Original Article

# Relationship Between Craniocervical Posture and Vertical Face Pattern in Class II Division 1 Malocclusion

**Saba Sikandar,[1] Naseer Ahmad Chaudhry,[2] Muhammad Imran Rahbar,[3] Asim Riaz,[4] Muhammad Mohsin Kamal,[5] Farhan Ali[6]**

**Abstract**

**Objective:** To evaluate the cervical inclination and craniocervical posture (CCP) in a sample of Class II Division 1 malocclusion with different vertical patterns among adult population in Lahore.

**Method:** A total of 70 adult skeletal Class II division 1 cases (ANB0 > 4) with Dental Class II malocclusion (molar relation half cusp or full cusp Class II) and Overjet > 5mm, were enrolled in this study. Clinical examination and lateral cephalograms taken in natural head position were traced to classify the malocclusion, determine vertical pattern and evaluation of craniocervical posture.

**Results:** Results of the study showed that extended craniocervical posture (forward cervical inclination with backward head rotation) was found in 47.1 % of the study group and was significantly correlated to the vertical pattern of the face (r = 0.496, p =0.000). This indicated that the CCP is not only related to sagittal craniofacial relations but also vertical pattern of the face and as the vertical pattern of face increased the cervical spine inclined forward and the head rotated backwards on spine. Flexed head posture was found to be the least prevalent. Subjects with high vertical pattern of facial development had extended CCP whereas subjects with normal vertical pattern mainly had normal CCP.

Conclusion: Results of this study suggest a significant relationship between Type of malocclusion and craniocervical posture. There was a moderately strong relationship between vertical pattern of the patient and cervical inclination and craniocervical posture which was highly significant.

**Keywords:** Class II division 1, Craniocervical posture, Malocclusion.

**How to cite:** *Sikandar S, Chaudhry NA, Rahbar MI, Riaz A, Kamal MM, Ali F. Relationship Between Craniocervical Posture and Vertical Face Pattern in Class II Division 1 Malocclusion. Esculapio - JSIMS 2023;19(02):241-246*

***DOI: https://doi.org/10.51273/esc23.2519221***

## Introduction

Posture refers to the alignment of body parts. Craniocervical posture is alignment of the neck in space and alignment of head in relation to neck.[1]

Craniocervical junction is defined as the region comprising the occiput, atlas and axis, as well as ligaments and other associated structures. They are specialized to allow a wide range of head movement in flexion, extension, lateral bending, and lateral rotation.[2]

Cranium, face and cervical spine are adjacent structures acting in synergy to provide complex stomatognathic functions. These are functionally related and mutually influenced.

A forwardly inclined cervical column with extended head is collectively called a forward head posture. D`Attilio et al found that the lower part of cervical spine is strongly related to the size and position of the mandible in sagittal plane specially.[3] A recent systematic review concluded that increased cervical inclination is associated with the posterior mandibular position.[4] On the contrary research on adult Pakistani population reported that only cervical curvature is weakly correlated with the skeletal malocclusion and cervical inclination is

1-4. Department of Orthodontics, FMH College of Medicine and Dentistry
5. Community & Preventive Dentistry Department, FMH College of Medicine & Dentistry,
6. Department of Orthodontics., Multan Medical and Dental College,

**Correspondence:**
Dr. Saba Sikandar. *Senior registrar, Department of Orthodontics, FMH College of Medicine and Dentistry, Email: saba.sikandar@hotmail.com*

Submission Date: 02-04-2023
1st Revision Date: 22-04-2023
Acceptance Date: 25-05-2023

not associated with it.[5]

Schwartz suggested a relationship between head position and dentofacial morphology.6 When the head tilts back on cervical spine it is considered extended and when it tilts downwards anteriorly it is called flexed head posture. Michael Marcotte related the flexed head posture with Class III malocclusion and concave profile and those with convex profile tended to bend head backward.[7,8]

In a recent study extended head posture was showed to be related to Class II malocclusion, crowding of teeth, Overjet, Overbite, Dental proclination, increased lower facial height and high vertical pattern.[9] The mechanism of this remains unclear. The influence of gravity on craniofacial form is rejected in a recent study.[10] Solow et al gave soft tissue stretching hypothesis which states that as the head posture varies from flexed to extended, the soft tissue envelope stretches and the passive pressure on the underlying skeletal structures increases and redirects their growth.[11] (Fig.1)

This also is supported by Proffit's equilibrium theory, that even the lightest of soft tissue pressure from muscles, fascia and skin maintained over long term and more than 6 hours a day can influence craniofacial skeleton.[12,13]

The cause-and-effect relationship is not yet established but it is now well known that craniocervical posture is a substantial yet neglected factor in development of facial skeleton.

**Fig. 1:** *Soft tissue stretch with change in Craniocervical posture.*[11]

One study emphasized that evaluation of craniocervical posture 2-4 years before the peak pubertal growth can give predictive information about subsequent facial development.[10]

Thus, a comprehensive knowledge of biological and functional dynamics regulating the growth of craniofacial complex is essential for proper diagnosis and treatment planning. It can be speculated that evaluation and intervention to correct faulty head posture may as well server as an interceptive measure against future skeletal jaw disproportion. Moreover, Treatment aiming at both the anatomic and functional disturbances is more likely to be successful and stable in long term. In the light of above discussion, this study aimed to evaluate a craniocervical posture in a subtype of skeletal Class II malocclusion i.e., Class II Division 1 which is more prevalent. No existing study distinguished between Class II Division 1 and Class II Division 2 which are entirely different entities with respect to skeletal, dental and muscular features.[14]

## Materials and Methods

The study was approved by Institutional Review Board of FMH College of Medicine & Dentistry. Informed consent was taken once the sample is selected. The primary outcome variable was the craniocervical posture assessed through cephalometric analysis. Lateral cephalograms of all participants were taken in natural head position and were drawn manually. Outcome variable in terms of various types of craniocervical posture i.e., flexed, normal and extended were noted as per operational definition.

A total of 70 adult skeletal Class II division 1 cases (ANB0 > 4) with Dental Class II malocclusion (molar relation half cusp or full cusp Class II) and Overjet > 5mm, were enrolled in this study. There was absence of history of previous Orthodontic treatment and any bone, muscle or joint diseases. Absence of upper respiratory disease or allergic rhinitis and deviated nasal septum were also ensured.

Reference lines and angles used for cephalometric analysis in Fig.2.

*NSL Nasion-sella plane:* Line through Nasion and Sella points

*SNA angle:* Angular relationship of maxilla to cranial base.

*SNB angle:* Angular relationship of mandible to cranial base.

*ANB angle:* Angular relationship of maxilla to mandible

*MP:* anatomical plane of mandible

*PP:* anatomical plane of maxilla

*HOR:* true horizontal plane, perpendicular to true

vertical plane

*OPT (Odontoid process tangent):* Posterior tangent to the odontoid process. Drawn through the most posterior and inferior point on the corpus of the second cervical vertebra. Represents upper part of column

*CVT (Cervical tangent):* Drawn as posterior tangent to the most posterior and inferior point on the corpus of the fourth cervical vertebra. Represents mid part of cervical column

***Angles that describe the vertical skeletal pattern:***

*SN/MP:* angle formed b/w NSL and MP.

*MMA:* angle formed b/w PP and MP

***Angle that describes the cranial posture with upper part of cervical spine:***

*NSL/OPT;* Angle formed between NSL and OPT

***Angle that describes the cranial posture with middle part of cervical spine:***

*NSL/CVT;* Angle formed between NSL and CVT

***Angles that describe neck position***

*OPT/HOR:* Angle between OPT and true horizontal plane

*CVT/HOR:* Angle between CVT and true horizontal plane

Lateral cephalograms of patients fulfilling inclusion criteria were taken in natural head posture and traced by a single researcher. Maxillary and mandibular skeletal bases were measured by SNA and SNB respectively and ANB angle and Overjet was taken to classify skeletal malocclusion.

Two angles were used to find out vertical skeletal pattern, SN/MP (32+4) and MMA (25+4). The angle SN/MP was taken between Nasion-Sella line and Mandibular plane. MMA was between the anatomical planes of both maxilla and mandible. Vertical pattern was labelled as normal when both of these angles fell within norms. It was considered high when either of the angles was above the normal range and low when either of the angles was below the norms.

Two angles NSL/OPT and NSL/CVT were recorded to define craniocervical posture. Normal range of angle NSL/OPT is 89-105 degrees. Normal range of angle NSL/CVT is 96-112 degrees.

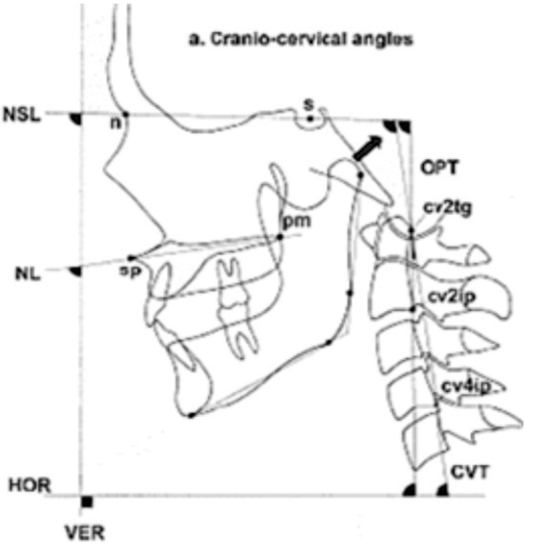


**Fig. 2:** *cephalometric landmarks and planes*

Normal Craniocervical posture is when the value of angle NSL/OPT is within the range of 89-105 degrees. And angle NSL/CVT is within the range of 96-112 degrees.

Extended Craniocervical posture is when the angle NSL/OPT is >105 degrees and angle NSL/CVT is >112 degrees.

Flexed Craniocervical posture is when the value of angle NSL/OPT is <89 degrees and angle NSL/CVT is <96 degrees.

Cervical inclination was measured by two angles i.e., OPT/HOR (93+5) and CVT/HOR (86+4). It is labelled as forward neck inclination if the angle OPT/HOR is <880 and the angle CVT/HOR is <820. Forward neck posture with extended craniocervical inclination is called forward head posture.

## Results

A total of 70 Class II Division 1 cases were enrolled in this study. Data obtained was mainly organized into tables. The mean age of the patients was 21.5±1.9 years with a range of 19 & 26 years respectively. Out of the sample 43 (61%) were females and 27 (39%) were males. Frequency distribution of molar relation showed that there were 38.6% patients were of class 2 and 61.4% patients were end on class II. The results of descriptive statistical analysis of this cross-sectional study are shown in Table 2. Craniocervical posture was determined by two angles, namely NSL/CVT and NSL/OPT. The mean NSL/OPT of the patients was 104.2±8.$^{6}$ degrees with a range of 83-121 degrees. Mean NSL/CVT of the patients was 108.3±7.4 with a range of 89-127 degrees.

(Table 1) With regards to angle made between the mid-section of cervical spine and cranial base i.e., NSL/CVT Craniocervical posture was found to be Extended in 20(28.6%) of the sample, Flexed in 3(4.3%) and Normal in a majority of 47(67.1%). As per angle formed between the upper section of the cervical spine and cranial base i.e., NSL/OPT Craniocervical posture was Extended in 33(47.1%), Flexed in 2(2.9%) and Normal in 35 (50%) of the subjects. (Table 2) The cervical inclination and position were forward in 24.3 % of the sample as per angle OPT/HOR and in 44.3% of population as per angle CVT/HOR. (Table 2)

The vertical skeletal pattern had significant correlation with both the variables i.e., cervical inclination and craniocervical posture (p= 0.000). The correlation was positive with craniocervical angles which means that both the parameters increased in proportion to each other. If the vertical skeletal pattern was high the craniocervical posture was also extended.

The correlation was negative and significant for cervical inclination (P=0.000). This denotes that as the vertical skeletal pattern became high the cervical angles reduced which brought the cervical spine in more forward/ horizontal position in relation to the true horizontal plane. (Table 3)

**Table 1:** *Descriptive statistics of NSL/CVT and NSL/OPT*

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| NSL/CVT | 70 | 89 | 127 | 108.26 | 7.450 |
| NSL/OPT | 70 | 83 | 121 | 104.16 | 8.551 |

**Table 2:** *Descriptive statistics of Craniocervical posture though angle NSL/CVT*

| | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|
| Flexed | 3 | 4.3 | 4.3 | 4.3 |
| Normal | 47 | 67.1 | 67.1 | 71.4 |
| Extended | 20 | 28.6 | 28.6 | 100.0 |
| Total | 70 | 100.0 | 100.0 | |
| **Descriptive statistics of Craniocervical posture through angle NSL/OPT** | | | | |
| Flexed | 1 | 1.4 | 1.4 | 1.4 |
| Normal | 36 | 51.4 | 51.4 | 52.9 |
| Extended | 33 | 47.1 | 47.1 | 100.0 |
| Total | 70 | 100.0 | 100.0 | |
| **Descriptive statistics of cervical inclination as per angle OPT/HOR** | | | | |
| Forward | 17 | 24.3 | 24.3 | 24.3 |
| Normal | 24 | 34.3 | 34.3 | 58.6 |
| Backward | 29 | 41.4 | 41.4 | 100.0 |
| Total | 70 | 100.0 | 100.0 | |
| **Descriptive statistics of cervical inclination as per angle CVT/HOR** | | | | |
| Forward | 31 | 44.3 | 44.3 | 44.3 |
| Normal | 24 | 34.3 | 34.3 | 78.6 |
| Backward | 15 | 21.4 | 21.4 | 100.0 |
| Total | 70 | 100.0 | 100.0 | |

**Table 3:** *Correlation coefficient between craniocervical posture angles, cervical inclination angles and vertical pattern of face:*

| | | SN/MP (face length) | MMA (face length) |
|---|---|---|---|
| NSL/CVT | Pearson Correlation | .475** | .405** |
| | Sig. (2-tailed) | .000 | .001 |
| | N | 70 | 70 |
| NSL/OPT | Pearson Correlation | .496** | .401** |
| | Sig. (2-tailed) | .000 | .001 |
| | N | 70 | 70 |
| OPT/HOR | Pearson Correlation | -.445** | -.423** |
| | Sig. (2-tailed) | .000 | .000 |
| | N | 70 | 70 |
| CVT/HOR | Pearson Correlation | -.420** | -.412** |
| | Sig. (2-tailed) | .000 | .000 |
| | N | 70 | 70 |

## Discussion

Craniocervical posture is the position of the head in a standing or sitting subject. The head is balanced by the post-cervical, suprahyoid, and infrahyoid muscle groups. In the present study, all the lateral cephalograms were obtained in the natural head position. In the present study, the relationship between head posture, cervical inclination and the anteroposterior skeletal relationship was investigated. The frequency of various types of Craniocervical posture in Class II Division 1 malocclusion and cervical inclination was recorded and their correlation with several variables was calculated.

According to this study the highest percentage of craniocervical posture in Class II division 1 was Normal i.e., 51.4 -67.1%. The next most prevalent type of head posture was Extended (posterior head rotation) i.e., 28.6-47.1%; whereas Flexed type of head posture (anterior head rotation) was seen in only 1.4-4.3% of the Class II division 1 sample according to the two angles NSL/OPT and NSL/CVT. Both angles showed moderate

positive correlation with the vertical pattern of the face but did not show any significant correlation with sagittal skeletal variables. This suggested an increase in craniocervical angle along with the increase in vertical height of the face. This tendency was reported in a recent study as a significant increase in lower anterior facial height, maxilla-mandibular plane angle, mandibular angle with the cranial base, and posterior vertical maxillary height with craniocervical extension in Class II malocclusion group[8].

Another study by Aditya et al. related extended craniocervical posture to Class II malocclusion, crowding, increased lower facial height and bimaxillary dentoalveolar proclination[9].

There has been contradicting findings regarding this topic in the literature. Findings of this study do not agree authors who stated there is no difference between craniocervical posture among different malocclusions.[15] In this study the cervical inclination was forward in 24-44% of the sample. Both cervical inclination angles showed negative moderate correlation with vertical pattern of the face which indicated that as the vertical height of the face increases the cervical spine inclines forward. This in turn needs the head to be tilted backwards upon cervical spine to maintain a straight line of sight. These results agree with a recent study reporting that posteroinferior angle of the cervical spine decreased in Class II subjects showing forward neck extension.[16]

Adeel Tahir also reported that there is increased cervical curvature in cervical spine of children of Class II malocclusion which shortens the length of neck resulting in increased cervical spine inclination and increased cranial rotation on spine.[17] These results agree with previous studies in that craniovertical and craniocervical angles significantly correlated with mandibular growth direction and facial development. The correlation coefficients ranged from low to moderate.[18]

Results of this study were found in contradiction with studies of Bernal et al. who did not find any significant difference in cervical inclination or curvature among different classes of skeletal malocclusion.[19] Likewise, D'Attillio et al. found changes in middle part of cervical spine but not in the upper part of it with different skeletal malocclusions.[3] Same results were described by Tauheed S et al. who reported no association between cervical inclination and skeletal malocclusion but found a weak and significant correlation of cervical curvature with the skeletal Class of the patients.[5] Based on a number of studies suggesting a link between a systematic review concluded that significant associations are found between head posture and craniofacial morphology but it should be interpreted with caution as correlation coefficients ranged from weak to moderate[19], which is in agreement with this study.

However, a recent study did recommend that any postural alterations should be corrected as early as possible before the growth spurt so that any disproportion in the development of craniofacial structures is not aggravated and all musculoskeletal systems can be used efficiently to achieve optimum growth.[17]

## Conclusion

Results of this study suggest a significant relationship between Type of malocclusion and craniocervical posture. There was a moderately strong relationship between vertical pattern of the patient and cervical inclination and craniocervical posture which was highly significant. Therefore, it is concluded that craniocervical posture of skeletal malocclusion patients should be evaluated and corrected as part of their Orthodontic treatment plan. This may have significant effects on treatment outcomes and their stability.

**Conflict of Interest:** *None*

**Funding Source:** *None*

## References

1. Khayatzadeh S, Kalmanson OA, Schuit D, Havey RM, Voronov LI, Ghanayem AJ, Patwardhan AG. Cervical spine muscle-tendon unit length differences between neutral and forward head postures: biomechanical study using human cadaveric specimens. Physical therapy. 2017 Jul 1;97(7):756-66.
2. Menezes AH. Anatomy and biomechanics of normal craniovertebral junction and biomechanics of stabilization. Childs Nerv Syst. 2008; 24:1091-100.
3. Peng H, Liu W, Yang L, Zhong W, Yin Y, Gao X, Song J. Does head and cervical posture correlate to malocclusion? A systematic review and meta-analysis. Plos one. 2022 Oct 25;17(10):e0276156.
4. Zokaitė G, Lopatienė K, Vasiliauskas A, Smailienė D, Trakinienė G. Relationship between Craniocervical Posture and Sagittal Position of the Mandible: A Systematic Review. Applied Sciences. 2022 May 25; 12(11): 5331.

5. Tauheed S, Shaikh A, Fida M. Cervical Posture and Skeletal Malocclusions – Is there a Link?JCMS Nepal. 2019;15(1):5-9.
6. Peng H, Liu W, Yang L, Zhong W, Yin Y, Gao X, Song J. Does head and cervical posture correlate to malocclusion? A systematic review and meta-analysis. Plos one. 2022 Oct 25;17(10):e0276156.
7. Suleman Shah SY, Rasool G. Relationship between head posture and lower arch dental crowding. Pakistan Oral & Dental Journal. 2015 Sep 1;35(3).
8. Sandoval C, Díaz A, Manríquez G. Relationship between craniocervical posture and skeletal class: A statistical multivariate approach for studying Class II and Class III malocclusions. CRANIO. 2019 Apr 29.
9. Tankhiwale A RSJ, Agarkar S, Deshmukh S, Manerikar R. Relationship between extended head posture and malocclusion. IP Indian Journal of Orthodontics and Dentofacial Research. 2020;4(1):35-40.
10. Sharmila. R BB, Shalini G J NA. Assessment of correction of cervical hyperlordosis in Class II skeleatl patients with mandibular retrognathism after twin block therapy. IJISRT. May 2022;7(5):217-27.
11. Armijo-Olivo S, Pitance L, Singh V, Neto F, Thie N, Michelotti A. Effectiveness of manual therapy and therapeutic exercise for temporomandibular disorders: systematic review and meta-analysis. Physical therapy. 2016 Jan 1;96(1):9-25.
12. Proffit RW, Fields WH, Larson B, Sarver MD. Contemporary Orthodontics.In: The Etiology of Orthodontic problems.6th ed. Elsvier;2018.pg.124,130.
13. Glaros AG, Fricton J. Oral parafunctional behaviors. Orofacial disorders: Current therapies in orofacial pain and oral medicine. 2017:115-25.
14. Saghiri MA, Eid J, Tang CK, Freag P. Factors influencing different types of malocclusion and arch form–A review. Journal of Stomatology, Oral and Maxillofacial Surgery. 2021 Apr 1;122(2):185-91.
15. Bernal LV, Marin H, Herrera CP, Montoya C, Herrera YU. Craniocervical posture in children with class I, II and III skeletal relationships. Pesquisa Brasileira em Odontopediatria e Clinica Integrada. 2017;17(1):1-2.
16. Pradeep S, Venkatasubramanian P, Parameswaran R, Vijayalakshmi D. Quantitative Analysis of Body Posture and Its Correlation with Cervical Posture in Various Malocclusions. Research Square.2021 Feb 05;1-29.
17. Kamal AT, Fida M. Evaluation of cervical spine posture after functional therapy with twin-block appliances: A retrospective cohort study. American Journal of Orthodontics and Dentofacial Orthopedics. 2019 May 1;155(5):656-61.
18. Alexa VT, Fratila AD, Szuhanek C, Jumanca D, Lalescu D, Galuscan A. Cephalometric assessment regarding craniocervical posture in orthodontic patients. Scientific Reports. 2022 Dec 16;12(1):21729.
19. Bernal VL, Marin H, Herrera PC, Montoya C, Herrera UY. Craniocervical Posture in Children with Class I, II and III Skeletal Relationships. Pesq Bras Odontoped Clin Integr 2017, 17(1):e3038.

## Authors Contribution

**SS:** Conceptualization of Project
**AR, SS:** Data Collection
**IR:** Literature Search
**NAC:** Statistical Analysis
**FA:** Drafting, Revision
**MMA:** Writing of Manuscript