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Research Paper: The Effect of Head and Neck Stabilization Exercises on Dynamic Balance in the Elderly With Forward Head Posture

Shahram Irani[1], Maryam Abbaszadeh-Amirdehi[2*], Seyed Reza Hosseini[3], Shima Sum[4], Hossein Matlabi[5,6], Setareh Mirasi[7]

1. Department of Community Medicine, School of Medicine, Babol University of Medical Sciences, Babol, Iran.
2. Mobility Impairment Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.
3. Social Determinants of Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.
4. Department of Public Health and Gerontology, Faculty of Health, Babol University of Medical Sciences, Babol, Iran.
5. Department of Geriatric Health, Tabriz University of Medical Sciences, Tabriz, Iran.
6. Research Center for Integrative Medicine in Aging, Aging Research Institute, Tabriz University of Medical Sciences, Tabriz, Iran.
7. Department of Physiotherapy, School of Rehabilitation, Babol University of Medical Sciences, Babol, Iran.

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ABSTRACT

Introduction: This study aimed to investigate the effect of head and neck stabilization exercises on improving balance in older adults with forward head posture.

Materials and Methods: Thirty elderly participants with forward head posture and Mean±SD age of 65.7±5.2 years were examined. The forward head posture was measured by plumb line and craniovertebral angle. Elderly balance was evaluated before and after 8 weeks of head and neck stabilization exercises with Timed Up and Go (TUG) and Functional Reach (FR) tests. The paired t-test was used to examine the changes that occurred after the intervention.

Results: The results showed that head and neck stabilization exercises in the elderly significantly changed TUG test (8.3 s before the intervention, 7.8 s after the intervention; P=0.03) and FR test (23.4 cm before the intervention, 24.7 cm after the intervention; P=0.01) omitted. No significant statistical changes were observed in the amount of the craniovertebral angle after the intervention.

Conclusion: Based on the study results, performing the head and neck stabilization exercises did not cause significant changes in the craniovertebral angle but improved the dynamic balance of the elderly.

Keywords: Elderly, Forward head posture, Balance, Craniovertebral angle, Stabilization exercises

*** Corresponding Author:**
Maryam Abbaszadeh-Amirdehi, PhD.
Address: *Mobility Impairment Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, Iran.*
Tel: *+98 (911) 1158723*
E-mail: *abbaszadeh_m@alumnus.tums.ac.ir*

1. Introduction

Aging can be defined as a complex dynamic process characterized by a progressive decline of physiological function [1-3]. Aging changes occur in all organs of the body and affect the functioning of all body systems [4]. The specific changes of the musculoskeletal system during the aging process led to deviations from the standard alignment, which is called postural malalignments. Different body segments such as head, neck, shoulders, thoracic and lumbar spine may be affected by this malalignment [5-8].

Forward Head Posture (FHP) is one of the most common postural malalignments in the sagittal view in the elderly [9]. This condition is part of the upper crossed syndrome, functional impairment of the muscular system [10]. In this disorder, the cervical spine is flattened. Also, a backward bending in the upper cervical region, coupled with a forward translation of the lower cervical region, is seen [11, 12]. This situation causes an anterior shift in body weight. This shift changes the relationship between the line of gravity and the level of foot rest. It ultimately reduces the balance and increases the incidence of falling in the elderly [13, 14]. In response, the cervical muscles, which have a high density of muscle spindles that play an essential role in providing deep neck sensory information, go through some adaptive change in response to malalignment of the head and neck [15]. These changes include shortening of cervical spine extensors and lengthening of the intrinsic cervical spine flexors [16]. A change in the function of these muscles due to the inappropriate state of the head adversely affects the movement and balance control, which leads to balance disturbance and a higher risk of falling [14, 17].

Therapeutic exercises and postural training are generally used to improve balance [7, 18-20]. Several studies have investigated the effects of different exercise regimes for addressing FHP [6, 21-25]. Since FHP creates a specific muscle imbalance pattern that affects proprioception and balance, stabilization exercises activate and strengthen deep cervical flexor muscles that help restore the normal muscle recalling pattern, proprioception, and balance. This study aims to evaluate the effects of head and neck stabilization exercises on improving balance in the elderly with FHP.

2. Materials and Methods

Study subjects

In this clinical trial study, 30 participants more than 60 years old with FHP took part after signing the consent form. If any of the elderly has a history of spinal surgery, neck injury, acute and repetitive pain in the neck and back, spinal anomalies, lack of autonomy in daily tasks, vision problems, dizziness, balance disorders, chronic headache, temporomandibular joint dysfunction, rheumatic disease, orthopedic and neurological problems, depression, anxiety and or other psychiatric disorders were excluded from the study. The sample size was determined 30 according to the G*Power software version 3.1.7 for statistical power of 80%, confidence interval of 95%, and medium effect size. This study was supervised by the Ethics Committee of the Babol University of Medical Sciences (MUBABOL, HRI.REC.1395.35).

Head postural assessment

First, all participants were evaluated in a standing position with a plumb line suspended from the ceiling to observe the head's position related to the vertical line and ensure that they had FHP. With normal head posture, a vertical plumb line passes through the mid-shoulder and external auditory meatus, but in forward head posture, the head lies anterior to this vertical line. Then, the exact angle of the FHP was determined using craniovertebral angle. To measure the craniovertebral angle, the participants were asked to stand in a comfortable position while moving their weights evenly to the feet and look at a spot on the wall. The spinous process of the seventh cervical vertebra and the tragus of each person's ear were marked on their skin by a label. Next, the participants were shot in profile by a digital camera (Olympus VG-160, China) set on a tripod at a distance of 1.5 m from the subjects' shoulder level. After that, the craniovertebral angle was measured on the taken photographs by calculating the angle of the horizontal line passing through the seventh cervical vertebra and the line passing through the tragus to the seventh cervical vertebra (Figure 1) [8, 26]. The craniovertebral angles smaller than 48-50 degrees indicate the forward head posture. The greater forward head posture has the smaller craniovertebral angles [9].

Dynamic balance assessment

To evaluate the dynamic balance of each participant, we used the Timed Up and Go (TUG) and Functional Reach (FR) tests. In the TUG test, the subject was asked to sit on a chair and put his or her hands on an armrest.

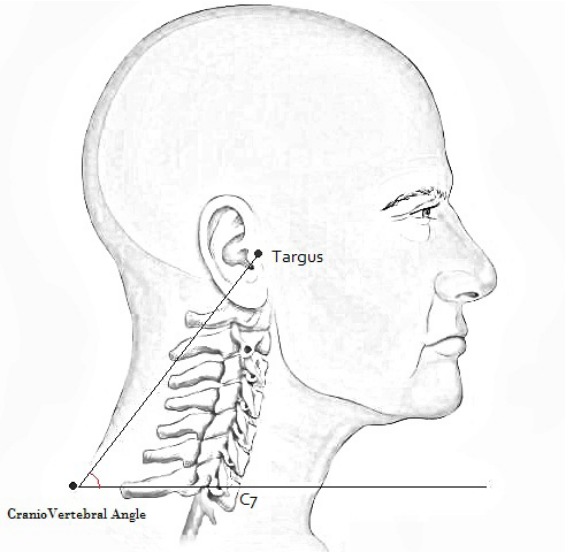

Figure 1. Craniovertebral angle measurement

After the "start" announcement, the subject should rise and walk up a 3-m distance along the straight line marked on the floor, then rotate, go back, and sit in the chair again. The duration of this test is recorded in seconds [27].

To perform the FR test, the subject is asked to stand next to but not touch a wall and elevate the upper extremity closer to the wall to 90 degrees of shoulder flexion with a closed fist. The examiner records the starting position at the third metacarpal head on the yardstick mounted on the wall. The starting position at the third metacarpal head is highlighted on the installed measuring tape. Next, the subject is asked to reach forward as far as possible without taking a step and losing his or her balance. After reaching the maximum possible displacement, the new position of the third metacarpal head was re-recorded (Figure 2). The score was determined by calculating the difference between the two positions in cm [28].

Intervention

Maintaining the head and neck's neutral position during daily living activities and stabilization exercises were taught to the elderly three times a week for 8 weeks (a total of 24 sessions). Education and exercises were conducted under the supervision of a physiotherapist at an Elderly Health Center. To perform the stabilization exercises, we instructed four training exercises with 12 repetitions, including strengthening of the neck deep flexors, stretching of the neck extensors, strengthening of shoulder retractors, and stretching the pectoral muscles [12, 29, 30].

Statistical analysis

The obtained data were analyzed with the SPSS v. 20 (SPSS Inc, Chicago, IL, USA). The Kolmogorov-Smirnov test was used to determine the normal distribution of the data ($P>0.05$). The paired t-test was performed to evaluate the changes of the variables before and after the intervention. The confidence interval was set at 0.95, and statistical significance was ≤ 0.05.

3. Results

Thirty participants were included in this study. The demographic characteristics of the individuals are pre-

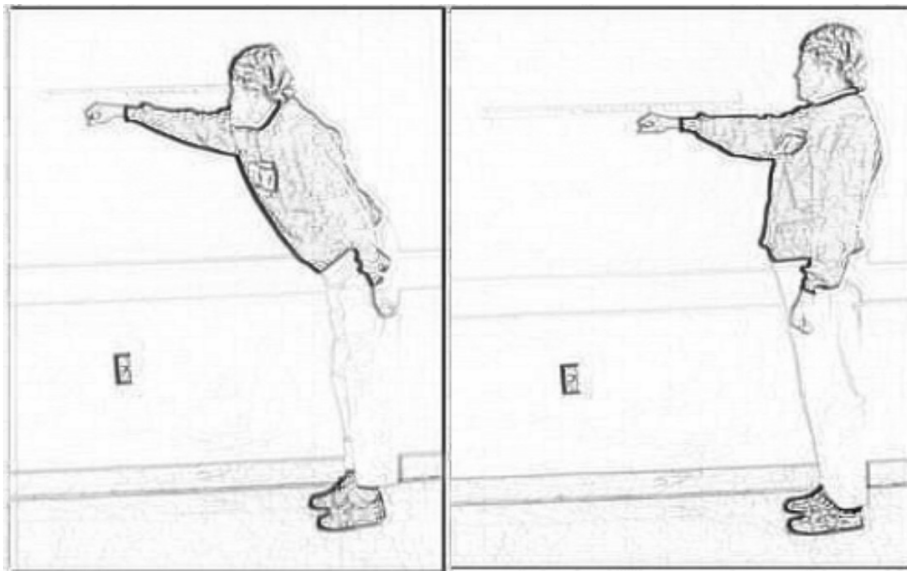

Figure 2. Functional Reach Test

Table 1. Demographic characteristics of the participants (n=30)

Variables		No.	Mean±SD	Min	Max
Age (y)			65.7±5.2	60	75
Height (cm)			157.0±7.7	142	176
Weight (kg)			70.8±11.1	47	108
Body mass index (kg/m^2)			28.9±4.7	18	40
Gender	Female	25	-	-	-
	Male	5			

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sented in Table 1. The frequency distribution of the variables showed that all had a normal distribution (P>0.05). The paired t-test results before and after the intervention showed significant statistical in TUG and FR test results. The mean change in craniovertebral angle after the stabilization exercises has not demonstrated a statistically significant difference (Table 2). Minimal detectable change and mean difference were calculated to determine whether the change measurement of the variable has improved clinically (Table 2).

4. Discussion

This study demonstrated that head and neck stabilization exercises significantly improved dynamic balance in the elderly with FHP. The mean score of the TUG test significantly decreased with medium effect size, and the FR test mean score increased dramatically with an almost large effect size after the intervention. Although changes in the craniovertebral angle were not statistically significant, they are clinically significant. All variables in this study, including the TUG test, FR test, and craniovertebral angle, showed clinically significant changes due to their increased value of the mean difference relative to the value of minimal detectable change.

The head and neck area closely contribute to maintaining a person's balance because vision, vestibular, and proprioception systems play an essential role in the stability of posture and balance. Proprioception is a significant part of the somatosensory system, responsible for providing information for the central nervous system to maintain a good balance. Proprioception afferents are essential in controlling the condition by providing information about the head's position relative to the trunk [31, 32]. The forward head posture by changing the biomechanics of muscles and ligaments caused changes in the muscle length and tension and, consequently, changes in muscle spindle sensitivity and proprioception responses. The altered proprioceptive response leads to different impulses that transmit to the central nervous system and cause disturbances in the central processing of postural balance [31-34]. According to Nummer et al., older adult women with a higher FHP are less likely to have balance [35].

Evidence suggests the positive effects of various exercises on improving the FHP and reducing the craniovertebral angle in adults [6, 12, 36-41]. Benedetti et al. demonstrated improved FHP using occiput-to-wall distance after flexibility and strengthening exercise in older adults [42]. According to Abdolahzadeh et al., four weeks of postural corrective exercise improves postural alignment related to FHP, confirmed by measuring craniovertebral angle on female students [43]. Several studies have shown that spinal stability exercises increase postural stability and improve balance [44, 45]. However, our

Table 2. Comparing the variables changes after the intervention

Variables	Mean±SD		P	Effect Size (Cohen's d)	Mean Difference	Minimal Detectable Change
	Before Intervention	After Intervention				
Time Up and Go test (s)	8.3±1.8	7.8±2.2	0.03	0.4	6.2	1.0
Functional Reach test (cm)	23.5±6.6	24.7±7.8	0.01	0.5	4.9	3.7
Craniovertebral angle (degree)	43.0±9.8	45.0±4.2	0.16	0.2	5.0	3.8

Cohen's d 0-0.2 small, 0.2-0.5 medium, 0.5-0.8 large, ≥0.8 very large.

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study did not show improvement in forward head posture statistically after stabilization exercise in the elderly, but dynamic balance improved after the intervention.

The goal of stabilization exercises is to re-educate global and local stability simultaneously through modifying motor control. Neck stabilization exercises affect postural control through concurrent contractions of the agonist and antagonist muscles, the suboccipital muscles, the multifidus, and deep neck flexors which are the most important cervical stabilizers. With the activation of local muscles, the global stabilizing muscles of the neck and scapula act synergically to maintain normal function. Consequently, stabilization exercises improve the neck muscles' proprioception by increasing agonist muscles' contractions, improving head and neck reflexes, and increasing the environmental inputs. An improvement in proprioception leads to better balance [33, 46, 47]. Similar to our study, a previous study reported that six weeks of stabilization exercise improved the balance of participants with FHP.

Nevertheless, the authors did not measure the cranio vertebral angle after the intervention. Furthermore, the sudy' target group was young people [47]. Since the neck muscles have the highest levels of afferent nerves in the motor system and have the most significant impact on the central nervous system concerning motor planning, modifying these muscles can provide appropriate status responses. Even though the changes in muscle length and tension in this study were not considerable enough to significantly improve the head and neck position, it seems that the positive effect of the exercise on the proprioception has produced more satisfactory postural responses and good balance than before the exercise.

5. Conclusion

In the present study, the effect of head and neck stabilization exercises on improving the dynamic balance of the elderly people with the forward head posture showed that although correction of head position and reduction of forward head posture was not statistically significant, stabilization exercises effectively improved dynamic balance of the elderly. Since in the maintenance of the balance, proprioception afferents of muscle spindles play an essential role, and the deep muscles of the neck area are also rich in muscle spindles, it seems that head and neck stabilization exercises improve the function of these sensory receptors and by doing so provide appropriate postural responses in the elderly adults.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of the Babol University of Medical Sciences (Code: MUBABOL.HRI.REC.1395.35).

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Authors contributions

Conceptualization and supervision: Maryam Abbaszadeh-Amirdehi; Seyed Reza Hosseini; Methodology: Maryam Abbaszadeh-Amirdehi; Seyed Reza Hosseini; Shima Sum; Investigation, writing – original draft, and writing – review & editing: All authors; Data collection: Shahram Irani; Setareh Mirasi; Data analysis: Maryam Abbaszadeh-Amirdehi; Hossein Matlabi.

Conflict of interest

The authors declared no conflict of interest.

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