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Association of variations in Cranio-vertebral Angle and Vascular Parameters in patients with Forward Head Posture: A cross-sectional study

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Author Contribution:
Ms. Apoorva Srivastava has conceptualized and investigated the study along with writing of manuscript. Dr. Digvijay Sharma has reviewed the manuscript, performed final analysis and has supervised the study.

ABSTRACT

Cranio-vertebral Angle (CVA) is an estimate of the degree of alignment and cervical musculature which not only maintains the posture of the neck but also tends to impact significantly its physiological and biomechanical aspects. The aim of the study was to analyse the association between CVA and vascular parameters such as blood pressure, peripheral oxygen saturation and heart rate. It was a cross-sectional study which recruited patients with Forward Head Posture (FHP). Patients with Forward Head Posture, i.e., Cranio-Vertebral Angle < 53 degrees aged between 18 to 35 years irrespective of their gender and BMI were included within the study. A sample size of 100 participants was selected through purposive sampling technique. The outcome measure for measuring FHP was CVA using MB Ruler software, Blood pressure was measured using a standard sphygmomanometer, heartrate and oxygen saturation were measured using a standard oximeter. Normality was assessed using Kolmogorov Smirnoff Test which yielded parametric distribution of the data (since p-value > 0.05). The difference between the values of CVA and vascular parameters of the three instances were analysed using ANOVA. The correlational analysis using Pearson Correlational Coefficient suggests a strong positive correlation existing between CVA and POS while a strong negative correlation existing between CVA, SBP, DBP and HR. The overall power of the study yielded p-value of 0.009 and d value of 0.6 suggesting that good strength of the study. The main strength of study suggests strongly that CVA should be analysed in three different setups that is sitting posture, standing posture and concentration posture as analysed within this trial since its effect are varied all vascular parameters. Thus, it can be concluded that reduction in the CVA as in case of FHP can trigger the vascular parameters leading to further deterioration of health within such individuals. These vascular parameters constituting blood pressure both systolic and diastolic, peripheral oxygen saturation and heart rate can impact the interventions too being rendered to patients with FHP.

KEYWORDS: Cranio-vertebral Angle, Forward Head Posture, Blood Pressure, Heart Rate, Oxygen Saturation

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INTRODUCTION

Cranio-vertebral Angle (CVA) is an estimate of the degree of alignment and cervical musculature which not only maintains the posture of the neck but also tends to impact significantly its physiological and biomechanical aspects. [1] Due to its location, the cervical spine impacts the basic physiological parameters of the body which overall demand functional outcomes of an individual. Previous researches published within the scope of cranial region and its physiological responses paid attention to the postural abnormalities it can create at various other joints of the body.[2]

However, there are various literatures present that suggest a relationship between the biomechanical and physiological aspects as well.[1] These literatures suggest that not only postural abnormalities but disorders of the vascular system involving the blood parameters and oxygen saturation can also be sincerely impacted by the presence or absence of any sort of deformity within the spinal region.[3, 4] However there has been lesser discussion on the variations between measurement and misalignment of this angle.

Cervical region being crucial due to presence of the blood brain barrier near to it can have multiple complications to the vascularity of the body.[4] Although there are researches which define that assessment of this cranio-vertebral region can be in different forms but there is no such literature existing which defines that whether there is a direct relationship between alignment of CVA and vascular parameters of the body or whether there is a direct relationship between the changes in assessment of CVA. Thus, the aim of the study was to analyse the association between CVA and vascular parameters such as blood pressure, peripheral oxygen saturation and heart rate. Another aim of the study was to identify whether change in mode of assessment of CVA impacts the changes within these vascular parameters.

METHODOLOGY:

Study Design: It was a cross-sectional study

Ethical Considerations: The study is a part of a doctoral study and is in line with all the Ethical Guidelines. The study has been approved from the Institutional Ethical Committee of Chhatrapati Shahu Ji Maharaj University and is registered on Clinical Trial Registry and was conducted in line with the guidelines of the Declaration of Helsinki (Revised 2013).

Study Participants: Patients with Forward Head Posture

Inclusion Criteria: Patients with Forward Head Posture, i.e., Cranio-Vertebral Angle < 53 degrees aged between 18 to 35 years irrespective of their gender and BMI were included within the study.

Exclusion Criteria: Patients suffering from any lifestyle disorder like diabetes, hypertension, hypotension, any sort of musculoskeletal impairment apart from reduced CVA and its complications, any sort of eye disease or tumor, any neurological, cardio-pulmonary or gynaecological impairment were excluded from the study.

Sample Size & Sampling: A sample size of 100 participants was selected through purposive sampling technique.
Outcome Measures: The outcome measure for measuring FHP was CVA using MB Ruler software, Blood pressure was measured using a standard sphygmomanometer, heartrate and oxygen saturation were measured using a standard oximeter.

Procedure: All participants were screened for the inclusion criteria, on selection of participants assessed for the degree of their CVA through photographometery analysis. This was carried out using digital camera placed at a distance from the participant and using MB Ruler software.[5] If the CVA was less than or equal to 53 degrees they were recruited within the trial.[6] The participant was then asked to fill an Informed Consent for the study and then they were asked to stand comfortably against a wall where their CVA was reassessed and post assessment their blood pressure was measured using a standard sphygmomanometer, peripheral oxygen saturation and heart rate was measured using a standard pulse oximeter. After this, the participant was made to sit comfortably in a chair for 3 minutes and then re-assessment of all the vascular parameters mentioned above were analysed. Post second assessment, the participants were asked to concentrate over the laptop screen placed 15 cm apart from their chair over a table and were asked to watch the video played on it with full concentration so that they may answer questions related to the video post assessment. After 4 minutes when the participant was completely occupied with the video, their CVA was re-assessed and their vascular parameters were again analysed as third assessment.

RESULT:

Statistical Analysis was performed using Statistical Package for Social Sciences (SPSS) version 20.0. Normality was assessed using Kolmogorov Smirnoff Test which yielded parametric distribution of the data (since p-value > 0.05) (depicted in **Table 1**). The difference between the values of CVA, Systolic Blood pressure (SBP), Diastolic Blood pressure (DBP), Peripheral Oxygen Saturation (POS) and Heart Rate of the three instances were analysed using ANOVA (depicted in **Table 2**). Correlation between the CVA and vascular parameters was assessed using Pearson's Correlational coefficient (depicted in **Table 3**). This correlational analysis suggests a strong positive correlation existing between CVA and POS while a strong negative correlation existing between CVA, SBP, DBP and HR. The post hoc analysis was done using Tuskey's HSD test for analysis and to analyse power of the study. Through post hoc testing it was found that the blood parameters while concentrating were more disturbed than sitting and standing position. The overall power of the study yielded p-value of 0.009 and d value of 0.6 suggesting that good strength of the study.

Table 1: Normality testing of the data:

S.No.	Variables	Mean ± SD	p-value
1.	Age (in years)	25.64 ± 5.4	0.894
2.	Height (in cms)	161 ± 10.58	0.678
3.	Weight (in kgs)	69.60 ± 8.22	0.421
4.	BMI (in kg/m^2)	24.68 ± 4.2	0.323
5.	CVA (in degrees) (Standing)	49.76 ± 4.25	0.08
6.	CVA (in degrees) (Sitting)	51.2 ± 3.25	0.674
7.	CVA (in degrees) (Concentrating)	48.21 ± 1.12	0.345
8.	SBP (mmHg) (Standing)	143.2 ± 2.3	0.23
9.	SBP (mmHg) (Sitting)	138.32 ± 3.1	0.897
10.	SBP (mmHg) (Concentration)	152.47 ± 2.22	0.65
11.	DBP (mmHg) (Standing)	98.7 ± 3.4	0.098
12.	DBP (mmHg) (Sitting)	94.32 ± 2.21	0.095
13.	DBP (mmHg) (Concentration)	100.43 ± 1.2	0.10
14.	POS (%) (Standing)	97.3 ± 1.12	0.065
15.	POS (%) (Sitting)	98.34 ± 2.23	0.078
16.	POS (%) (Concentration)	94.35 ± 4.41	0.094
17.	HR (per minute) (Standing)	102.3 ± 2.3	0.346

18.	HR (per minute) (Sitting)	91.21 ± 3.4	0.789
19.	HR (per minute) (Concentration)	113.21 ± 1.98	0.453

Abbreviations: SD: Standard Deviation; p-value: Significant value; BMI: Body Mass Index; CVA: Cranio-vertebral Angle; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure, POS: Peripheral Oxygen Saturation, HR: Heart Rate

Table 2: Between Variable Analysis:

S.No.	Variables	F-value	p-value
1.	CVA	4.15	0.001
2.	SBP	4.23	0.0.12
3.	DBP	3.23	0.026
4.	POS	2.45	0.049
5.	HR	4.38	0.009

Abbreviations: p-value: Significant value; CVA: Cranio-vertebral Angle; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure, POS: Peripheral Oxygen Saturation, HR: Heart Rate

Table 3: Correlation of CVA with vascular parameters:

S.No.	Variables	(r)	(p-value)
1.	CVA_Standing & SBP_Standing	-0.41	0.001
2.	CVA_Sitting & SBP_Sitting	-0.37	0.0211
3.	CVA_Concentration & SBP_Concentration	-0.68	0.026
4.	CVA_Standing & DBP_Standing	-0.321	0.029
5.	CVA_Sitting & DBP_Sitting	-0.52	0.003
6.	CVA_Concentration & DBP_Concentration	-0.598	0.039
7.	CVA_Standing & POS_Standing	0.65	0.042
8.	CVA_Sitting & POS_Sitting	0.52	0.001
9.	CVA_Concentration & POS_Concentration	0.47	0.012
10.	CVA_Standing & HR_Standing	-0.35	0.001
11.	CVA_Sitting & HR_Sitting	-0.511	0.001
12.	CVA_Concentration & HR_Concentration	-0.492	0.001

Abbreviations: (r): Pearson Correlation Coefficient; p-value: Significant value; CVA: Cranio-vertebral Angle; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure, POS: Peripheral Oxygen Saturation, HR: Heart Rate

DISCUSSION:

Involvement of vascular parameters in the study of alignment and misalignment of body can be a useful tool in the assessment of overall function of an individual suffering from Forward Head Posture.[7] This is the first study by far that assess blood parameters and their values in patients suffering from postural misalignments and even with the changes within the assessment technique can hamper the vascularity of an individual. Through this study it is reported that patients suffering from FHP due to reduced CVA had increased systolic and diastolic blood pressure values, decreased saturation and mild to moderate increase within the heart rate within an individual.

It was seen within the study that participants suffering from angles lesser than 53 degrees had developed hypertension like symptoms. These findings were further confirmed when separate analysis of groups were performed which stated that when the participants concentrated at a single point such in the case of group C participants, the blood pressure values and parameters were disturbed to a larger extent as compared to participants of the Group B and Group A. Most of the participants within Group C had moderate level of changes within their blood pressure parameters as compared to Group A and Group B. these findings are

in line with the previous literatures published within this respect. Previously published literatures suggest that these findings are due to the physiological characteristics like increased activity of the sympathetic nervous system and the increase in the cardiac output.[8, 9]

Another key finding of the study is that through changes within the CVA of an individual impacts the changes within the heart rate of an individual. The study suggests that as CVA gets reduced the individual's heart rate increases and may also report tachycardia like symptoms which can affect the overall functional degradation of an individual's health. Previous literatures suggest the same findings and explained them on the basis of fluctuations within the sympathetic and parasympathetic nervous system and malfunctioning of the baroreceptors present at the carotid region.[10] Since the cervical region is in close connection to the carotid sinus and aortic arch, any deformation in the cervical spine or it's anterior translation can instigate the baroreceptors to increase the blood output rate from the aortic arch making it a situation for increase in the baroreflex sensitivity.[11]

Peripheral oxygen saturation is usually vulnerable and sensitive output that can be hampered with any minute declamation and deformations at the heart rate and cardiac output.[12, 13] The results of peripheral oxygen saturation within this study suggests that any immediate changes within the oxygen saturation was perceived as soon as the position of the participant changed. This change was then resolved when the participant's posture was stabilised for 1-2 minutes. This suggested that there were immediate changes within the oxygen saturation on posture's malalignment but these changes were not permanent when analysed on the longer run. These studies were also supported with previous literatures that mentioned the same physiological corrections stating the reason for increase in the heart rate, cardiac output and blood pressure parameters.[14, 15, 16] Some literatures also suggest that these findings of the oxygen saturation variation are due to the compression or compromise of the airways when the head is shifted anteriorly, reducing further the oxygenation of the blood and reducing the lung volume.[17]

The main strength of study suggests strongly that CVA should be analysed in three different setups that is sitting posture, standing posture and concentration posture as analysed within this trial since its effect are varied all vascular parameters. Also, this study supports the previously published literatures which suggest that vascular parameters are significantly influenced with any changes within the cervical region posture and that CVA can be useful in diagnosing and treatment of patients suffering from such anomalies. However, there are some limitations to the study as well. There was no prior sample size calculation done for the study and thus power analysis was performed. Secondly the population studied had no further analysis of the BMI of collected data. Thus, in future studies that analyse these vascular parameters based on BMI of individuals, treatment approaches fir blood pressure and tachycardia using interventions for FHP can also be performed.

CONCLUSION:

Reduction in the CVA as in case of FHP can trigger the vascular parameters leading to further deterioration of health within such individuals. These vascular parameters constituting blood pressure both systolic and diastolic, peripheral oxygen saturation and heart rate can impact the interventions too being rendered to patients with FHP.

Conflict of Interest

There is no conflict of Interest among the Authors

Financial Support Statement

This study did not receive any financial support

Approval Reference Number

This study was a part of a doctoral study registered under the Clinical Trial Registry with registration number CTRI/2023/10/058581.

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