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Evaluation of head position using craniovertebral angle in two sitting and standing positions in the elderly

M. Abbaszadeh Amirdehi (PhD)[1], S.R. Hosseini (MD)*[2], Sh. Sam (PhD)[2], Sh. Irani (MSc)[2], S. Mirasi (BSc)[3]

1.Mobility Impairment Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R. Iran
2.Social Determinants of Health Research Center, Health Research Institute, Babol University of Medical Sciences, Babol, I.R.Iran
3.Department of Physiotherapy, School of Rehabilitation, Babol University of Medical Sciences, Babol, I.R. Iran

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ABSTRACT

BACKGROUND AND OBJECTIVE: Abnormal head posture can lead to pain, physical limitations, falls and fractures that have a negative impact on people's quality of life. Since head orientation in sagittal view varies according to different body postures, this study was conducted to investigate the effect of two standing and sitting postures on sagittal view.

METHODS: This observational study was performed on 70 elderly people referred to Elderly Health Center of Babol University of Medical Sciences. In order to measure the craniovertebral angle to determine the direction of the head in the sagittal view, participants were photographed in both standing and sitting positions. After initial evaluation, participants were divided into two groups of head posture (forward head posture and normal head posture) based on craniovertebral angle, with an angle of less than 51° as abnormal head posture.

FINDINGS: The mean age of the subjects was 67.9±3.8. The size of the craniovertebral angle in sitting position (52±8.3) was greater than in standing position (48.1±6.5) (P<0.0001). In addition, two subgroups of forward head posture and normal posture showed increased craniovertebral angle in sitting position (forward head posture: 48.3±7.2, normal: 59.6±4.6) comapred to standing position (forward head posture: 43.7±6.5, normal: 56.9±4.2) (P<0.003, P<0.0001, respectively).

CONCLUSION: According to the results, the craniovertebral angle increases in sitting position compared to the standing position.

KEY WORDS: *Head posture, craniovertebral angle, standing position, sitting position, elderly.*

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***Corresonding Author: S.R. Hosseini (MD)**
Address: Department of Social Medicine, School of Medicine, Babol University of Medical Sciences, Babol, IR. Iran
Tel: +98 11 32199592-6
E-mail: hosseinirezaseyed@gmail.com

Introduction

Clinical evaluation of head posture is used to identify abnormal head posture. Abnormal head posture lead to pain, physical limitations, falls and fractures that have a negative impact on one's quality of life (1). Therefore, evaluation of head posture is important for timely treatment of this disorder. Proper alignment of the cervical spine and posture is crucial in maintaining postural stability and balance in the elderly. Postural stability decreases when the head deviates from its ideal position. Postural disorder is one of the most important risk factors for falls in the elderly (2).

There are several methods for assessing head posture including neck slope angle (3), head tilts (4), and craniovertebral angle (5). Several studies have investigated the sagittal alignment of the head by the craniovertebral angle using a simple and low-cost photography technique (6-8). The validity and reliability of this evaluation method have been confirmed in previous studies with intraclass correlation coefficient (ICC) between 0.88 and 0.98 (5,9). In fact, the craniovertebral angle has a good inverse relationship with the anterior displacement (10). Therefore, the craniovertebral angle is an appropriate measure for assessing head position.

Photogrammetry assesses posture by measuring linear distances and angles generated through body markers on digital photographs in specific software. The craniovertebral angle is the angle between the connected line of the forward position of the head and the larger angles indicate the optimum position of the head (10,11). Posture evaluation is usually performed in a standing position (12), and sitting position is generally not considered as part of posture evaluation (13). The standing position is now used to determine the sagittal direction of the head (14). Since the sagittal direction of the head is affected by different body postures, standing or sitting, such a limited use of reference values does not seem appropriate (15).

Some studies have examined the position of the head in sitting position and others in standing position. To date, no studies have examined the difference between head alignment in two sitting (6,16) and standing (10,17) positions, except for Shaghayegh Fard et al., who reported that the craniovertebral angle decreased in sitting position (8). The purpose of this study was to evaluate the effect of two standing and sitting positions on the sagittal direction of the head using craniovertebral angle measurement in the elderly.

Methods

Participants: This observational study was approved by the Ethics Committee of Babol University of Medical Sciences (MUBABOL.HRI.REC.1395.35) and conducted among 70 elderly people over 60 years (52 females, 18 males) referred to the Elderly Health Center of Babol University of Medical Sciences, who were independent in their day-to-day activities. They were recruited through non-random sampling.

The sample size in this study was estimated to be 70 people considering 95% confidence level and 80% power to find 3 degrees of difference in sitting and standing position. Subjects with a history of neck pain in the past six months, cervical spine fractures, clear spinal deformities such as scoliosis, neurological and neuromuscular disorders, chronic headaches, temporomandibular joint problems, rheumatic diseases, vision problems, dizziness and balance disorders were excluded.

To determine the craniovertebral angle difference in two different body positions, all 70 participants were studied in both sitting and standing positions. Subjects were then divided into two subgroups of forward head position and normal head position according to the size of the craniovertebral angle. According to studies by Kim et al., who viewed the craniovertebral angle of less than 51 degrees in standing position as an indication of forward head disorder (11), 47 participants were diagnosed with forward head position and 23 subjects with normal head position. All participants signed the consent form after receiving oral explanations.

Head Posture Examination: For an objective assessment of posture, a photograph was taken of everyone's profile. A 14-megapixel digital camera (Olympus vg-160, China) was placed at shoulder height, one and a half meters away from participants in standing or sitting position and in a way that the camera not rotating or tilting. The tragus of the ear and the processus spinosus of the seventh cervical vertebra (C7) were clearly marked by affixing colored paper markers to the skin to measure the angles more accurately in the image. The photos were taken in both sitting and standing positions. To take photos in a sitting

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posture, participants were asked to sit comfortably in a chair that was placed in the correct position so that the hips hit the back of the chair, the hip and knee had 90 degrees, the feet on the ground and hands on thighs. In the standing position, the participant had to stand in balance that his or her weight was evenly distributed on both feet, the head was perfectly normal, and the person's gaze was on a clear spot on the wall in front of the patient. This spot was set by the examiner at the level of participant's eyes. When each of the standing and sitting modes was repeated three times, the craniovertebral angle was measured using images by a person unaware of the groupings. To calculate the angle, a straight line was drawn between the tragus of the ear and the C7 processus spinosus; the angle between this line and the horizontal line passing through the processus spinosus is called the craniovertebral angle. To calculate the angle using geometric method, thickness-side ratio (h/b) and the arc tang were calculated by calculating the angle in radians and then converting radians to degrees (Figure 1) (6,8).

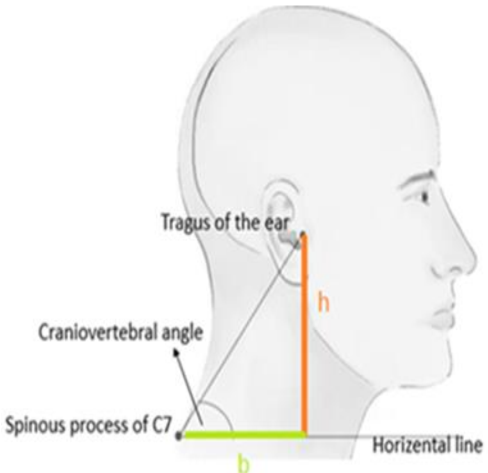

Figure 1. Craniovertebral angle measurement

The angle was calculated by specifying the coordinate axis of each marker, tragus, and processus spinosus in Excel software. Then, the mean angles of the three images were used in statistical analysis.

Statistical analysis: Data were analyzed using SPSS 18. The Kolmogorov-Smirnov test was performed to determine the normal distribution of the data. Paired t-test was used to compare craniovertebral angle difference based on degree in sitting and standing postures. After grouping, paired t-test was used for comparing craniovertebral angle in two standing and sitting postures in both forward head posture and normal head posture subgroups and $P < 0.05$ was considered significant.

Results

The Kolmogorov-Smirnov test showed the normal distribution of all data. Comparison of the craniovertebral angle between the two sitting and standing modes showed a significant difference using paired t-test, while the craniovertebral angle in the sitting position increased compared to the standing position (Table 1).

A larger angle means that the head on the sagittal plate is less forward and is normal. Subsequently, by dividing the subjects into two subgroups, the forward head posture and the normal head posture, these two groups were similar in age, weight, and height (Table 2).

Independent t-test also showed a significant difference between the craniovertebral angle in the two groups (standing posture: $P < 0.0001$, $t = 8.9$, sitting posture: $P < 0.0001$, $t = 6.9$). In addition, paired t-test in each group (forward head posture and normal head posture) also showed a significant increase in craniovertebral angle in sitting position compared to standing position (Table 3).

Table 1. Comparison of craniovertebral angle (degree) between the two sitting and standing positions in all participants

craniovertebral angle (degree)	number	Mean±SD	Min	Max	t	P-value
standing	70	48.1±8.5	19.6	70.9	6.98	0.0001
sitting		82±8.3	26.5	70.3		

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Table 2. Demographic characteristics of all participants in total and participants in each subgroup

	Number	Mean±SD	Min	Max	P-value
Age					
All participants	70	66.3 ± 4.6	60	76	0.2
forward head posture	23	65.8 ± 4.8	60	75	
normal head posture	47	67 ± 4.2	60	76	
Weight					
All participants	70	70.4 ± 9.4	47	90	0.3
forward head posture	23	70.9 ± 9.3	47	90	
normal head posture	47	69.6 ± 9.8	53	85	
Height					
All participants	70	158 ± 7.6	142	192	0.7
forward head posture	23	156.8 ± 6.9	142	176	
normal head posture	47	160.3 ± 8.5	142	192	

Table 3. Comparison of craniovertebral angle (degree) between two sitting and standing modes in each subgroup

Craniovertebral Angle		Number	Mean±SD	Min	Max	t	P-value
forward head posture	standing	47	43.7±6.5	36.3	50.5	6.25	0.0001
	sitting		48.3±7.2	38.6	55.8		
normal head posture	standing	23	56.9±4.2	51.8	70.9	3.28	0.003
	sitting		59.6±4.6	51.2	70.3		

Discussion

Our results show an increase in the craniovertebral angle in sitting position compared to standing position in the elderly. In addition, intra-group comparisons of two subgroups of forward head posture and normal head posture also showed an increase in craniovertebral angle in sitting position compared to standing position. Postural changes in the elderly are associated with age-related physiological changes. Degenerative changes in the cervical spine lead to changes in head posture (18). Forward head posture, thoracic kyphosis and reduced lumbar lordosis are important examples of age-related postural disorder in response to habitual postures. The forward head posture increases elbow flexion on the spine. Since the weight force of the head crosses the front of the body's gravity, we observe upper cervical spine extension and lower spine flexion in forward head posture (19). There was a direct linear relationship between increasing age and increased forward head posture. The mean craniovertebral angle was reported to be 48.8 degrees in the age range of 65 to 74 years, 41.2 degrees in the age range of 75 to 84 years, and 35.6 degrees in the ages above 85 years (20). In our study, participants were generally between 60 and 75 years of age with an average standing craniovertebral angle of 48.1, which is consistent with the study by Nemmers et al. (20). Nemmers et al. used methods similar to our study to determine the head posture and calculated the craniovertebral angle by profile imaging. All spinal arches, including the cervical, thoracic and lumbar arches, affect each other. As a result, the posture of the neck and changes in the posture of the head follow changes in the lower arches and they change accordingly. For example, when a person sits, the lumbar spine and thoracic spine are flexed and, as a result, the cervix is in a forward position compared to the standing position. As observed in the study of Shaghayegh Fard et al. (8), postural changes appear to be significantly different between sitting and standing in the elderly. Yet in our study, unlike the study of Shaghayegh Fard et al., the craniovertebral angle increased in sitting position. Numerous studies have examined the changes of the lumbar and thoracic arches in different body postures (15,21,22), but there are limited studies on the changes of the cervical spine and posture of head. Lee et al. showed that the lumbar lordosis was higher in both the elderly and young adults

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in sitting position compared to standing position. In addition, decrease in lumbar lordosis from standing to sitting position is less in the elderly than young adults (23). Meakin et al. used active modeling to determine spine changes in standing and sitting positions, and their research found that the spine was more straight in standing position and had the highest curvature in sitting position (24). It was also found that people with lower lumbar lordosis had more lumbar flexion when sitting, and, on the other hand, those with greater lumbar lordosis showed greater extension of their lumbar spine when sitting. Therefore, changes in spine arches in different positions may be related to the specific shape of the spine (25).

The shape of spine in the elderly undergoes special changes due to degenerative changes of the intervertebral discs, facet joint arthritis and muscle atrophy. Changes in the mechanical and functional properties of the spine changes its arch flexibility. Age-related sagittal spine abnormalities such as forward head posture, excessive thoracic spine kyphosis and loss of lumbar arch are the most prominent examples of mechanical and functional changes of spine (26). Comparison of the sagittal alignment of the vertebral column between healthy young and elderly subjects in both sitting and standing postures revealed a more severe forward head posture in the elderly (22).

It is difficult to compare existing studies with each other because of their different methodology, for example due to different sitting situations. Sitting in a chair with a backrest in both the young and the elderly decreases the lumbar arch and increases the thoracic arch (19). In addition, stiffness and reduced age-related flexibility in the lumbar region may limit lumbar flexion. Lumbar flexion restriction in the elderly may be offset by greater flexion of the thoracic region and increased thoracic kyphosis to provide enough stability for the trunk in the standing position. On the other hand, the position of the lumbar thoracic spine is associated with posture of the head and neck in different sitting positions (28).

Studies have also shown that in the sitting position, the lumbar region and neck move counterclockwise so that in sitting without support, lumbar extension is associated with greater flexion of the lower neck. In addition, it has been found that increased thoracic kyphosis is associated both mechanically and functionally with forward head posture, although forward head posture in elderly may also be independent of high thoracic kyphosis (19). Other studies have previously evaluated head posture based on craniovertebral angle in different sitting (3,6,7,10,29) or standing (5,10,17) positions, but it is not known which one is more appropriate for head posture evaluation. By comparing craniovertebral angle in standing and sitting position, Shaghayegh Fard et al. found a significant difference between sitting and standing position in both groups of forward head posture and normal head posture (8).

However, contrary to the results of the present study, the craniovertebral angle decreased in sitting position. However, it should be borne in mind that Shaghayegh Fard et al. studied young people. Their findings showed that when the lumbar lordosis is lowered in sitting position, the thoracic arch also changes and as a result, the head and neck are more forward. Conversely, in our study, the elderly had a more forward head posture in the standing position and when sitting, craniovertebral angle and forward head posture decreased. If the craniovertebral angle of the person in the standing position placed him in the forward head posture group, he/she would not be in this group in the sitting position and would be in the normal group. Changes in spine flexibility are directly related to degenerative changes due to aging. Some studies have reported increased spinal stiffness following degenerative disc changes in the vertebrae (30).

The direction of the spine and head are affected by age and changes that occur in body (23). As a result, lower forward head posture in sitting position in this study may be due to age-related stiffness that restricts lumbar region flexion and leads to decreased forward head posture. In addition, Hey et al. believe that lumbar spine changes in sitting and standing position are largely offset by thoracic spine to minimize the need for cervical spine changes (14).

Cervical spine and head position changes in our study might be due to maintenance of direct vision in the elderly. Since spine curvature and forward head posture, especially in the elderly, is affected by age-related changes in sitting position, it is recommended that head posture assessment be performed in standing position. The forward head posture in sitting position decreases compared to standing position in the elderly. Given that postural changes in sitting position are strongly influenced by complex age-related changes in spine curvature as well as the need to maintain direct vision in the elderly, calculating the craniovertebral angle in standing position is recommended.

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