Cranial base morphology in different skeletal classes (A cross-sectional lateral cephalometric study)

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ABSTRACT

Background: It was stated in scientific literatures that the entire craniofacial complex is influenced by the growth of the cranial base structures. Nevertheless, many times this is not the case, and this point is subject to great controversy so the aim of this study is to evaluate the possible differences in cranial base shape and flexure between different skeletal classes for both genders and to investigate any possible correlation between cranial base variables and other skeletal base variables.

Materials and Methods: The sample include 75 lateral cephalometric radiographs of Iraqi adults aged between 18-25 years (39 males, 36 females), collected from patients and undergraduate students in the orthodontic department of College of Dentistry-Baghdad University. The total sample was divided to three major categories depending on ANB angle and dental occlusion into class I control group (12 males, 13 females), class II group (13 males, 12 females) and class III group (14 males, 11 females).

Results: The results revealed that no significant difference in all the angular measurements of both skeletal and cranial bases existed between genders, while all linear and area measurements were usually higher in males than females and there was no significant difference in all the skeletal and cranial bases angles existed between different skeletal classes in both genders meaning that there is no relationship between cranial base flexure and skeletal classes. The angles N-S-Ar, N-S-Ba and SN-FH were always correlated negatively with both the angles SNA and SNB in all skeletal classes for both genders, while the angle SBa-FH showed weaker correlation with the angles SNA and SNB than the angle SN-FHin all skeletal classes for both genders.

Conclusion: Cranial base flexure is not the main cause of skeletal malocclusions.

Key words: Cranial base, lateral cephalometric, skeletal classes. (J Bagh Coll Dentistry 2013; 25(Special Issue 1):108-113).

INTRODUCTION

The cranial base supports the brain and provides adaptation between the developing neurocranium and viscerocranium during growth(1,2).Located on a junction point between the cranium, midface and glenoid fossa, the cranial base may affect the development of both the face and the cranium (3).

The cranial base forms the floor of the cranial vault and extends from the foramen caecum anteriorly to the basi-occipital bone posteriorly. It is essentially a midline structure comprising parts of the nasal, orbital, ethmoid, sphenoid and occipital bones. Sellaturcica lies near the center of the cranial base and divides it into anterior (Sella to Nasion) and posterior (Sella to Basion) limbs. The two limbs of the cranial base form a flexion of 130-135 degree at Sella. The maxilla appears attached to the anterior segment and the mandible to the posterior segment (4).

The cranial base or saddle angleusually measured radiographically as the angle between the Basion-Sella-Nasion points, although the Articulare and Bolton points have also been used to describe the posterior limit, making it difficult to compare the results of different studies (5).

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The cranial base plays a key role in craniofacial growth, helping to integrate, spatially and functionally, different patterns of growth in various adjoining regions of the skull such as components of the brain, the nasal cavity, the oral cavity, and the pharynx. Depending on the fact that the maxilla is connected with the anterior part of the cranial base and the rotation of the mandible is influenced by the maxilla, a relationship can be found between the cranial base variations and sagittal malpositions of the jaws (6).

Different factors like basicranial morphology, head and neck posture and soft tissue stretching are thought to influence the occurrence of a skeletal malocclusion. The influence of cranial base angulation as a factor in the etiology of sagittal jaw discrepancies is still a matter of debate. While investigation of a longitudinal data can show the cause-effect relationship of this problem, a cross-sectional sample may search for morphological differences in different skeletal classes (6).

MATERIALS AND METHODS

The sample consisted of lateral cephalometric radiographs collected from patients attending the orthodontic department of College of Dentistry-Baghdad University and undergraduate students. All of the sample were Iraqis with an age ranged between 18-25 years.The sampleconsisted of 3 groups with a total of 75 subjects (39 males and 36 females)as shown in table 1:

Table 1: Distribution of the Sample

Distribution of the Sample	Male	Female	Total
Class I	12	13	25
Class II	13	12	25
Class III	14	11	25
Total	39	36	75

1. Class I control group (12 males & 13 females): ANB 2°- 4°, bilateral class I molar and canine relationship, normal overjet and overbite (2-4 mm), well aligned upper and lower arches with less than 3mm of spacing or crowding in either of them.
2. Class II group (13 males & 12 females): ANB > 4°, bilateral class II molar and canine relationship, overjet> 4 mm.
3. Class III group (14 males & 11 females): ANB < 2°, bilateral class III molar and canine relationship, overjet< 2 mm.

Class II division 2 malocclusion were excluded from the study.

The sample criteria include:
1) No oral habits according to the subject history and clinical examination.
2) No history of previous orthodontic treatment.
3) No gross facial asymmetry.
4) No history of facial trauma or craniofacial disorder interfering with the normal growth, such as cleft lip or palate.
5) For class I group, clinically almost equal middle and lower facial height and full complement of permanent dentition excluding the third molars.

Lateral cephalometric radiographs were taken for the entire sample separately under strict standardized conditions. After that a software program (AutoCAD 2012) was used for analyzing them.

The following anatomical cephalometric bony landmarks were used in this study (Figure 1):

1. Nasion (N): The most anterior point on the fronto-nasal suture in the mid-sagittal plane.
2. SellaTurcica (S): The midpoint of the hypophysial fossa.
3. Point A: Is located at the most posterior part of the anterior shadow of the maxilla, usually near the apex of the central incisor root.
4. Point B: Is located at the most posterior point on the shadow of the anterior border of the mandible, usually near the apex of the central incisor root.
5. Menton (Me): The most inferior point on the outline of the symphysis.
6. Gonion (Go): A point midway between the most inferior and most posterior points on the angle of the mandible.
7. Articulare (Ar): The point of intersection of the dorsal contour of the condylar head and the outer margin of the cranial base.
8. Orbitale (Or): Located on the lower most point of the outline of the bony orbit in the radiograph.
9. Basion (Ba): The lowest point on the anterior margin of the foramen magnum in the median plane.
10. Porion (Po): The upper surface of the ear rod of the cephalometric head holder.

The following constructed cephalometric points were used in this study (Figure 1):

1. Point I: Represents the intersection of the two lines N-Ba and S-Go.
2. Point J: Represents the intersection of the two lines N-Ba and Ar-Go.

The following skeletal base measurements were done (Figure 1):

Angular measurements

1. SNA: Represents the antero-posterior position of the maxilla in relation to the anterior cranial base.
2. SNB: Represents the antero-posterior position of the mandible in relation to the anterior cranial base.
3. ANB: Difference between SNA and SNB and represents the antero-posterior relation of the maxilla and mandible to each other

Linear measurements

1. Ar-Go: The distance measured between Articulare and Gonion and represents the length of the ramus.
2. S-Go: The distance measured between Sella and Gonion and represents the posterior facial height.
3. N-Me: The distance measured between Nasion and Menton and represents the anterior facial height.
4. Jarabak ratio(Posterior facial height S-Go x100 / Anterior facial height N-Me) [7].

The following cranial base measurements were done (Figure 1):

Angular measurements

1. N-S-Ar: The angle between the anterior and the posterior cranial base and formed at the point of intersection of the S-N line and the S-Ar line.

2. N-S-Ba: The angle between the anterior and the posterior cranial base.
3. SN-FH: The inclination of the anterior cranial base.
4. SBa-FH: The inclination of the posterior cranial base.

Linear measurements

1. S-N: The distance measured between Sella and Nasion and represents the anterior cranial base length.
2. S-Ba: The distance measured between Sella and Basion and represents the posterior cranial base length.
3. N-Ba: The distance measured between Nasion and Basion and represents the total cranial base length.
4. S-Ar: The distance measured between Sella and Articulare and represents the posterior cranial base length.

Area measurements

1. The area N-S-I.
2. The area S-I-J-Ar.
3. The area S-Ar-J-Ba.
4. The area Ba-N-S.

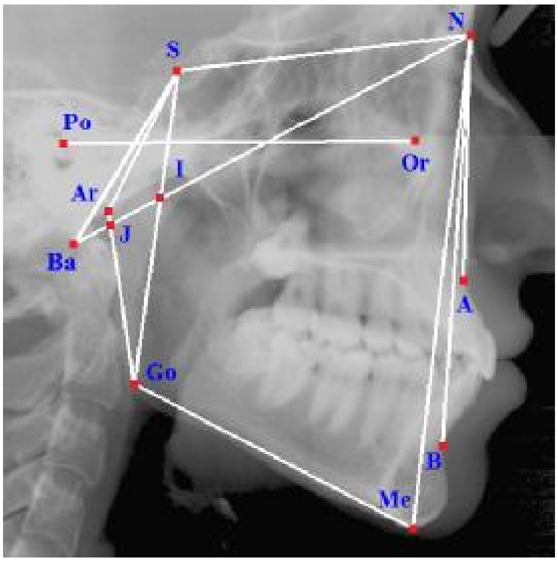

Figure 1: Cephalometric points and measurements

RESULTS

All the data were subjected to computerized statistical analysis by using descriptive statistics including mean, standard deviation, standard error, minimum and maximum and by using inferential statistics including ANOVA test and Pearson correlation test. The results show that no significant difference was found in the angular measurements of both the skeletal and cranial bases between genders and also no significant difference was found in the same angular measurements between different skeletal classes in both genders (Figures 2,3), while the linear measurements S-Go, S-Ba and N-Ba were significantly higher in males than females in all skeletal classes. The mean value of Jarabak ratio was found to have non-significant difference between genders in all of the skeletal classes, while it was significantly larger in the order of class I > class II > class III in both genders.

The mean value of the linear measurement Ar-Go and S-Ba were found to have non-significant difference between all skeletal classes in both genders and also the mean value of the linear measurement N-Me and S-Ar showed non-significant difference between all skeletal classes in males only and the mean value of the linear measurement S-N also showed non-significant difference between all skeletal classes in females only.

The mean value of the area measurements S-I-J-Ar and S-Ar-J-Ba showed non-significant difference between al skeletal classes in males only while the mean value of the area measurements N-S-I and Ba-N-S showed non-significant difference between all skeletal classes in females only. The Pearson correlation test showed that the cranial base angles N-S-Arand N-S-Ba and angle SN-FH showed negative somewhat moderate correlation with SNA and SNB angles in all skeletal classes for both genders while the angle SBa-FH showed weaker correlation with the angles SNA and SNB than the angle SN-FH.

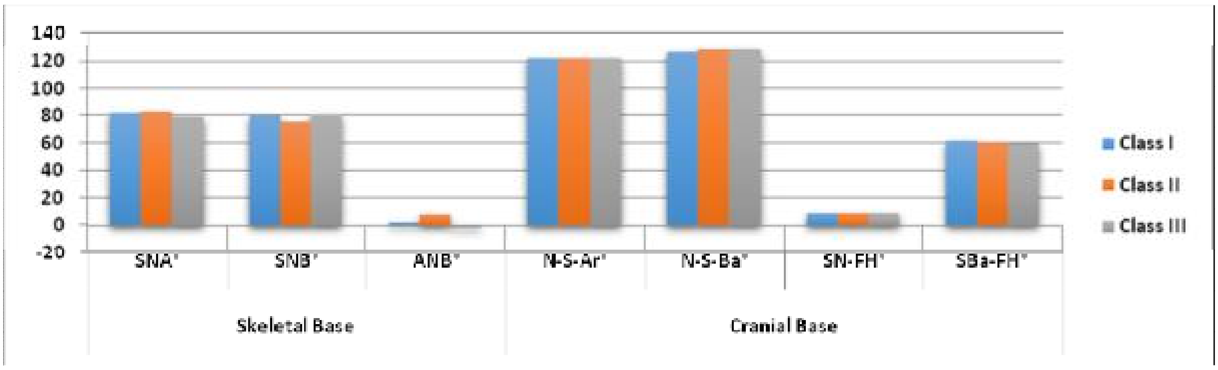

Figure 2: Comparisons of mean values of angular measurements of skeletal and cranial bases between different skeletal classes in males

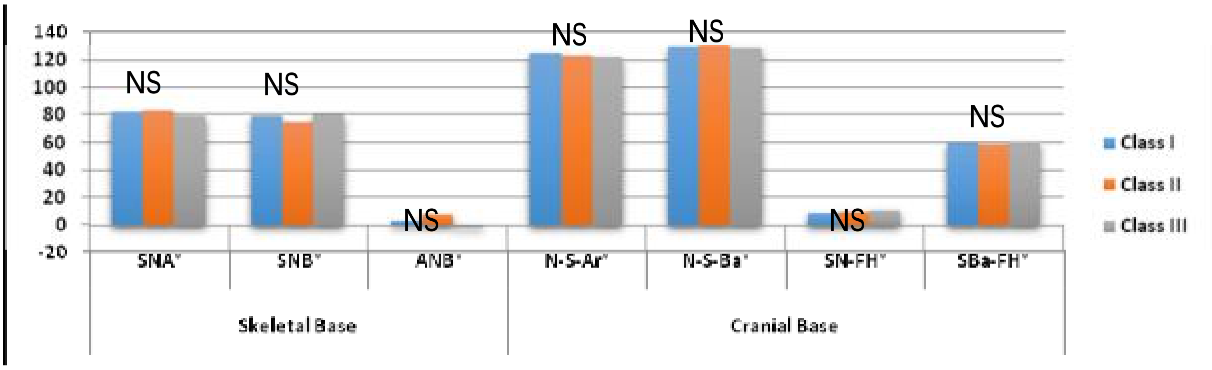

Figure 3: Comparisons of mean values of angular measurements of skeletal and cranial bases between different skeletal classes in females

DISCUSSION

This study targeted all the three types of skeletal jaw relationships (class I, class II and class III skeletal patterns) and it aimed to investigate the differences in their cranial base morphology. The identifications of cephalometric points, angular, linear and area measurements were done directly on a digital radiograph by using a computer with modern analyzing software in an effort to enhance the reliability of the measurements and to reduce tracing and measuring errors.

Frankfort horizontal was selected as the reference plane in describing the anterior and posterior cranial bases because of the close physiologic relation between the ear and the eye as represented by the cephalometric landmarks porion and orbitale[8].The variation of the Frankfort plane has been shown to vary around zero degrees and represents a horizontal to the earth's surface [9].The semicircular canals in the ear and the orbital size change little at an early age with the downward movement of the maxilla compensated by deposition on the orbital floor [10].

The sample selected in this study was composed of cephalometric radiographs of young adults 18-25 years of age because most of the growth of the craniofacial bones could be considered as complete after the age of 18 years [11].

The non-significant gender difference of the angular measurement of the cranial base angles agrees with other studies [12-19], while in general, the linear measurements and area were found larger in males than females and this indicated that the males have larger head than females and can be attributed to the fact that the maximum growth rate of females is reached two years earlier than males[20] and this was also in agreement with previous studies [17, 21-25].

The reason why the angularmeasurements were not significantly different between genders in contrast to the linear and area measurements was because the angular measurements usually refers to the direction of growth rather than to increase or decrease in the size. Additionally, the angular measurements were influenced by the geometrical factors.

The non-significant skeletal class difference in the angular measurements of the cranial base in both genders indicates that the cranial base angles N-S-Ar and N-S-Ba were not the only cause for skeletal malocclusions and this was similar to previous studies [6,26-28]; however, other studies showed that the cranial base angle was found larger in the order of class II > class I > class III[17-19,29].The negative correlation between cranial base angles (N-S-Ar and N-S-Ba) and maxillary and mandibular prognathism angles SNA and SNB despite being moderate to weak correlation, it means that whenever the cranial base angles increase,the angles SNA and SNB (the maxillary and mandibular prgnathism angles) both decreases together almost equally indicated by the non-significant difference in the cranial base angles between skeletal classes and these results agrees with other studies [4,19,30].

Finally it should be noted that the differences between the results of this study and the other studies may be attributed to the differences in the case selection procedure because other authors [4] selected the cases on the bases ofdental classification not skeletal and it is not always necessary that dental occlusion coincide with skeletal jaw relationship [31].

Another fact to consider is that for example N-S-Ar angle can vary due to changes in the height of the anterior cranial base [32]. This is due to the fact that this angle depends on the location of three points: Nasion, Sella, and Articulare. If one of these points changes position, the value of the resulting angle will be equally modified. This means that, if Nasion is placed in a more superior position, the anterior cranial base S-N plane will tilt upwards, and this will open the angle of the cranial base. The opposite result takes place when Nasion is located in lower position [28].

Another variation which must be taken into account is the length of the posterior cranial base which can compensate any cranial flexure [32]. For example, the effect of a closed cranial base angle which will locate glenoid fossa and lower jaw in an anterior position could be countered by an increased length of the posterior cranial base, which would displace the Articular point and consequently the mandible, to a posterior position [28].

In this study, we can conclude that the cranial base angle is not the only factor in determining a malocclusion. There are three main factors influence facial prognathism-opening of the cranial base angle, the relative forward movement of components such as the maxilla and the mandible to the cranium and the amount of surface deposition along the facial profile between the Nasion and Menton. Despite the genetic influence in the occurrence of malocclusions, the role of soft tissues in the position of the jaws should not be underestimated [33].

It was hypothesized that factors inducing cranial extension, such as impairment of nasal airflow, will influence craniofacial development, because of increased pressure from the soft tissue of the anterior regions of the face and neck. There are also several reports mentioning about the relationship between the cervical angle and mandibular position [34].A previous study found a statistically significant correlation between distal jaw position, sagittal mandibular length and increased cervical lordosis [35], while other study found astatistically significant correlation with mandibular position and length, overjet, and the mandibular plane angle to the cervical curvature [36].

The present study failed to find any significant differences in cranial base angle between skeletal malocclusions; however, to accurately see the changes in the growth of the cranial base, further studies with a large longitudinal sample should be performed.

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