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Biomechanical Analysis of Craniovertebral Angle changes and its Impact on Neck-pain

Mamta Vijay[1*], M.K. Singh Chauhan[2] and Kuntal Ghosh[3]
[1]Research Scholar, Department of Yoga, Manipur University, Imphal (Manipur), India.
[2]Doctoral Fellow, Department of Rachana Sharir, Faculty of Ayurveda, IMS, BHU, Varanasi (Uttar Pradesh), India.
[3]Assistant Professor, Department of Yoga, Manipur University, Imphal (Manipur), India.

(Corresponding author: Mamta Vijay)*
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ABSTRACT: Neck pain significantly impacts society as one of the most prevalent and disabling health issues worldwide. The region between the inferior edge of the occipital bone and T1 is commonly affected by neck pain, discomfort, or soreness. Annually, 30% to 50% of workers have neck pain due to musculoskeletal conditions. This review paper analyzes the biomechanical implications of craniovertebral angle (CVA) changes and their effect on neck pain. A line that runs from the ear tragus to C7 and a horizontal line that goes through C7 combine to form the CVA. A thorough assessment of the literature was done, emphasizing research examining the connection between CVAs and neck pain alterations. The search strategy included a combination of "Craniovertebral angle," "Neck pain," "Biomechanical analysis," "Posture correction," "Forward head posture," and "Relationship between Craniovertebral Angle and Neck Pain." This review aims to investigate the biomechanical effects of alterations from CVAs on neck discomfort. Research shows the relationship between neck pain and FHP, which is defined by a lower CVA. According to biomechanical assessments, FHP puts more mechanical strain on the cervical spine structures, which causes pain. Changes in CVA have a significant effect on neck pain, which highlights the importance of preserving ideal head and neck alignment.

Keywords: Craniovertebral Angle, Neck-pain, Forward Head-posture, and Biomechanical.

INTRODUCTION

A musculoskeletal equilibrium that places minor strain and tension on the body characterizes proper posture. Neck pain significantly impacts society as one of the most prevalent and disabling health issues worldwide (Pauw *et al.,* 2015). Annually, between 30% to 50% of workers have neck pain due to musculoskeletal conditions (Haldeman *et al.,* 2010). Adults who use electronic devices for extended periods and who also adopt lousy posture when using EDs may develop musculoskeletal diseases. The CVA is measured to determine FHP. Many people do not have proper posture, even when it is wanted. The cervical extensor muscles, including the levator trapezius and scapulae, are overworked when the head moves forward, resulting in myofascial discomfort and excessive muscle activity. Second, the altered posture puts pressure on the facet joints and cervical intervertebral discs, leading to deterioration and decreased mobility. The cervical spine is a complex biomechanical structure with at least 20 muscle pairs and countless degrees of mobility for each joint, many of which serve identical purposes (Falla *et al*., 2007). The FHD can also press against the cervical nerves and blood vessels, impairing normal blood flow and nerve conduction and intensifying pain and suffering (Nejati *et al.,* 2015).

The CVA is a significant biomechanical assessment of the head's posture about the cervical spine. This angle is used to indicate head and neck alignment. The method connects a line from the ear's tragus to the spinal process (Land *et al.,* 2017). The seventh cervical vertebra (C7) has a horizontal line that passes through C7. "Natural head posture" is a neutral and resting head posture. In order to reach a balanced, comfortable position, the subject is asked to perform extensive cervical flexion and extension with increasing amplitude. The CVA is a representative measurement when combined with the upper cervical flexion or

extension and an anterior or posterior position of the lower cervical spine (Shinde and Shah 2022).

The cervical spine, which comprises the vertebrae in the neck, has a curvature known as normal cervical lordosis. This curvature stabilizes the head and spine. The cervical lordosis, which points to the rear of the neck, resembles a big C in a healthy spine. Much research looked at the neck's moment-generating capacity and reported strength values for various cervical postures in males, women, and various age groups. It is expected to experience discomfort from prolonged, static postures during neutral and non-neutral neck postures (Fung *et al*., 2008).

Research has shown that individuals experiencing discomfort in their heads, necks, and shoulders are likelier than those who are asymptomatic and have a lower CVA, indicating a greater FHP (Nejati *et al.,* 2015). This postural misalignment, often quantified by a reduced CVA, has been widely studied due to its significant impact on various physiological and biomechanical functions. Research has shown that FHP can lead to numerous musculoskeletal issues, particularly neck pain, by altering the natural head and neck posture and increasing strain on cervical spine structures (Kim, 2015). Neck pain is a common problem among young adults. It can be caused by improper sitting posture and repetitive use of electronic devices such as computers, phones, laptops, and others that require good posture (Singh *et al.,* 2020).

MATERIAL AND METHODS

A thorough assessment of the literature was done, with an emphasis on research examining the connection between alterations from CVAs and neck pain. The databases PubMed, Scopus, Web of Science, and Google Scholar were utilized. A combination of the following keywords and their synonyms were used in the search strategy: "Craniovertebral angle," "Neck pain," "Biomechanical analysis," "Posture correction," "Forward head posture," and "Relationship between Craniovertebral Angle and Neck Pain."

Inclusion Criteria: Studies that assessed the CVA in individuals with neck pain, Studies that investigated the relationship between CVA changes and neck pain. Peer-reviewed journal articles, review articles, and clinical trials.

Exclusion Criteria: Studies not focused on CVA or neck pain. Non-peer-reviewed articles, such as editorials and opinion pieces. Articles in languages other than English. Studies with insufficient methodological quality or lacking detailed CVA measurement methods. The study design, sample characteristics, CVA assessment methods, interventions employed, and results about posture and neck discomfort were among the vital information that was taken out of the chosen studies. The standardized instruments suitable for every research design were used to evaluate the quality of the included studies. This specified the correctness and dependability of the results. A thorough understanding of the biomechanical impact of CVA alterations on neck discomfort was achieved by synthesizing the retrieved data. With evidence-based suggestions for successful intervention options, this review attempts to shed light on the connection between alterations from CVAs and neck pain by methodically examining the body of available material.

RESULTS AND DISCUSSION

According to research, forward head position (FHP) and neck pain are related, which is defined by a lower CVA. According to biomechanical assessments, FHP puts more mechanical strain on the structures of the cervical spine, which causes pain. The biomechanical analysis of CVA changes and their effect on neck pain underscores the importance of maintaining proper cervical posture- CVA is one of the most prevalent techniques for evaluating forward head posture and a good sign for distinguishing between FHP (Yip *et al.,* 2008). The cervical spine is a complex biomechanical system of at least 20 muscle pairs with numerous degrees of freedom of motion between them, many of which carry out comparable tasks (Falla *et al.,* 2007). One way to compensate for the decrease in muscle activity brought on by neck pain is to either increase the activity of synergistic muscles or decrease the activity of antagonistic muscles. According to an experimental investigation, the local activation of the noxious afferents in the cervical muscles inhibits the painful muscles. However, this impact is countered at the level of the muscle group performing the task by intricate motor strategy reorganization. Because this shift in muscle coordination is task-dependent, motor output does not vary when in pain (Falla *et al*., 2007). Altered CVA, particularly forward head posture, is strongly associated with increased neck pain and functional impairments (Kyvanloo *et al.,* 2010).

The review of studies on the biomechanical analysis of CVA changes and their effect on neck pain offers valuable insights into the intricate relationship between posture and musculoskeletal health. The findings consistently suggest that alterations in the CVA, particularly reductions indicating an FHP, are closely linked with increased neck pain and associated dysfunctions. This discussion synthesizes the key findings, explores potential mechanisms, and evaluates the effectiveness of various interventions (Herman *et al.,* 2009). This review includes numerous research that shows a substantial association between increased neck pain intensity and lower CVA, which is an indicator of FHP. The biomechanical pressures placed on the cervical tissues are responsible for this association. An FHP causes the center of gravity to shift anteriorly, increasing strain on the cervical spine, especially the

lower cervical segments, and requiring more powerful muscle contraction to keep the head in place. Pain, exhaustion, and strain in the muscles can be caused by this posture.

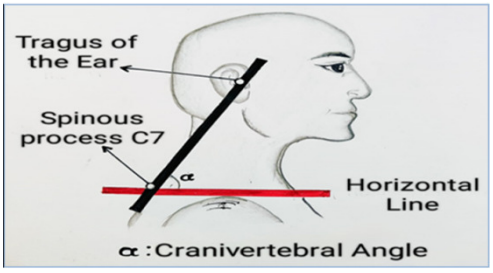

Fig. 1. Measurement of Craniovertebral Angle.

Posture illustrates how the environment affects the alignment of the spinal segments and how they relate to one another. It is thought that the way the arms, trunk, legs, and pelvis are positioned affects the cervical posture when standing or sitting (Fung *et al.,* 2008). A standardized method is necessary for a particular orthopedic evaluation of the cervical posture, which positions the lower body correctly. An essential component of the clinical orthopedic evaluation of patients with neck pain is postural examination (Herman *et al.,* 2009). As previously indicated, the primary source of awareness of position afferents in the neck is muscle spindles closely packed in the deep neck muscles. The absolution of muscle spindles can be altered by these anatomical and functional changes in the cervical deep and superficial muscles, impacting afferent input and modifying proprioception.

A more forward-leaning head posture is indicated by a narrower CVA. Forward head position is a CVA of less than 48–50. There are various techniques for determining the craniocervical position. Reduced cervical muscle cross-sectional area and functional deficits in muscle strength, are endurance, accuracy and acuity, and range of motion. In addition to altering neck muscle coordination and reducing the specificity of neck muscle activation, for example, by activating the superficial muscles more than the deep segmental muscles, neck pain can also lead to maladaptive strategies (Falla *et al.,* 2007; Falla, 2004).

An FHP, a typical postural misalignment where the head protrudes anteriorly relative to the trunk, can result from deviations from the ideal CVA (Lau *et al.,* 2010). The region between the inferior edge of the occipital bone and T1 is commonly affected by neck pain, discomfort, or soreness (Shinde and Shah 2022). Pain sources may come from many structures of the cervical spine and can become chronic. Physical, psychological, and social functions can be adversely impacted by neck issues. Additionally, neck pain causes high costs to the national healthcare systems (Verma *et al.,* 2018).

Cervical discomfort and dysfunction are influenced by head and neck posture, both at the beginning and throughout the condition. The FHP is among the common bad head postures observed in patients with neck issues (Nejati *et al*., 2015). FHP is prevalent in young adults and is one of the most prevalent effects of incorrect posture. The cervical spine muscles can become elongated and shortened due to a protracted and repeated adaptation to poor posture that results in muscular imbalance. Increased flexion of the upper cervical spine and upper thoracic region, as well as the increased extension of the lower cervical spine, are characteristics of faithful hyperplasia. It is linked to a reduction in the length of the sternocleidomastoid, levator scapulae, posterior cervical extensor, and upper trapezius muscles (Jull *et al.*, 2007). Appropriate motor responses to mechanoreceptive input from joints and muscle spindles are necessary for controlling neck posture and movement. It's been discovered that in patients with whiplash-related neck pain, a reduction in physiological awareness impairs postural repositioning accuracy post-movement (Hannu *et al.,* 1998).

CONCLUSIONS

This review aims to examine the biomechanical implications of CVA-related alterations on neck discomfort. This review emphasizes how variations in the craniovertebral angle (CVA) majorly affect neck pain. Reduced CVA causes forward head position (FHP), which raises cervical spine stress and causes discomfort. Specifically, this study aims to elucidate the mechanisms by which changes in CVA cause mechanical strain on the cervical spine and surrounding muscles. The fact that cervical sensorimotor control deteriorates as a result of cervical proprioception impairment is one of the primary issues facing individuals with neck discomfort. The results highlight the significance of a thorough strategy for treating musculoskeletal problems associated with posture, ultimately enhancing the quality of life for those with neck pain.

The biomechanical analysis shows that a decreased CVA results in more mechanical stress on the cervical spine, which causes pain, strained muscles, and persistent pain. Targeted therapies are necessary because modern lifestyle factors, like prolonged use of electronic devices, have been found to be pivotal contributors to these postural abnormalities.

FUTURE SCOPE

Subsequent studies may investigate the amalgamation of sophisticated imaging methodologies and wearable technology to oversee CVA alterations instantaneously. Longitudinal research evaluating the effects of specific therapies on outcomes related to CVA and neck pain may also be beneficial. Examining the part individual variability plays in how CVA responds to various

therapeutic modalities could improve individualized care and treatment plans.

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Conflict of Interest. None.

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