the elderly

Submitted: 21 October 2013
Accepted: 10 December 2013

Introduction

Increasing the life span, quality of life and general health in old people, as a part of the society, are among important issues in recent studies (1). The increasing population of old people has made it essential to focus on their problems. According to Iran's census report, 6.4% of the total population were aged over 60 in 1998 and it is predicted to be 25-30% by 2031 (2).

In line with the increase in elderly population, the physical disability increases as well. Different factors such as balance and mobility difficulties cause disability in elderly. Because balance and mobility are important factors in independency, quality of life and prevention of falling (3), so maintaining the balancing is an essential requirement for daily activities and has an important role in static as well as dynamic activities (2). Therefore, balance problem is very effective in daily life activities of old people (4). On the other hand, there is a high correlation between balance impairment and increasing risk of falling in the elderly (5-7), which makes it more important to focus on factors related to old people balance problem (8). Studying the role of attention in balance activities has recently received a lot of attention (9). Although it was believed that there is no relation between balance and attention, today researches results have shown that attention has an important role in old people's balance (8,10) and prevents them from falling (11) and there is a need for more attention resources for maintaining balance (10,12,13).

One of the attention types is sustained attention. Sustained attention is a fundamental executive function for achieving complex goals over time (13) and it is the ability of maintaining a consistent behavioral response during continuous and repetitive

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activities (14) and is an essential element of administrative applications which need permanent supervision (10). Some research have reported the sustained attention reduction as a risk factor to increase the old people's falling (13) and many studies have investigated the relation between selective and divided attention and balance or falling in different diseases like Parkinson, stroke and dementia. The aim of this study was to investigate the relation between sustained attention and the sample's balance (both static and dynamic) that was tested in two conditions (eyes opened and closed) in the elderly.

Methods

At first a pilot study was performed to calculate the inter class correlation coefficients (ICC) and Standard Error of Measurement (SEM) as relative and absolute reliability of the Biodex balance system and CPT. Data from 10 people was recorded during the first and second seven days of data collection.

After confirming the results reported by ICC and SEM, we started the main study. In this cross-sectional study which was conducted in May 2013, 50 old people from Semnan city (25 male and 25 female) were enrolled in the study. The inclusion criteria in this study included having at least 60 years of age, the ability of walking independently, and performing the time up and go test (TUG) in less than 13 seconds. Because of the effect of different factors on elderly balance and attention, people with a history of following problems were excluded from our study: knee or ankle operation (15), diabetes, high blood pressure, aural problem (16), low back pain in the last 6 months, vertigo, faint or amnesia, heart disease, stroke ,multiple sclerosis (17), arthritis (16), sever musculoskeletal problem , alzheimer, parkinson, serious visual problem or visual problems which are not removed by glasses (18), having sever pain that prevented the person from balance evaluation and performing CPT, and using paregorics or alcohol in last 48 hours. Considering the results of Zhonget al study in 2010, the correlation coefficient between attention and balance was reported as 0.5 (19) which was significant. Following the findings of that their study and considering r=0.5 and α=0.01, the minimum sample size for each research group was determined as 25 subjects. Since determined levels for the gender (male and female) of the research sample size can be divided into two groups , the total sample size of this study was determined as 50.

In this study, Biodex balance system was used to evaluate balance. This system has a moving plate which makes the deviation possibility of 20 degree in a range of 360 degree (20). In evaluating the static balance, people should stand on the plate and keep the image on the center of gravity (COG) on a specific point, and for dynamic balance evaluation people should maintain their balance while they are facing the movable plate and must place the image of their COG on the specific point. Biodex balance system has three grades for balance evaluation, two grades for sagital and frontal direction balance, and one grade for total balance. Grades closer to zero indicated better balance. In this study, the static and dynamic balances of people with open and closed eyes were evaluated and the degree of severity for evaluation was eight. Subjects who were used to wear glasses used their glasses when they were evaluated.

CPT is a computer test for evaluating the sustained attention. In this test, the subject should concentrate on a simple visual or auditory stimulus for a period of time and when the stimulus appears, the subject should present his response by pushing a button. In CPT, when the subject doesn't response to the target stimulus, omission error will be recorded and this kind of error will be considered as a problem in sustained attention. According to the results of Hadianfard et al, research the Persian version of CPT has a good reliability; there liability coefficient in different parts of the test was 53-93% (21). Data analysis was performed using SPSS 16 software. Based on Kolmogorov-Smirnov test it was proved that the hypothesis had a normal distribution. Since our variables had normal distribution, Pearson correlation coefficient and independent t tests were used to study the relation between the variables. All tests were performed at a confidence interval of 95% ($p<0.05$).

Results

The results of ICC and SEM for sustained attention were 0.88 and 0.15, respectively, for static balance 0.93 and 0.14, respectively, and for dynamic balance were 0.98 and 0.18, respectively. Therefore, these results showed high level of reliability of Biodex balance system and CPT. Following the inclusion and exclusion criteria, 50 old people were selected. Their mean age and standard deviation (SD) were 65.48±4.36 years. Other characteristics of participants are shown in Tables (1) and (2).

Table 1. Mean and SD in demographic variable

variables	gender	number	mean	SD	min	max
age	Female	25	66.72	2.54	60	74
	Male	25	64.24	3.88	60	71
Weight	Female	25	69.24	10.01	53	96
	Male	25	72.52	11.68	45	98
height	Female	25	158	4.89	149	165
	Male	25	166.56	6.75	150	180
BMI	Female	25	27.80	4.26	20.70	37.53
	Male	25	25.15	4.23	17.58	36.44

Table2 . Mean and SD in balance index and omission errors

variables	number	mean	SD	min	max
static balance	50	3.64	2.69	0.4	10.8
static balance with closed eyes	50	4.10	2.47	0.7	10.5
dynamic balance	50	4.55	2	1.6	10.5
dynamic balance with closed eyes	50	6.65	1.98	3.4	13.7
omission error	50	2.56	4.11	0	18

The results of independent t-test showed that mean of static and dynamic balance with closed eyes was significantly higher than that with open eyes ($p<0.05$).As it is shown in table (3) correlation coefficient among four balance indices and sustained attention was only significant in dynamic balance with closed eyes and sustained attention; there was not any other significant relation among other evaluated indices of balance with sustained attention.

Table 3. Pearson correlation coefficient between omission errors and balance

	Variables	Coefficient correlation	***P*-value**
omission error	static balance	0.14	0.34
	static balance with closed eyes	-.0.05	0.71
	dynamic balance	0.16	0.26
	dynamic balance with closed eyes	0.37	0.03

Discussion

Maintaining balance is a process performed by central nervous system which forms the pattern of muscular activities and requires connections between the center of mass and base of support. Sensory and motor processing contributes to balance control. The inputs from visual, vestibular and somatosensory systems and sensory integration have important roles in maintaining balance and they provide unique information for balance system which makes its performance efficient (22). Decreased function of vestibular and somatosensory systems by aging is inevitable, so elderly are more dependent on their visual information (23). In addition, displacement of the center of gravity (COG) and balance task requirements will be increased by eliminating visual

Information (24) therefore as the sensory input decreases, old people ability to maintain the balanced will be decreased (23). The results of our study showed that static and dynamic balance reduction will occur in old people as a result of losing visual information.

As it was mentioned, balance is accompanied with sensory integration which is adjusted by attention. Attention demand for balance will increase in different level of balance tasks and it depends on postural challenges, age and individual abilities (10). The result of our study did not show a significant relation between sustained attention and static balance with open or closed eyes. As the mean score of balance in our samples showed, these people had high static balance ability; since attention demand to maintain balance changes with the level of task challenges (10), it seems that the subjects of our study had no problem to maintain their static balance. So it can be said that there was no significant relationship between stable surface and sustained attention with and without visual input. These results are in line with the results of Landers et al, which had reported that there was no significant relation between static balance with open

or closed eyes and attention; they explained that the small number of subjects was the cause of insignificant correlations (25). Stapleton in 2001 didn't observe a significant relation between attention defect and increased falling of old people with a history of stroke (26). However, in 2003, Hyndman et al, reported that attention defect will increase the risk of falling in elderly with a history of stroke (7) also, Nagamatsu and O'Halloran reported sustained attention as a risk factor for old peoples falling (27, 28).

Since losing balance occurs mostly in dynamic conditions (20), old people's dynamic balance score is more considered. In our study, there was a significant relation between dynamic balance with closed eyes and sustained attention. It is worth mentioning that there was high increase of subjects balance mean score (balance ability reduction) in dynamic balance test with closed eyes. Considering insignificant relation between dynamic balance with open eyes, it can be said that the relation between dynamic balance and sustained attention is significant by eliminated the visual input. It seems in dynamic balance with open eyes, visual input compensates balance challenges and difficulty level of balance activities will be decreased in comparison with dynamic balance with closed eyes. As it was mentioned, attention demand for the balance changes with balance challenge levels (10). Because the cortex of frontal lobe is an area which supports sustained attention , and has a wide connection with frontal cortex area, as the important areas of motor control (29), the existence of a significant relation between the sustained attention and motor skills is likely. Shumway in his book has mentioned the supplementary motor area and primary motor cortex will show more activities by hardening the balance activities (8). On the other hand, old people need more brain activities for their sustained attention and more activity in anterior cingulate cortex and supplementary motor area (30). Therefore, with hardening balance activities for old people they need more activity of motor cortex and supplementary motor area. Supplementary motor area is a common part of sustained attention and balance; as a result it leads to observation of a significant relation between sustained attention and dynamic balance with closed eyes.

Conclusion

Considering the significant relation between sustained attention and dynamic balance with eyes close, it can be said that the relation between balance and sustained attention will become significant by increasing the difficulty level of balance tasks. It is suggested for old people with attention deficiency to avoid from doing balance tasks in difficult conditions of balance without visual feedback.

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