Original Article

Association between Cranio-vertebral Angle and Cognitive Functions in Adults: Preliminary Findings of a Cross-sectional study

Apoorva Srivastava, Digvijay Sharma

Abstract:

Background: Cranio-vertebral Angle (CVA) is an important tool in detecting cervical posture which imparts a significant contribution to the biomechanics of the body. Cervical spine biomechanics is a key factor in postural studies sinceit's abnormality or deterioration can affect posture and its associations at any age.

Aim: The aim behind this study was to evaluate the effect of reduced CVA on cognitive functions in adults.

Methodology: This was a cross-sectional study with a sample size of 100 adults aged between 25 to 40 years with absence of any sort of systemic, neurological or musculoskeletal disease. The study was approved ethically and registered as CTRI/2023/10/058581. The outcomes used were CVA through Photographometery and MB Ruler Software, Saint Louis Mental Status Examination (SLUMS) scale and Addenbrooke's Cognitive Examination (ACE-III) scale.

Result: Kolmogorov Smirnoff test depicted not normal distribution and thus Spearmann Correlation Coefficient was used to analyse the association of CVA with SLUMS (p-value<0.0001) and CVA with ACE-III (p-value<0.0001).

Discussion: Participants who had CVA reduced than normal (i.e., 53 degrees) had mild to moderate delay in cognitive functioning. Among all the domains tested, majority of the participants with reduced CVA had specific deterioration within the short-term memory, attention, executive function and comprehensibility. No changes were observed in fluency and language of the participants.

Conclusion: This study depicts a significant and strong association between the CVA variations and the cognitive functioning of an individual.

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INTRODUCTION

Cervical spine posture imparts a significant contribution to the biomechanics of various physiological processes of the body[1].This accounts for all the normal and abnormal biomechanical relationships with other joints and body systems as well[2]. Although there are many alterations within the cervical posture, one of the most common anomalies is the reduction of cranio-vertebral angle (CVA) or Forward Head Posture (FHP)[3]. This CVA is crucial in assessment of cervical posture along with translation of head and upper cervical spinal column[3][4]. This region has a definite relationship with the parameters andfunctionings of upper extremity, thorax as well as the brain[5]. Since one of the major physiological functions of the brain include cognitive abilities of an individual, its appropriate working is necessary to maintain the normal functions within an individual[6].

Cognitive abilities of an individual describe the basic cognition and physiology of brain to work in response to a stimulus or to work in a symmetrical fashion[6][7]. It is a set of functions that govern the daily activities and also command the quality of life of individuals[6]. This cognitive ability is found to be associated with various factors both biomechanical and physiological[8]. Previous literatures suggest the relationship of this CVA with balance, quality of life, pain intensity, etc[9, 10, 11]. There are numerous studies that define cognitive functions and their association with differentbiomechanical impairments of the body such as balance abnormality and its

Author Affiliations

Apoorva Srivastava, PhD Scholar, MPT, BPT, Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India, Digvijay Sharma Associate Professor & Director, School of Health Sciences, Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India

Correspondence

Apoorva Srivastava, PhD Scholar, MPT, BPT
Chhatrapati Shahu Ji Maharaj University, Kanpur, Uttar Pradesh, India, 208024
E-Mail: apoorva.pt12@gmail.com
Contact: 8953634686

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association with decreased cognitive abilities in elderly, decreased physical activity owing to stressful conditions causing decreased cognitive abilities, etc.[12,13].Previously studies have been conducted that drew conclusions that CVA changes as per postural abnormalities within the body[14] and posture plays a crucial role in maintenance of healthy cognition in individuals[15].

Since cervical spine biomechanics is a key factor in postural studies it's abnormality or deterioration can affect posture and its associations at any age[11, 12, 14]. There were studies which evaluated this relationship between cervical posture and cognition in elderly population[16, 17]but by far to the author's knowledge no study was conducted to evaluate this relationship in healthy young individuals. Thus, it is hypothesized that there is no relationship between CVA deterioration or reduction on cognitive abilities of healthy young individuals.

MATERIALS AND METHODS

This was a Cross-sectional study. The study was a part of a doctoral study which is ethically approved and registered with the Clinical Trial Registry Number CTRI/2023/10/058581. Adult participants aged between 25 to 40 years with absence of any sort of systemic, neurological or musculoskeletal disease. Participants with any health disorder or taking any sort of medications, or had any injury to the spine or head within 1.5 years of duration were excluded from the study. Since it was a preliminary study, a sample of 100 adults were selected[18].To analyse CVA photographometery method,as explained in previous literature[4], was utilised along with MB Ruler Software[19]. Cognition was assessed using the Saint Louis University Mental Status Examination (SLUMS)and Addenbrooke's Cognitive Examination Scale (ACE-III). Both the scales are valid and reliable to be used in adults and have good validity in detecting mild cognitive impairment[20, 21].The participants were recruited as per the inclusion criteria. They were then asked to provide their consent before inclusion within the study. Post which they were assessed for their demographic details. During assessment of CVA through photographometery [22], participants were asked to enlist any symptoms they perceive during rest or during continuous work around the neck region. After this, the participants were asked to participate in the cognitive assessments. Analysis was performed using the Statistical Package for Social Sciences (SPSS Version 20). Normality was assessed using Kolmogorov Smirnoff test and p-value was set at 0.05 to be considered significant.

RESULTS:

The data depicted not normal distribution and thus it was depicted in Median (IQR). Spearmann Correlation Coefficient was used to analyse the association of CVA and Cognition. The demographics were as displayed in **Table 1**. Gender distribution within data was expressed in **Figure 1**. **Table 2** represents the Correlation coefficient and significance values of CVA, SLUMS and ACE-III. Figure 2 & 3 represent the correlational relationship of the outcomes with CVA.

Table 1: Demographic details of Participants (n=100)

S.No.	Variable	Median (IQR)	p-value
1.	Age	27.50 (9)	0.027
2.	Height	170 (20.75)	0.001
3.	Weight	70 (11.75)	0.001
4.	BMI	24.7 (7.83)	0.001
5.	CVA	49.25 (3.7)	0.004
6.	Ex/day	2 (2)	0.001

Abbreviations: IQR: Inter-quartile Range; p-value: Significance level; BMI: Body Mass Index; CVA: Cranio-vertebral Angle; Ex/day: Duration of Physical activity in a day

Figure 1: Gender Distribution within data

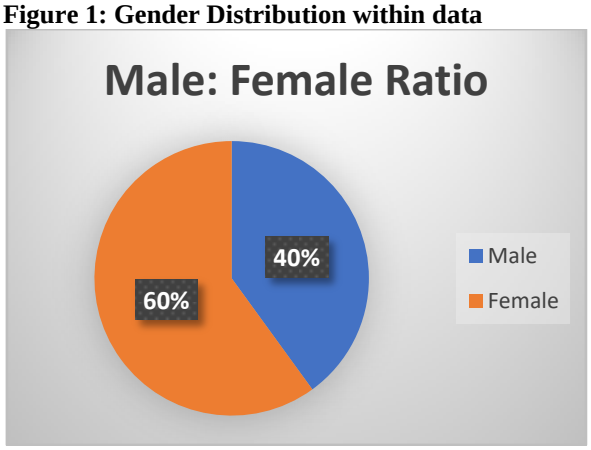


Table 2: Correlational Analysis:

Variables	ʃ	p-Value
SLUM	0.952	<0.0001*
ACE III	0.976	<0.0001*

Abbreviations: ʃ: Spearmann Correlation Coefficient; SLUMS: Saint Louis Mental Status Examination; ACE-III: Addenbrooke's Cognitive Examination Scale

Figure 2: Relationship between CVA and SLUMS

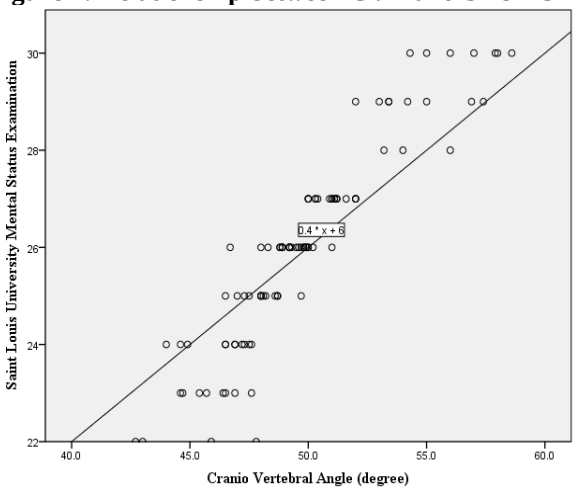
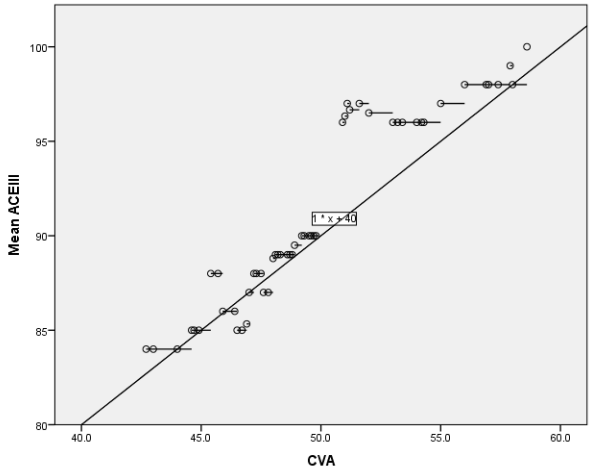


Figure 3: Relationship between CVA and ACE-III



DISCUSSION

Biomechanics of cervical spine causes numerous alterations in overall body mechanics[5]. CVA is an appropriate tool that tends to depict the positioning of cervical spine and head of an individual. This region governs the movement of head with respect to the trunk and lower extremity[4]. Previous studies depict that the abnormalities of postural like lack of coordination or balance impairment directly or indirectly impact the biomechanics of cervical spine[3, 9, 10]. Likewise, there can be direct relationship of reduction in CVA and postural abnormality which tends to effect other parameters as well. Majorly inabilities like postural sway or balance impairment have a significant effect over the cognitive function of an individual[11, 15, 16, 23].

Through the results of this study, it was found that there was a significant relationship between cognitive functioning of an individual and its degree of CVA. Since, this study focused on cognitive functioning evaluation through two tests. Since, two separate tests were used for cognitive evaluation, it was found that both the test had similar findings with respect to testing separate cognitive domains. The reason behind assessing two different scales for cognitive functioning was to ensure all cognitive domains were tested. It was found that participants who had CVA reduced than normal (i.e., 53 degrees)[4] had mild to moderate delay in cognitive functioning, which was not in line with the previous literature which evaluated effect of posture on cognition and mood since the study was conducted only on sedentary participants and included workspace activity [24]. The findings of this study could be justified with the fact that even mild pain at any instance can have deviated attention and prolonged pain or pain related issues can impact the cognitive functionings [25].

Among all the domains tested, majority of the participants with reduced CVA had specific deterioration within the short-term memory, attention, executive function and comprehensibility. The results depicted that attention was majorly influenced in individuals with abnormal cervical posture which is in line with the literature that suggests that attention and posture of an individuals are co-dependent [26]. Deterioration within short term memory and executive functioning could be justified with the fact that even other literatures suggest the implication of motor and somatosensory inputs over attention and its deficits in individuals [27]. The study revealed that there was no effect of degree of CVA over fluency, language, visuo-spatial orientation and mathematical abilities. However, the study also found that the participants with reduced CVA had only mild impairment which did not bother their daily routine activities.A distinctive finding within the data was reported that the females who were homemakers had reduced CVA possibly due to prolonged usage of mobile phone and tablets.

Participants were also interviewed for their engagement in physical activity as per their perception in a single day which turned out to be relatively lower (2 hours per day as Median value) which could be a justification for the deterioration within the cognition [28]. This study had some limitations as well. Since, it was a preliminary study the sample size selected was small and thus generalization of the result is doubtful secondly, there were no outcomes assessed for estimation of reaction time and quality of life in such individuals. Through this study, future recommendations within the subject can be proposed that evaluating usage of screens or mobile phone and their relationship with cognition can be studied, future studies having a larger sample size, incorporating cognitive assessment along with assessment of both reaction time and quality of life, and inclusion of participants irrespective of their profession must be done for future references.

CONCLUSION

This study depicts a significant and strong association between the varying degrees of CVA and the cognitive functioning of an individual. There was a statistically significant impact of reduced CVA over attention, memory, comprehensibility and executive functioning of individuals.

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