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Cranial Base Measurements in Skeletal Malocclusion among Orthodontic Patients

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ABSTRACT

Background: Facial growth and development is necessary for proper orthodontic diagnosis and treatment planning. Growth of cranial base is linked to the overall growth of facial bones, especially the maxilla and mandible. Any change in the amount and direction of growth of the cranial base can have direct or indirect effects on the developing maxilla and mandible. Thus the aim of this study was to determine the linear and angular cranial base measurements in different skeletal malocclusion in Nepalese population.

Methods: Pretreatment lateral cephalograms of 225 patients aged between 17-30 years were collected. Linear measurements Sella-Nasion (S-N), Sella-Articulare (S-Ar), Articulare-Gonion (Ar-Go), Gonion-Gnathion (Go-Gn) and angular measurements Saddle angle (N-S-Ar), Articular angle (S-Ar-Go) and Gonial angle (Ar-Go-Gn) were measured.

Results: In angular measurements statistically significant differences were found in the saddle and gonial angles between class I, II, and III skeletal pattern. In linear measurements, anterior and posterior cranial base lengths were not significantly different among groups however, ramal height and mandibular body length were significantly different among groups with a P value < 0.05.

Conclusions: Skeletal class III has a larger gonial angle, ramal height and mandibular length. Males have larger linear measurements and females have larger angular measurements.

Keywords: Cephalogram; Cranial base; Skeletal malocclusion

INTRODUCTION

The cranial base, which articulates with the maxilla and mandible has the potential to influence growth of cranium and facial structure.[1] Cranial base and its variations in morphology due to change in growth and orientation have always been assumed to affect the antero-posterior relationship of jaws either directly or indirectly.[2,3]

Maxilla is directly attached to the anterior cranial fossa (foramen caecum to sella turcica) through growth sutures and mandible is indirectly attached to the middle cranial fossa (sella turcica to basion) through temporomandibular joint.[4,5] Variations in the cranial base angle and the anterior and posterior lengths can causes imbalance in facial growth and consequently occlusion.[6]

The understanding of facial growth and development is necessary for proper orthodontic diagnosis and treatment planning. Thus the aim of this study was to determine the relationship between cranial base measurements and different type of skeletal malocclusions among orthodontic patients in Nepalese population.

METHODS

A cross sectional study was conducted on 225 lateral cephalograms from the patients visiting Department of Orthodontics People's Dental College and Hospital for orthodontic treatment by non- probability convenience sampling method. Written consent was taken from each participant before pre-treatment record collection on the basis of inclusion and exclusion criteria. This study was done on prospectively collected data from

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November 2022 to April 2023. Ethical approval was obtained from Institutional Review Committee, Peoples Dental College and Hospital before conducting the study [Ref.1.CH No.38.2079/2080].

The inclusion criteria was age 17-30 years, good quality radiographs without image distortion. No history of previous orthodontic treatment, orthognathic surgery, craniofacial anomalies and facial trauma were excluded. Sample size was calculated by using formula $n= z^2x\sigma^2/e^2$ Where, z=1.96, σ = 7.65 from reference article[2], e = 1 = $(1.96)^2 x (7.65)^2 / 1^2 = 225$

Lateral cephalograms were taken in centric occlusion using Sirona Orthophos SL. exposed at 73KV-15mA to 84KV-13mA with cephalostat and 0.64 second exposure time. Lateral cephalograms were manually traced in a dark room under the same standardized technique.

Magnification of radiographs were adjusted using the radiopaque ruler (calibration marker). Points and lines were marked with a 3H pencil. All measurements were performed by the principal investigator to eliminate interexaminer error. The linear and angular measurements derived from Bjork-Jarabak analysis were shown in figure 1. The ANB angle was measured and used to classify skeletal relationships into three groups. Class I: ANB angle 2-4^0; Class II: ANB angle >4^0; and Class III: ANB angle < 2^0.

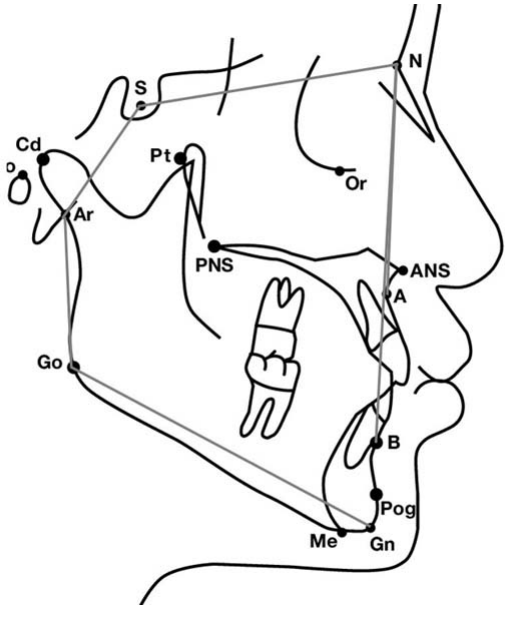

Figure 1. Linear and angular measurements.

Angular measurements: Saddle angle (N-S-Ar), Articular angle (S-Ar-Go) and Gonial angle (Ar-Go-Gn). Linear measurements: Sella-Nasion (S-N), Sella-Articulare (S-Ar), Articulare-Gonion (Ar-Go), Gonion-Gnathion (Go-Gn).

Descriptive analysis (mean and standard deviation) was calculated for all of the measured variables with SPSS version 20 (IBM, Chicago). Analysis of variance was used to assess the differences among groups and multiple pairwise comparisons were assessed by Bonferroni in post hoc test. Gender differences were detected using the independent sample t-test. Level of statistical significance was set at 0.05%.

RESULTS

Majority of study sample were female (65.33%) as compared to male (34.67%). The sample comprised of 62.22% skeletal class I, 20% class II and 17.78% class III cases. In skeletal class I 30.71 % were male and 69.29% were female, class II pattern had 44.44% male and 55.56% were female and in class III 37.5% were male and 62.5% were female (Table 1).

Table 1. Distribution of sample according to the skeletal pattern and gender.

Skeletal Pattern	Male	Female	Total
Class I	43 (30.71%)	97 (69.29%)	140 (62.22%)
Class II	20 (44.44%)	25 (55.56%)	45 (20.00%)
Class III	15 (37.50%)	25 (62.50%)	40 (17.78%)
Total	78 (34.67%)	147 (65.33%)	225 (100%)

The mean and standard deviation of angular and linear measurements of cranial base were shown in Table 2. In angular measurements statistically significant differences were found in the saddle and gonial angles with a P value of < 0.05. However no statistically significant difference were observed in articular angle between Class I, II, and III skeletal relationships (P > 0.05). In linear measurements, anterior and posterior cranial base lengths were not significantly different among groups (P > 0.05). However, ramal height and the mandibular body length were statistically significant among groups (P < 0.05).

The saddle angle was found to be significantly larger in class II compared with class I and class III skeletal pattern (P < 0.05), with a mean difference of 3.22^0 and 4.45^0 respectively. However, there was no significant difference in saddle angle between class I and class III groups (P > 0.05). On the other hand gonial angle was found to be significantly larger in class III compared with

class I skeletal relationships (P < 0.05), with a mean difference of 3.37^0.

The ramal height was larger in class III compared with class I and class II (P < 0.05) with a mean difference of 1.89 mm and 5.60 mm, respectively. Also ramal height was statistically larger in class I compared to class II (P < 0.05), with a mean difference of 3.71 mm. The length of mandibular body was significantly larger in class III compared with class I and class II (P < 0.05), with a mean difference of 3.91 and 5.53 mm, respectively.

Table 2. ANOVA test to assess the difference among groups in different skeletal relationship.

Cranial Base Measurements	Class I Mean (SD)	Class II Mean (SD)	Class III Mean (SD)	Difference Class I to Class II	Difference Class I to Class III	Difference Class II to Class III
Saddle angle	124.91(5.69)	128.13(5.72)	123.68(8.37)	-3.22*	1.23	4.45*
Articular angle	143.49(7.61)	142.67(5.73)	143.68(6.89)	0.82	-0.19	-1.01
Gonial angle	120.61(6.48)	122.69(7.10)	123.98(5.24)	-2.08	-3.37*	-1.29
N-S, mm	70.67(4.75)	72.29(5.34)	72.00(4.23)	-1.62	-1.33	0.29
S-Ar, mm	36.22(3.43)	37.58(4.83)	35.98(3.73)	-1.36	0.24	1.60
Ar-Go, mm	50.24(6.17)	46.53(4.93)	52.13(4.60)	3.71*	-1.89	-5.60*
Go-Gn, mm	77.24(4.84)	75.62(5.48)	81.15(6.26)	1.62	-3.91*	-5.53*

* The mean difference is significant at P < 0.05.

Cranial base measurements according to gender and the mean differences between them were shown in Table 3. Angular measurements were not statistically significant among male and female (P > 0.05) but female showed larger angular values compared to male. Male showed significantly larger anterior (N-S) and posterior cranial base (S-Ar) lengths compared with female (P < 0.05), with mean differences of 5.80 mm and 3.18 mm respectively. Ramal height (Ar-Go) and length of mandibular body (Go-Gn) were also significantly larger in male compared with female (P < 0.05), with mean differences of 5.35 mm and 3.69 mm respectively.

Table 3. Independent sample t-test to detect gender difference.

Cranial Base Measurements	Male Mean(SD)	Female Mean(SD)	Difference Mean
Saddle angle	123.71(5.24)	126.03(6.84)	-2.32
Articular angle	143.26(7.51)	143.51(7.03)	-0.25
Gonial angle	121.60(7.09)	121.82(6.51)	-0.22
N-S, mm	75.00(3.52)	69.20(3.93)	5.80*
S-Ar, mm	38.49(4.31)	35.31(3.14)	3.18*
Ar-Go, mm	53.20(6.34)	47.85(4.94)	5.35*
Go-Gn, mm	80.11(5.19)	76.42(5.30)	3.69*

* The mean difference is significant at P < 0.05.

DISCUSSION

Center of cranial base lies near to sella turcica which divides it into anterior and posterior parts. Maxilla is attached to the anterior part and mandible to the posterior part, if there is any change in flexion that would alter maxillary and mandibular positions relative to the cranial base. This in turn influences the skeletal relationship and type of malocclusion.[7] Cranial base angle is not the only factor which is involved in determining malocclusion, number of

factors may influence jaw position and orientation in individual cases.[8]

In this study lateral cephalogram of 225 patients aged between 17 to 30 years were chosen. Cranial base angle is mostly stable after the pubertal growth spurt. Although the cranial base angle and lengths are stable after the age of 5 years however, minor changes occur during the growth spurt.[9] Therefore ages older than 17 years were chosen in this study.

Few measurements of Bjork-Jarabak analysis were used, because it was shown to be very useful for assessing facial characteristics.[10,11] Anterior cranial base length is the linear distance between points N and S, while the posterior cranial base length is controversial, either S-Ba or S-Ar linear distances. Articulare point is simple and easily visualized by the clinician so, it was used in this study, many studies supported that basion and articulare were highly correlated and the differences between them were negligible.[12, 13]

In the present study, the saddle angle was found to be smaller in class III followed by class I and class II skeletal relationship. This was in agreement with findings reported by previous studies.[6, 14-16] Smaller cranial base angle in skeletal class III pattern, might be due to anterior articulation of the condylar eminence with the glenoid fossa. This study was not supported by other studies and found that the saddle angle was not different among different skeletal patterns.[4, 17]

In this study, there was no statistically significant difference between the articular angle and skeletal pattern. It was in agreement with other studies.[2, 18] Present study also showed that articular angle was higher in skeletal class III followed by class I and class II respectively; it may be due to nature and size of samples and included age groups.

Gonial angle was larger in class III compared with the class I and class II skeletal relationship. It was supported by other studies. [13,19] The reason behind increase in gonial angle in skeletal class III was due to increase in the effective length of the mandible (Ar-Gn), causing an increase in the angle.

In the current study anterior and posterior cranial base lengths were larger in class II compared to class I and class III patterns and these results coincided with findings of previous studies.[7, 14] However, these findings were contradicted by other studies.[20, 21] It may be due to difference in sample, age group included and ethnicity.

In the present study, ramal height and mandibular body length were larger in Class III skeletal relationship compared with the Class I and Class II groups and these findings were supported by the previous studies.[14, 19]

Concerning the angular measurements there was no significant differences between male and female sample. Linear measurements were found to be significantly greater in male compared with female patients and these findings were supported by various studies.[22, 23]

Further investigation can be carried out in the future to evaluate the relationship between cranial base and skeletal malocclusion three-dimensionally. Three-dimensional cone beam computer tomography is more accurate than two dimensional cephalometric radiographs and can also solve the problem of image overlapping.

CONCLUSIONS

The results obtained from the present study based on Nepalese population concludes that skeletal class II has a larger saddle angle compared with Class III and class I. The skeletal class III has a larger gonial angle, ramal height and mandibular body length. Males have larger linear measurements and females have larger angular measurements.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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