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The effect of forward head posture on spinal curvatures in healthy subjects

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ABSTRACT

Background: Forward head posture also known as scholar's neck is nowadays considered to be most common musculoskeletal postural imbalance causing protrusion of head anterior to trunk. It is still unclear how age-related habitual changes such as forward head posture having an influence on thoracic kyphosis and lumbar lordosis in normal healthy adults. The aim of this study was to explore the effect of forward head posture in association with spinal curvatures in healthy subjects. In this study, we used craniovertebral angle, cranial-rotational angle, and flexicurve meter.

Materials and Methods: Hundred and eight adults (24.98 ± 5.45) participated in the study, out of which 60.15% were males and 49.07% were females. The subjects were assessed for forward head posture using the digital method lateral-side photograph of each subject; for thoracic kyphosis and lumbar lordosis flexicurve method was used.

Result: There was decreased kyphotic index with lesser craniovertebral angle, also, statistically thoracic kyphosis was extremely significant (P = < 0.0001) in normal adults. As well as the correlation between craniovertebral angle, cranial-rotational angle, thoracic kyphosis, and lumbar lordosis had shown extreme significance (P = < 0.0001) in normal adults, although the correlation between forward head posture and kyphosis was found to be insignificant with P = 0.067.

Conclusion: Thus, there is no significant correlation between forward head posture, thoracic kyphosis, and lumbar lordosis in normal adults aged 18–35 years.

Key words: Flexicurve, forward head posture, lumbar lordosis, photographic method, thoracic kyphosis

INTRODUCTION

In modernized time, extended use of mobile phone and computers has increased anterior weight bearing of cervical spine leading to a variety of musculoskeletal disorders related to the neck by changing the biomechanical stress of cervical spine.[1] Forward head posture is nowadays most common postural problems.[2] Head when positioned anterior to trunk, increasing the cervical convexity with the apex of lordotic cervical curve considering the distance from Line of Gravity in optimal posture is known to be forward head posture.[3] Forward head posture is defined as "any alignment in which the external auditory meatus is positioned anteriorly to the plumb line through the shoulder joint." Forward head posture is generally recognized types of poor head posture in sagittal plane.[1] Head maintained forwardly for long periods of time causes musculoskeletal disorders leading to reduced lordosis of lower cerival, in parallelism with kyphosis of upper thoracic vertebrae.[4]

Forward head posture is one of the reasons that changes biomechanical stress around the cervical spine leading to cervical pain, headache, temporomandibular, and muscular dysfunctions. Photogrammetry is an objective technique to measure posture of different body parts and has also demonstrated good validity for analysis of craniovertebral posture. This simple technique can be used to diagnose forward head posture. Different studies have different measurement angles such as craniovertebral angle, cervical inclination angle, head tilt angle, and cranial-rotational angle to measure forward head posture. Out of all angles used, craniovertebral angle is considered to be the most common angle used for evaluated forward head posture as it examines head status in relation to seventh cervical vertebrae (C7).[1]

Prolonged or repetitive forward head flexion causes constant isometric contraction of the cervical extensors to counteract the excessive external flexion moment and to maintain the head in forward position. This leads to muscle imbalances which causes postural impairments; if prolonged, they may cause chronic forward head posture.[5] There is a change in the length and the reduction in strength of Deep Cervical Flexors and tightness of Suboccipitals muscles. Due to this sustained posture, there is an injury to the soft tissues, reduced range of motion as well as diffused pain in the neck, scapular, and head pains.[6] Forward head posture is also associated with increased thoracic kyphosis,

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reduced lumbar lordosis as well as reduced proprioception. Therefore, it is important to recover from forward head posture to relieve neck pain, improve posture, and increase the range of motion.[7]

The prevalence of anterior head translation in neck pain patients was found to be 37%, out of which 58% were female and 42% were male number. A review of different observational studies of neck pain around the world showed that its 1-year prevalence ranged from 16.5 to 75.1% for the entire adult population which aged from 17 to 70 years. The diagnosis of forward head posture comprises of various methods. The most common ones are, calculating the anterior weight bearing in a lateral view of plain radiograph, Cranial Vertical Angle and Cranial Rotation Angle through a photograph of the lateral view of the subject.[8]

The spine is like an "S" considered to be an important part of skeletal system. The shape of the curve is in such a way that it adjusts the pressures and stresses and maintains better performance of muscles attached to it. If the natural alignment of the spine not only affects the person's cosmetic appearance but also causes pain and physical disorders along with respiratory problems or damage to internal organs.[9] Thoracic and Lumbar curves of the spinal column refers to kyphosis and lordosis, respectively.[10] Lumbar spine maintains posture and provides stability during static and dynamic postures.[11] Kyphosis is referred to the outward curvature of the thoracic spine and lordosis is referred to inward curvature of lumbar spine. Kyphosis is commonly caused due to poor posture and weakened muscles, while increased lordosis may increase the risk of degeneration and injury to spinal ligaments.[10] The lumbar spine supports the upper body by transmitting weight of the upper body to pelvis and lower limbs.[11]

Forward head posture is poorly noticed and an under-diagnosed problem of neck. The positioning of skeletal structures directly influenced adjacent structures as the regions of spinal columns interact through the vertebral system. Poor sitting posture causes posterior pelvic tilt which in-turn causes reduced lumbar lordosis that leads to increase in thoracic kyphosis through anticlockwise mechanism of cogwheel and eventually affects the cervical spine. This final cogwheel mechanism is a cause for forward head posture. No studies till date have found the prevalence of forward head posture in age group of 18–35 years. There is paucity in literature for the association of forward head posture and spinal curvatures in age group 18–35 years.

MATERIALS AND METHODS

Methods

Subjects

- A convenient sample of 108 healthy subjects aged 18–35 years (mean 24.98 ± 5.45) participated in the observational experiment. Exclusion criteria were a history of neck pain, cervical spine fractures, scoliosis, severe thoracic kyphosis, rheumatic disease, torticollis, History of Cervical spine surgery, History of Whiplash injury, Rheumatoid Arthritis, and Cervical disc herniation. The verbal information about the nature of the study was given, and informed consent was obtained from each participant.

Procedure for assessment of head posture

- Photogrammetry: A digital imaging technique was used to evaluate head and neck posture in standing position. A digital camera (Nikon Coolpix P7100) was paced at a distance of 1.5 m and height was adjusted to the level of subject's shoulder. The lines were drawn from spinous process of C7 to the external corner of the eye and tragus of the ear. The eye level was established by asking the subjects to look forward at a point directly in front of them and then the photo was taken. The external ear meatus should be in vertical alignment with the middle line of the trunk and is used as reference for detecting forward head posture.[10]
- Forward head posture measurement: Based on the vertical alignment of the ear tragus in relation to middle of shoulder, subjects were put in three group: Non forward head posture (external ear meatus perpendicular to shoulder), slight forward head posture (external ear meatus slightly forward to shoulder), and moderate-severe forward head posture (external ear meatus forward from the shoulder). Two angles - craniovertebral angle and cranial-rotational angle - were measured to quantify forward head posture and head tilt angle was computed to measure subjects' head position. All the angles were measured using the MB ruler software.[1]
- Measuring the craniovertebral angle: The intersection of a horizontal line passing through the C7 spinous process and the line joining the midpoint of tragus of the ear is identified as craniovertebral angle. There are no cutoff values used to identify forward head posture for craniovertebral angle. In general, smaller the craniovertebral angle more is forward head posture.[1]
- Measuring the cranial-rotational angle: The angle formed by the line connecting C7 with the tragus of the ear and the line connecting the tragus of the ear with lateral canthus of the eye is cranial-rotational angle. Similar to craniovertebral angle, there is no standard cut off value for this, but the larger cranial-rotational angle more is forward head posture.[1]
- Thoracic kyphosis: Thoracic kyphosis was measured using flexicurve method. The validity and reliability of measurements from flexicurve method are intra- and inter-rater reliability coefficients of 0.88 and higher. Subjects were asked to stand normally, and the assessor placed the ends of flexicurve over the C7 and S2 spinous processes. The shape of the flexicurve was fixed with the curvature of the spine. Then, the flexicurve was then placed on the graph paper, and the curve was traced by hand on a 10x10 gridded graph paper with a pencil. A ruler with marking was used to measure the length and width of each segment. The kyphosis index was calculated as: [Thoracic width (TW)/Horizontal length (TH)] × 100. Higher indices indicated greater degrees of kyphosis.[12]
- Lumbar lordosis: Lumbar lordosis was measured using flexicurve method. Subjects were asked to stand normally, and then the flexicurve was placed along the spinal curvatures from C7 to S2 spinous processes. The flexicurve was placed on a 10x10 gridded graph paper and was traced with a pencil. A straight vertical line was drawn to connect C7–S2. The maximum width and total length of curve were measured in centimeters. The lordosis index was calculated as: (Lordosis width/lordosis length) × 100. Higher the indices indicated greater degrees of lordosis.

Data Analysis

Statistical analysis

MS-Excel 2007 was used to enter the data which were analyzed using instat software. Descriptive analysis for numerical data consists of mean with standard deviation (SD) for various parameters. Paired *t*-test was used for comparison of parameters within the groups. $P < 0.05$ was considered to be statistically significant.

RESULTS

By the careful examination of photographs of 108 subjects, the presence of forward head posture was determined in 18.51% subjects while on the other hand 81.48% subjects with neutral head posture, i.e., no forward head posture. The significance of Fisher's exact test was used to check whether the percentage of subjects with forward head posture was significantly higher than the percentage of subjects with forward head posture and altered in spinal curvature. The test showed no significant difference ($P = 0.067$) in subjects having forward head posture and the subjects with forward head posture and altered spinal curvatures. The study showed 10% subjects had kyphosis and forward head posture and 25% subjects had kyphosis but no forward head posture.

Craniovertebral angle is a widely used method for objective forward head posture measurement.[3] The mean of craniovertebral angle was 55.84 degrees which is consistent with the findings of other studies. The normal craniovertebral angle range was 30.52–71.85 degrees, reducing ranges 30.52–45.00 and 45.00–49.74 degrees in subjects with moderate-severe forward head posture and slight forward head posture, respectively. The mean of cranial-rotational angle was 139.91 degrees. The normal range of cranial-rotational angle was 118.30–166.50 degrees. According to the results, the mean of kyphosis and lordosis are 6.83 ± 3.36 and 10.36 ± 4.12, respectively. Previous studies showed wide ranges of craniovertebral angle 40–56 degrees.[1] According to values of craniovertebral angle, many subjects with slight forward head posture have near normal posture, also, the many of literature defines forward head posture as craniovertebral angle <48–50 degrees.[1]

- Mean and SD of the variables:
- Correlation between the parameters:

DISCUSSION

In the present study, 108 individuals participated out of which 18.18% had forward head posture and 81.48% did not. Although the results of present study had no significant correlation between forward head posture and kyphosis; 55% individuals had kyphosis and 45% did not had kyphosis with forward head posture. While 30.68% individuals had kyphosis but head position was neutral. There were 64.81% individuals having no kyphosis irrespective of forward head posture. The purpose of the present study was to evaluate the prevalence of forward head posture in association with spinal curvatures in healthy subjects.

Posture is a fundamental piece of normal balance. Faulty posture is widespread in adolescence. In reality, forward head posture is prevailing more in the people of modernized community as they are expanding pace by sitting in front of computers or a desk at work for a long time. The forward head posture results due to the popularization of mobile phones, use of chairs with no maintenance of good physique, a bed not appropriate for good posture, lack of exercise, excessive learning activities and lastly, more importantly, heavy school bags. Scholar's neck may also be associated with muscle length and changes in muscle strength of neck muscles.[11,13,14]

The role of neck muscles is essential in postural adjustment and in maintaining the stability of neck. They sum up to support the weight of neck while moving the head in various directions. Posture may be influenced by intrinsic or extrinsic factors, making an individual more susceptible to injury. Inappropriate posture over prolong period triggers dynamic stress and pain over neck and shoulders, leading to muscles imbalances in relation to strength and flexibility and may also lead to restricting the range of motion and when contortion becomes severe, it may cause radiating pain.[11,13,14] In the present study, the subjects showed that maintaining the inappropriate posture for a long-time might not have caused changes in strength and flexibility of the relative structures leading to alteration in spinal structures.

Forward head posture contorts the alignment of trunk on alignment from head to trunk by increasing kyphosis of thoracic bone as well as the neck bone. Attitude of neck maintains balance of neck muscles which is important to prevent musculoskeletal disorders. If the body continues to be in an improper position for long periods of time, some muscles remain in their stretched positions while others in their contracted positions. Inappropriate position forms knots in contracted muscle and weakness in elongated muscles. Improper position is such a condition in which the individual adapts altering the normal spinal alignment and natural curves of spine causing reduced lordosis of the lower cervical and kyphosis of the upper thoracic vertebrae. Thoracic kyphosis and lumbar lordosis are the most common ones among the several postural alterations.[15] Although according to the results of the present study there was no correlation between the forward head posture and kyphosis.

In the modern era, there are many professions such as information technology; where most of their work is on computers requiring long hours of sitting, that ultimately requires more muscle activity than required in standing. This increase of muscle activity produces more forces in sitting pushing the pelvis into more of posterior pelvic tilt causing a reduction in lumbar curve.[11] The result of the present study also showed 10.36 ± 4.12 as mean for lordosis in healthy subjects with age group 18–35 years.

CONCLUSIONS

This study suggests that there is no significant association between forward head posture and alteration in spinal curvatures. The craniovertebral and cranial-rotational angle used to diagnose forward head posture showed significance with thoracic kyphosis and lumbar lordosis.

LIMITATIONS AND RECOMMENDATIONS

One of the limitations of this study was the inability of the control factors that influence the craniocervical posture

Table 1: Mean and SD of variables in adults

Variables	Mean±SD
Number of subjects	108
% Males	60.15%
% Females	49.07%
Age	24.98±5.45
Craniovertebral angle	55.84±6.87
Cranial-rotational angle	139.91±9.01
Kyphosis	6.83±3.36
Lordosis	10.36±4.12

SD: Standard deviation

Table 2: Correlation between craniovertebral angle - cra, cranial-rotational angle - kyphosis, +craniovertebral angle - lordosis, cranial-rotational angle - kyphosis, cranial-rotational angle - lordosis, kyphosis - lordosis was extremely significant in adults

Variables	*P*	"*t*"
Craniovertebral angle (cva) -cranial-rotational angle (cra)	<0.0001	60.612
Craniovertebral angle (cva) – kyphosis	<0.0001	62.096
Craniovertebral angle (cva) – lordosis	<0.0001	57.758
Cranial-rotational angle (cra) – kyphosis	<0.0001	146.66
Cranial-rotational angle (cra) – lordosis	<0.0001	139.88
Kyphosis - lordosis	<0.0001	6.366

such as psychological situation, upper limb alignment, pelvic tilt, and lower limb alignment. Using radiological imaging technique as a standard method that could determine the correlation of spine with head alignment could be done. Furthermore, further research can be done for statistical significance of forward head in association with thoracic kyphosis and lumbar lordosis taking age into consideration in their design.

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