The relationship between cranial base angle and malocclusion among Kurdish adults in Sulaimani city: A lateral cephalometric study

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ABSTRACT
Background: The skeleto-dental components of Kurdish adults with class II/1, class II/2 and class III malocclusion were investigated and compared to those of Kurdish adults with normal class I occlusion using lateral cephalometric radiographs.
Materials and methods: The sample included 160 patients from Sulaimani city, 80 females and 80 males, divided into class I, class II/1, class II/2 and class III groups according to specific criteria.
Results: There were no significant genders differences for skeleto-dental angular measurements in normal class I and each of class II/1, class II/2 and class III malocclusion groups, but Kurdish males possessed significantly greater skeletal linear dimensions compared to Kurdish females. The cranial base angles, N-S-Ar and N-S-Ba, were significantly increased in class II/1 and class II/2 patients and were decreased in class III patients. The anterior cranial base length decreased only in class III malocclusion but the posterior cranial base lengths, S-Ar and S-Ba, were significantly increased in class II/1 and class II/2 and decreased in class III patients.
Conclusion: A relationship existed between cranial base angle, malocclusion type and facial features.
Key words: Cranial base angle, lateral cephalometric, malocclusion. (J Bagh Coll Dentistry 2010;22(3):105-110).

INTRODUCTION
Malocclusion is a developmental deformity which may vary from a minor to a major deformity of a dental or skeletal origin. It may encompass the entire craniomaxillofacial region [1]. Malocclusions with skeletal discrepancies are caused by abnormal forms, sizes and positions of the cranial base, maxilla, and mandible. Facial patterns are expressed by the interrelation of variable factors such as heredity, function and environment. Such variable factors have an effect on the growth and development of maxillofacial bones [2]. In addition, it is important to recognize that growth at the cranial base can strongly influence facial growth [3], especially mandibular positioning [3]. Cranial base form the floor of the cranial vault and extend from foramen caecum anteriorly to the basioccipital bone posteriorly. It’s essentially a midline structure comprising parts of nasal, orbital, ethmoid, sphenoid and occipital bones. Sella turcica lies near the center of the cranial base and divide it to anterior (sella to nasion) and posterior (sella to basion) limbs. The two limbs of the cranial base form a flexion of (130°-135°) at sella.

The maxilla appears to be attached to the anterior segment and the mandible to the posterior segment. Since the cranial base consists of two segments articulating either with the maxilla or the mandible, respectively, any changes in flexure due to variations in shape and size of this region may alter the anteroposterior skeletal relationship of the jaws, thus influencing the type of malocclusion [5]. In orthodontic diagnosis and treatment planning, a cephalometric radiograph is an essential tool to relate patients with different malocclusions to their associated norms [6]. Since Broadbent and Hofrath introduced the cephalometer in 1931, cephalometric analysis has contributed to the analysis of malocclusion and has become a standardized diagnostic method in orthodontic practice and research [7]. Skeletal and facial balance with an ideal dental relationship to the cranial base has been more objectively assessed through the comparison of an individual’s cephalometric measurements with the means and standard deviations derived from population-based samples of the same race, sex, and chronological age. These standards have been developed from years of cephalometric data collection [8].

MATERIALS AND METHODS
The sample of the present study was selected randomly from patients attending the specialized Peramerd Dental Center in Sulaimani. Their age

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ranged between 20-30 years. The sample consisted of 4 groups, 1 control and 3 study groups; each group contains 40 patients, 20 males and 20 females.

Group 1: patients with class I skeletal jaw relationship and class I dental occlusion.
Group 2: patients with class II skeletal jaw relationship and class II div.1 malocclusion.
Group 3: patients with class II skeletal jaw relationship and class II div.2 malocclusion.
Group 4: patients with class III skeletal jaw relationships and class III malocclusion.

The sample criteria:
1-All of the patients were Kurdish in origin (Four grandparents were Kurdish).
2-Any cases with systemic diseases that affect the growth and development or craniofacial Syndromes, patient with trauma, previous orthodontic treatment and orthognathic surgery were excluded.
3- All teeth should be present and free of crown restorations.
4- For group 1 (class I or normal occlusion): Bilateral class I molar and canine relationship, the overjet ranged between 2-4 mm and over bite between 1-3 mm, radiographically the ANB angle was 2°-4°.
5- For group 2 (class II/1 malocclusion): Bilateral half unit class II or greater molar and canine relationship, overjet was >5mm, radiographically the ANB angle was >4°.
6- For group 3 (class II/2 malocclusion): Bilateral half unit class II or greater molar and canine relationship, retroclination of the maxillary anterior teeth, at least of the two central incisors and a deep bite, complete vertical coverage by a maxillary central incisor of the crown of the corresponding mandibular incisor, radiographically the ANB angle was >4°.
7- For group 4 (class III malocclusion): Bilateral half class III or greater molar and canine relationship, edge to edge or reversed overjet , radiographically the ANB angle was < 2°.

Lateral cephalometric radiographs were taken for the entire sample separately under strict standardized conditions. They were printed and the point identification and measurements were done directly on the radiographs using a lead pencil, protractor and metric ruler.

The following cephalometric bony landmarks were used in this study:
1. nasion (N).
2. Sella Turcica (S).
3. Basion (Ba).
4. Articulare (Ar).
5. Orbitale (Or).
6. Porion (Po).
7. Anterior nasal spine (ANS).
8. Posterior nasal spine (PNS).
10. Upper incisor edge (UIE).
11. Upper incisor apex(UIA).
12. Gonion (Go).
14. B-point (B).
15. Lower incisor edge (LIE).
16. Lower incisor apex (LIA).

The following measurements were done (Figure 1):
1. N-S-Ar: the angle between the anterior cranial base, S-N, and posterior cranial Base, S –Ar, when the point Ar represents the posterior cranial base extension.
2. N-S-Ba: the angle between the anterior cranial base, S-N and posterior cranial base, S –Ba when the point Ba represents the posterior cranial base extension.
3. SN-FH: the angle between the SN plane and Frankfort horizontal plane. It represents the angle of inclination of anterior cranial base.
4. SAr-FH: the antero-superior angle between the posterior cranial base S-Ar and Frankfort horizontal plane, it represent the posterior cranial base inclination angles.
5. SBa-FH: the antero-superior angle between the posterior cranial base, S-Ba and Frankfort horizontal plane, it represent the posterior cranial base inclination angles.
6. SNA: the angle between the SN plane and point A. It represents the position of maxilla in relation to anterior cranial base.
7. SNB: the angle between the SN plane and point B. It represents the position of mandible in relation to anterior cranial base.
8. ANB: the angle formed by the intersection of the point A –Nasion line and the point B-Nasion. This angle determines the anteroposterior relation of the mandible with the maxilla.
9. Upper central to maxillary plane angle (U1-Mx): the postero- inferior angle formed by the long axis of most prominent upper central incisor with the maxillary plane.
10. Lower incisor to mandibular plane angle (L1-Mp): the angle formed by the intersection of the long axis of the most prominent lower central and Go-Me.
11. Interincisal angle (U1-L1): the angle represented by the intersection of both long axis of most prominent maxillary and mandibular central incisors.
12. S-N: the length of the anterior cranial base measured by the distance between point S and Na.
13. S-Ar: the length of posterior cranial base which is the distance between point S and point Ar.
14. S-Ba: the length of posterior cranial base which is the distance between point S and point Ba.
15. Maxillary base length: the distance between ANS to PNS.
16. Mandibular base length: the distance between Go to Me.

Figure 1: cephalometric measurements

RESULTS

All the data were subjected to computerized statistical analysis by using descriptive statistics including mean, standard deviation, inferential statistics including t-test and Pearson correlation test. Generally, no significant differences were found in cranial base, maxillary, mandibular and dental angular measurements between class I, class II/1, class II/2 and class III males and females while all linear measurements including S-N, S-Ar, S-Ba, ANS-PNS, Me-Go were significantly higher in males than in females in all of the study groups. The mean values of the cranial base angular measurements were significantly different in class II/1 and class II/2 patients compared to class I except for SN-FH in which this difference was not significant. NSAr and NSBa angles were significantly higher, SAR-FH and SBA-FH angles were significantly lower in class II patients. The anterior base length S-N was equal in both groups while the posterior base lengths S-Ar, S-Ba were significantly greater in class II. The findings of class II/1 patients revealed that SNA angle had a non significant higher value and SNB angle had a significantly smaller value. Also ANB was significantly greater, in addition to a non significant increase in ANS-PNS length and significant decrease in Me-Go length than class I males. The angles U1-Mx and L1-MP showed a significant increase and the U1-L1 angle showed a significant decrease in class II/1 patients while U1-Mx angle was significantly lesser and the U1-L1 angle was significantly greater in class II/2 than in class I patients. The class III patients had a significantly smaller NSAr and NSBa angles and S-N, S-Ar, S-Ba lengths with greater SAr-FH and SBA-FH angles than class I patients. Also there was a non significantly smaller SN-FH angle. At the same time, for the maxillary and mandibular jaw positions and lengths, class III patients showed a non significant smaller SNA angle, a significantly greater SNB angle and Me-Go length, with a significantly smaller ANB angle and ANS-PNS lengths than class I. Regarding the dental parameters, the class III males had a significant increase in U1-Mx angle and a decrease in L1-MP angle with a non significant decrease in U1-L1 angle. All of the investigated cranial base parameters were correlated with maxillary and mandibular parameters for each classes of malocclusion and each gender separately. The trends were near to each other and relatively similar. There was a good linear negative correlation between cranial base angles and SNA, SNB angles, while the cranial base angles were positively correlated with the ANB angle, but their relation to the jaw lengths were little and even with no relations in some groups .The SN-FH had a good and positive correlation with SNA, with some correlation with SNB angle and ANB and no correlation with the Me-Go. Also, a strong positive correlation was seen between the SAr-FH, SBA-FH and SNB, with little negative correlation to SNA and ANB and no correlation to jaw lengths. S-N length had a better level of positive relation with maxillary length ANS-PNS, with little positive relations to SNA angle. The posterior cranial base lengths had somewhat good positive correlation to Me-Go length but had little correlation to the SNA, SNB and ANB angles.

DISCUSSION

In all of the studied skeletal (SNAr, NSBa, SN-FH, SAr-FH, SBA-FH, SNA, SNB, ANB) and dental (U1-Mx, L1-MP, U1-L1) angular measurements, a small difference existed between males and females of class I, class II/1, class II/2 and class III groups, but they were not statistically significant. This was similar to a previous study which stated that no significant differences were found in the angular measurements between the genders in Kurdish class I subjects [9]. The gender comparisons in each of class I, class II/1, class II/2 and class III groups confirmed that Kurdish
males possess significant greater anterior cranial base, posterior cranial base, maxillary and mandibular body linear dimensions than Kurdish females. This finding was close to that found by Alnaqshabandy in 2005 regarding the S-Ar length in the class I group. There were three postulates for the boys’ growth pattern as boys grow later, longer and larger than girls. In the present study, both Ar and Ba points were used as the posterior cranial base limits. In comparing the classes I control group and class II/1, class II/2 and class III study groups, the results indicated that the cranial base angles significantly increased in class II divisions and decreased in class III compared to that found in class I. This was true for male and female comparisons that were done separately. These findings were in agreement with other studies. The SN-FH, SAr-FH and SBa-FH angles represent the degree of inclination of anterior and posterior cranial base in respect to Frankfort horizontal plane as a reference plane. The Frankfort horizontal was selected as the reference plane in describing the anterior and posterior cranial bases inclinations since there was a close physiologic relation between the ear and the eye as represented by the cephalometric landmarks porion and orbitale and the variation of the Frankfort plane has been shown to vary around zero degrees and represents to be horizontal to the earth’s surface. Generally, the anterior cranial base inclination, SN-FH, angle was found to be very close in each of the control and the study groups. Some small non significant differences existed. On the other side the posterior cranial base inclinations, the SAr-FH and SBa-FH angles, showed a significant decrease in class II/1 and class II/2 groups and a significant increase in class III groups when compared to class I. These findings were also relatively the same when the comparisons are conducted separately in males and females. From these results it can be expected that the anterior cranial base flexure has little participation in the significant cranial base angle variations in different malocclusions, while posterior cranial base flexures play a more important role in this variation by virtue of their proximity to the mandibular complex. Articulation at the genoid fossa does provide potential influence from the cranial base. It can also be noted that wherever the mean values of cranial base angle increased in class II/1 and class II/2 groups, the SAr-FH and SBa-FH angles were decreased and the situations are reversed in class III. The exact mechanism by which the class II cranial base configuration formed is not understood but in class III malocclusion there are some explanations such as that reported by Singh et al in 1997 in his thin-plate spline analysis on lateral cephalographs to determine the deformations that contribute to a class III cranial base morphology. He stated that large spatial-scale deformations affect the posterior region of the cranial base and the body of the sphenoid, whereas localized shearing is more apparent at the sella turcica than the frontal region suture. These deformations may contribute to reduced orthocephalization or deficient flattening of the cranial base antero-posteriorly. This, in turn, leads to the formation of a class III malocclusion, i.e. moderate deformations, in the sphenoidal region of the mid-cranial base and significant changes affecting the occipital region of the cranial base, predominantly associated with the retention of a relatively acute cranial base angle. The S-N length showed a significant lower value in class III males and females when compared to class I males and females. This finding was similar to other studies, but it was in contrast to other who stated that S-N length in class III malocclusion shows minimal non-significant shortening. The posterior cranial base appeared to play a more important role in class II and class III morphogenesis by virtue of its proximity to the mandibular complex. Many cephalometric studies have reported elongation of the posterior cranial base for class II patients and shortening of it in class III patients as compared to class I cases. These observations are supported by significant trend indicating increasing of the S-Ba and S-Ar distances for class II groups in the present study. The position of upper jaw in class II and class III malocclusion, as related to the cranial base, was relatively close to class I. This may be due to the fact that the maxilla appeared to be attached to anterior cranial base and there were only small variations in the anterior cranial base area in different classes of malocclusion as compared to class I. In this study in the comparison between class I and each of class II/1 and class II/2 and class III males and females, the SNB angle was significantly decreased in class II divisions and increased in class III malocclusion groups. The mean values found in the present study groups reflected the retrognathic position of the mandible in the class II divisions and the prognathic position of the mandible in class III malocclusion. Anatomically, the mandible is attached to the posterior cranial base at the genoid fossae. The scientific contributions have indicated that the relative position of the genoid fossa, i.e. the attachment of the mandible to the cranium, can affect the dentoskeletal features of malocclusions, for instance, a more distal position.
of the fossa can facilitate mandibular retraction.

The short cranial base and small cranial base angle with a significant increased bending of posterior cranial base in class III malocclusion reported earlier may contributed to the protrusive position of the mandible, and the large cranial base angle with decreased bending of posterior cranial base may contribute to the retrusive position of mandible in class II malocclusions. It was observed that the effective maxillary length measured from the ANS point to PNS point was shorter in the class III group as compared with the control which indicated a smaller size of maxilla in class III malocclusion. This result was close to those in other studies [13,24,25] who reported similar results in class III malocclusion. On the other hand, the maxillary lengths in class II/1 and class II/2 for either gender did not show significant increase. According to the present study, the probable explanation for these findings is that in class III malocclusions the shorter anterior cranial base length was responsible for the shorter maxillary length while in class II/1 and class II/2 the anterior cranial base length was similar to that of class I, therefore the maxillary length showed no significant variation. The mean values of mandibular body length in the sample of the present study were lower in class II/1 and class II/2 males and females as compared to normal class I while they were higher in class III for both genders. The low values of mandibular body length in class II malocclusion and higher value in class III malocclusion were possibly due to hereditary factors, as supported by Michell et al where it was stated that the size of the jaws is mainly genetically determined [26]. The class II/1 males and females were characterized by more proclined upper and lower central incisors that resulted in decreasing interincisal angle as compared to class I genders. This was similar to other studies [27-29] who reported the same findings. In current study it was found that class II/2 malocclusion had a pronounced retroclination of upper central incisors in relation to the maxillary plane with a slight tendency of the lower incisors to be retroclined, thus resulting in an obvious increase of the interincisal angle. This was in accordance with the previous studies [20,29]. Class III malocclusion was characterized by a more proclined upper centrals and retroclined lower incisors with a non significant tendency of interincisal angle to be decreased. These variations in incisor inclination in different malocclusions reflect the dento-alveolar compensations to the underlying skeletal discrepancies. The present correlation analyses of the test and control groups yielded a significant association between cranial base angulation and the anteroposterior relation of the jaw bases.

The correlation matrices for each individual class of malocclusion showed similar trends, in particular with respect to cranial base angle. The correlation analysis also suggested a relationship between mandibular position and the magnitude of cranial base flexure. The smaller SAr-FH and SBa-FH angles, the more forward the mandibular position, indicated by angle SNB, and vise versa in class II. The maxilla was equally affected by the angle, which suggested fundamental role for the cranial base in determining facial prognathism than that indicated by a mere geometry. The positive and significant correlations between S-Ba and N-S distances with maxillary and mandibular lengths also suggested a link between jaw length and facial prognathism. According to the results whenever the cranial base angles were increased, there were decreased posterior cranial base inclination angles and the mandible was positioned more posteriorly, and a class II malocclusion was obtained. Wherever the cranial base angles decreased, there were increased posterior cranial base inclination angles and shortened anterior and posterior cranial base lengths, the mandible was positioned more anteriorly, and together with increased mandibular length and decreased maxillary length, a class III malocclusion appeared.

REFERENCES

9. Alnaqshabandi JM. Skeletodental patterns of Iraqi Kurd and Arab patients with class I skeletal relationship...