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Cephalometric evaluation of cervical column curvature with respect to sagittal jaw position

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Abstract
Introduction: There is variability in literature regarding association of spatial orientation of cervical column to anteroposterior position of jaws. The aim of this study was to examine whether any relation does exist between the two.
Materials and methods: Lateral cehalograms of 90 subjects were traced and various parameters associated with cervical column curvature were measured and related to sagittal jaw positions using statistical analysis consisting of descriptive statistics and intergroup comparison to find the level of significance for each parameter.
Results: Craniovertical angle was shown to have a statistically significant difference in all three groups. Also modified cervical angle (MCA) was shown to be significantly different in group A and group B. Lordotic curvature was found not to have a significant relation on different sagittal jaw position.
Conclusions: Modified craniocervical angle and craniovertical angle can be used to assess relation between cervical column curvature and sagittal jaw position.

Keywords: Modified cranial angle, cervical column curvature, sagittal jaw position, cervical vertebrae

1. Introduction
The association of anatomy and position of cervical vertebrae and dentofacial morphology has been a topic of inquisitiveness as is proved by the presence of various studies based on this subject. Most of these studies (both cross - sectional and longitudinal) were conducted on cephalograms and considered variables considering both anatomy [1, 2] and postural orientation of cervical vertebral column [3, 4].
There is a biomechanical association between position of head and cervical vertebrae and they form a single unit in static as well as dynamic interactions due to anatomic closeness [5]. Prorioception to orofacial region is essential for control of head and in turn body position [6].
The morphology and spatial position of cervical vertebrae have been shown to be related to various factors like: ethnicity [1, 7], gender [8, 9], age [10], stature [11], and craniofacial morphology [12]. Position and morphology of first cervical vertebra has been associated with variables like nasorespiratory function [13, 14], and orthodontic therapy, e.g. removable orthodontic appliances and removable splints to increase the vertical occlusal dimension [15] and to the use of anterior repositioning devices in the treatment of children with skeletal Class II malocclusions [16].
It was observed that position of cervical column had an association with mandibular length, with the finding that cervical column was more towards horizontal side when mandible was longer [17].Longer mandibles were also associated with a straighter cervical column [18]. Many authors agree on a link between head posture and facial morphology with the observation that extended head posture was associated with increased anterior facial height, decreased mandibular length and vice versa [4, 18]. Also a relation has been observed between growth pattern and cervical posture with a rduced forward rotation of mandible with extension of neck [19, 20].
Deviations in spatial orientation of cervical vertebrae have been found to be associated with craniofacial syndromes, cleft lip and palate as well as in sleep apnea [21, 22]. Literature does have contradicting views with some studies totally negating the influence of cervical posture on position of jaws [23, 24].
Using a parameter of the relative relation of the jaws will be valuable while considering correlation of both jaws simultaneously with another factor such as the cervical column

curvature. This would enhance the treatment prognosis. Cervical column curvature determination has been ascertained using different parameters in different studies [20, 25]. It is a well known fact that relation of maxilla to mandible in all three dimensions is of utmost importance in orthodontics and it has been found that cervical posture does effect it and hence is the aim of this study.

2. Materials and methods

The study was carried out on the patients received in the Out-Patient Department of the Department of Orthodontics & Dentofacial Orthopaedics, Government Dental College & Hospital, and Srinagar. The sample for this study consisted of 90 subjects which included 43 males and 47 females. Those subjects between the age group of 15-35 years, who did not undergo any prior orthodontic treatment and had a full complement of permanent teeth up to 2nd molars were selected for the study. It was ensured that the subjects selected had no caries or missing teeth, periodontal problem, TMJ abnormality any associated syndrome and had not undergone any surgery. Lateral standardized cephalograms were taken by a single operator using the same X-ray device and a standardized procedure, with cephalograms being taken in Natural Head Position based on the work of Solow and Tallgren [3]. The cephalograms were made with the mandible in the intercuspal position with an anode to midsubject distance of 5 feet. Thyroid shield and lead apron were worn by the subject to reduce radiation exposure. The procedure was approved by the ethical committee of the institution and a written consent was obtained from each participant. Lateral cephalogram was traced upon an A4 size acetate paper with a 2B or 3HB hard lead pencil over well-illuminated viewing screen. The linear measurements were recorded with a measuring scale up to a precision of 0.5mm. The angular measurements were analysed with a protractor up to a precision of 0.5°. The reference points and planes used are shown in Figure 1.

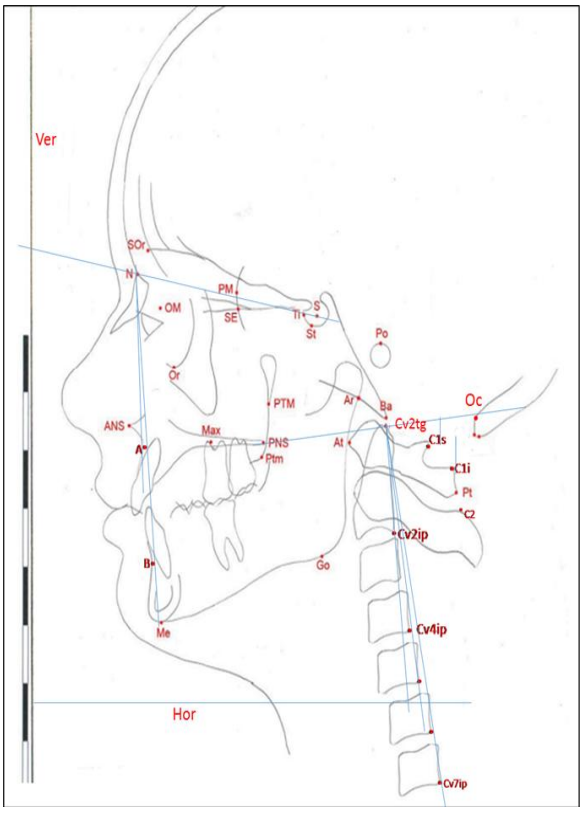

Fig 1: Cephalometric points, planes, and parameters.

2.1 Definition of reference points:

N: Nasion, most anterior point of frontonasal suture [26].
A: Point A, most posterior point of the anterior curvature of the alveolar maxillary process [26].
B: Point B, most posterior point of the anterior curvature of the alveolar mandibular process [26].
S: Sella, center of the sella turcica [26].
Cv2tg: Point most superior and posterior of the odontoid body [4].
Cv2ip: Point most posterior and inferior of the odontoid body [4].
Cv4ip: Point most posterior and inferior of C4 [4].
PNS: Posterior nasal spine, most posterior point of the maxillary at palatal level [27].
Oc: Occipital point, the most inferior point of the occipital bone [28].
C1s: Point C1s, most superior and posterior point of the posterior arch of the atlas bone [28].
C1i: Point C1i, most inferior and posterior point of the posterior arch of the atlas bone [29].
C2: Point C2, most superior and posterior point of C2 spinous apophysis [29].
Cv7ip: Point most posterior and inferior of C7 [30].

2.2 Definition of reference planes

Ver: True vertical
Hor: True horizontal
SN plane: Plane formed by joining point sella and point nasion.
Mc-Gregor plane: Plane formed by joining poaterior nasal spine and Occipital point.
OPT plane: Plane formed by joining Cv2tg and Cv2ip
CVT plane: Plane formed by joining Cv2tg and Cv4ip
Following parameters were used in the study:

Angular parameters

a) ANB
b) SN -Ver
c) OPT- Hor
d) MCA
e) CVT- Hor

2.3 Definition of angular parameters

ANB: This represents the difference between SNA & SNB angles [26] and determines the anterioposterior relationship of the maxillary and mandibular bases.
SN- Ver: Angle between Sella Nasion plane and true vertical. Inferior and external angle [4].
OPT- Hor: Angle between OPT plane and true horizontal [4].
CVT-Hor: Angle between CVT plane and true horizontal [4].
MCA: Angle between CVT plane and OPT plane [28].

Linear parameters

a) Lordotic curvature
b) Superior space
c) Inferior space

2.4 Definition of linear parameters

Lordotic curvature: a tangent is drawn from Cvt2tg to Cv7ip (Penning technique) [31]; and from the midpoint of the deepest vertebra a perpendicular is drawn to this tangent and this perpendicular is measured.

Superior space: Distance between the tangent of the occipital base delimited for Mc Gregor plane and C1s point [28].

Inferior space: distance between point C1i and point C2 [29].
ANB was used to divide the sample into three groups:
Class I: ANB; $(1\text{-}4)^0$
Class II: ANB; $(> 4^0)$
Class III: ANB $(< 1^0)$
32 subjects were found to be in Class I group, 31 in Class II group, and 27 in Class III group.

2.5 Statistical analysis: The statistical analysis of data was carried with the help of means, ranges and standard deviations. Inter group mean values were compared and Student's t-test was used to test the difference between means of various variables. In the statistical evaluation, the following levels of significance were used.
$P>0.05$ Non-significant
$0.05 \geq P>0.01$* Significant
$0.01 \geq P>0.001$** Highly significant
$P \leq 0.001$*** Very highly significant

3. Results
Descriptive statistics for each variable was calculated as seen in table 1.

Table 1: Descriptive statistics including mean and standard deviation for all variables in three groups.

S. No.	Parameter	Class I	SD	Class II	SD	Class III	SD
1.	SN- Ver (^{0})	98.71	4.22	99.3	3.99	96	4.4
2.	OPT- Hor (^{0})	92.20	6.90	93.4	7.8	95.4	7.3
3.	MCA (^{0})	3.98	3.33	6.7	2.8	5.75	2.5
4.	CVT- Hor (^{0})	89.41	7.24	88.6	7.03	90.01	6.98
5.	Lordotic curvature (mm)	5.70	3.02	6.5	3.42	5.3	3.36
6.	Superior space (mm)	6.33	2.4	6.7	2.29	7.5	1.99
7.	Inferior space (mm)	4.72	2.53	5.5	1.86	6.01	2.36

Group wise comparison of all the variables was done in order to find whether the difference was statistically significant or not as seen in table 2, table 3 and table 4. It was seen that difference between SN-Ver was statistically significant in all the three groups. Also statistically significant differences were observed between variable MCA in A group and B group. No significant difference was observed in C group with respect to this variable No significant difference was observed with respect to variable, lordotic curvature in all the three groups. Superior space and inferior space were shown to have significant difference in B group. OPT-Hor was found to have significant difference in group B.

Table 2: Comparison of variables between Class I and Class II group (A).

S.no.	Parameter	Class I	Class II	P-Value
1.	SN- Ver (^{0})	98.71	99.3	0.0112 *
2.	OPT- Hor (^{0})	92.20	93.4	0.5199
3.	MCA (^{0})	3.98	6.7	0.0009***
4.	CVT- Hor (^{0})	89.41	88.6	0.6541
5.	Lordotic curvature (mm)	5.70	6.5	0.3285
6.	Superior space (mm)	6.33	6.7	0.5339
7.	Inferior space (mm)	4.72	5.5	0.1694

Table 3: Comparison of variables between Class I and Class III group (B).

S. No.	Parameter	Class I	Class III	P-Value
1.	SN- Ver (^{0})	98.71	96	0.0192*
2.	OPT- Hor (^{0})	92.20	95.4	0.0893*
3.	MCA (^{0})	3.98	5.75	0.0268 *
4.	CVT- Hor (^{0})	89.41	90.01	0.7484
5.	Lordotic curvature (mm)	5.70	5.3	0.6321
6.	Superior space (mm)	6.33	7.5	0.0487*
7.	Inferior space (mm)	4.72	6.01	0.0490 *

Table 4: Comparison of variables between Class II and Class III group (C).

S. No.	Parameter	Class II	Class III	P-Value
1.	SN- Ver (^{0})	99.3	96	0.0041**
2.	OPT- Hor (^{0})	93.4	95.4	0.3200
3.	MCA (^{0})	6.7	5.75	0.1811
4.	CVT- Hor (^{0})	88.6	90.01	0.4478
5.	Lordotic curvature (mm)	6.5	5.3	0.1844
6.	Superior space (mm)	6.7	7.5	0.1642
7.	Inferior space (mm)	5.5	6.01	0.3618

4. Discussion
In this study all the subjects were in the age group of 15-35 years of age. The effect of age was not considered in this study. Some studies agree on the fact that postural variables are independent of age [31, 32]. But some studies report the effect of age on these variables and observed that there was a decrease in cervical lordiosis as the age increased [33].
Statistically significant relations were observed between only some postural variables and sagittal relationship of the jaws. Some studies have reported a totally nonsignificant relation between sagittal position of jaws and cervical variables [34] and some have reported the opposite [27, 29]. The difference

between the present study and other studies may arise due to difference in slection and classification of sample.

In this study craniovertical angle (SN- Ver) was found to be maximum in Class II group and least in Class III group. This in agreement with a study conducted on Chinese children [35].

Also OPT-Hor angle (inclination of superior part of cervical column) was found to be associated significantly with sagittal position of the jaws with highest value for Class III group and lowest in Class I group. This suggests that a more straight cervical column in Class III patients. This is in disagreement with other studies [28] which did not find any any association between this angle and sagittal position of jaws.

The angle CVT-Hor (inclination of middle part of cervical column) was also found to be greatest in Class III group and lowest in Class II group. This is similar to what another study had concluded that highest values are observed in Class III subjects [36].

Modified cervical angle [37] is used to determine curvature of cervical column in this study. This angle was chosen as it has a close relation with cervical curvature and can be measured easily. Highest value was found to be in Class II group suggesting that Class II malocclusion was associated with increased curvature of cervical column as compared to Class I and Class III malocclusion. This finding is similar to other studies [39] which also reported a similar finding.

Superior and inferior spaces were found to be lowest in Class I group and highest in Class III group suggesting a backward position of head in Class I group as compared to Class II and Class III group.

Class I and Class III presented low values of lordotic curvature as compared to Class II. This is in agreement with a study which reported lowest value of lordotic curvature in Class III subjects [27] and contarary to another study [39] which reported a decreased lordotic curvature in Class II subjects.

5. Conclusions

1. Modified cervical angle (MCA) was found to be significantly increased in Class II group.
2. Inclination of superior and middle part of cervical column was found to be lowest in Class III group but the difference was not statistically significant.
3. Head was backwardly positioned in Class I subjects as compared to Class III subjects.

6. Limitations and future directions

In this study factors like age, sex are not considered. Also from this study it cannot be concluded that whether cervical curvature is affected by malocclusion or vice-versa. Hence studies in which some variables are kept constant and others are studied with respect to them, should be conducted to understand the cause and effect relationship. Factors like age and sex should be considered.

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