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Original article

Relationship between cranial base and jaw base in different skeletal patterns

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ABSTRACT

Purpose: To determine the relationship between the cranial base and both jaw bases in different skeletal patterns.
Materials and methods: Lateral cephalometric radiographs of 180 adult patients of all three malocclusion groups were evaluated and analyzed. A group of linear and angular measurements were measured and compared among all study groups to assess the existence of any relationship between the cranial base and both jaw base discrepancies.
Results: Significant differences were found in the cranial base angle (NSBa) and both jaw base lengths among all three malocclusion groups, while no significant differences were found in the cranial base lengths. As for angular measurements, an inverse correlation was found between the cranial base angle and both SNA and SNB angles in both Class II and Class III malocclusion groups. Concerning linear measurements, a significant correlation was found between the total cranial base length and the total facial height among all malocclusion groups.
Conclusion: The cranial base angle affects the anteroposterior orientation of both maxilla and mandible with a minimal contribution to the appearance of different vertical skeletal patterns. Meanwhile, the cranial base length affects minimally the anteroposterior orientation of both the maxilla and the mandible. However, a significant link was found between it and the total facial height, thus contributing to the appearance of different vertical skeletal patterns.

1. Introduction

The relationship between the cranial base configuration and the appearance of different types of malocclusions has been an area of interest to many anthropologists and orthodontists over a long period of time. Huxley [1], performing his studies on dried skulls, concluded that the cranial base can affect how the maxilla and the mandible are inter-related to each other. In their study, Young and Bryce [2] realized that there might be a relationship between cranial base morphology and jaw prognathism. Using cephalometric radiographs, Björk [3] discovered a relationship between the cranial base morphology and the jaw base relationship.

Over the past few decades, numerous researchers have studied the cranial base morphology and orientation, and discussed how it affects the facial prognathism leading to the appearance of different patterns of malocclusion. Jacobson et al. confirmed that the anterior cranial base measurements were shorter in Class III than Class I malocclusion patterns [4].

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Table 1 – Cephalometric landmarks used in the study.

Nasion (N):	The most anterior point of the Fronto-Nasal suture in the midsagittal plane
Sella turcica (S):	The midpoint of the hypophysial fossa, it is a constructed point in the median
Porion (Po):	The most superiorly positioned point of the external auditory meatus. It is located by using the ear rod of the cephalostat
Basion (Ba):	The lowest point on the anterior rim of the foramen magnum in mid sagittal plane
Orbitale (Or):	The lowest point on the inferior rim of the orbit, midline between right and left images "bilateral"
Condylion (Co):	The most posterior–superior point on the head of the mandibular condyle
Gonion (Go):	The most posterior–inferior point at the angle of the mandible. It was located by bisecting the angle formed by the lines tangent to the posterior border of the ramus and the inferior border of the mandible
Menton (Me):	The most inferior point of the mandibular symphysis
Point A (Subspinale):	The deepest point on the curve of the maxilla between the anterior nasal spine and the dental alveolus
Point B (Supramentale):	The point most posterior to a line from Infradentale to Pogonion on the anterior surface of the symphyseal outline of the mandible, lies within the apical third of the incisor roots
Pogonion (Pog):	The most anterior point on the mid-sagittal symphysis
Gnathion (Gn):	The most antero-inferior point on the mandibular symphysis
Anterior nasal spine (ANS):	The anterior tip of the sharp bony process of the maxilla in the mid-sagittal plane
Posterior nasal spine (PNS):	The most posterior point at the sagittal plane on the bony hard palate

Dibbets noticed a gradual decrease in both cranial base linear measurements (S-N) and (S-Ba) as well as the cranial base angle (NSBa) between Classes II, I and III respectively with no difference in the mandibular measurements between all the three malocclusion classes [5]. Proff et al. showed that the total cranial base length and the cranial base flexure were both reduced in skeletal Class III subjects compared to subjects of other malocclusion patterns [6]. Chin et al. found that the SNB angle decreased as the cranial base angle increased [7].

Meanwhile, other researchers presented contradictory evidence to the previous findings indicating that the cranial base affects minimally the appearance of different skeletal patterns. Battagel was unable to find any differences between the cranial base morphology among Class I and Class III malocclusion subjects [8]. Kasai et al. found no significant differences in the cranial base form between Class I and Class II samples of Japanese crania [9]. Dhopatkar et al. did not find any link between the cranial base angle and skeletal base pattern as indicated by the variable ANB [10]. Similarly, Polat and Kaya found that both cranial base angular and linear measurements did not demonstrate any significant differences between all different types of malocclusion groups [11].

Apparently with all of these conflicting views, the influence of cranial base morphology as a factor in the etiology of malocclusion still remains controversial. Therefore, this study was performed to assess the relationship between the cranial base and both maxilla and mandible among subjects of different skeletal patterns, based on the hypothesis that the cranial base would have a significant impact on both jaw bases and on the appearance of different skeletal morphological patterns.

2. Materials and methods

This study was performed on a sample of 180 pre-treatment lateral cephalograms of Egyptian orthodontic patients of both sexes (59 males, 121 females) and of different skeletal malocclusion patterns (60 radiograph for each type of malocclusion) seeking treatment at the Orthodontic Department Clinic, Faculty of Dentistry, Tanta University. The selection criteria included; subjects with age range between 18–25 years old, no history of medical complications or syndromes, no history of craniofacial malformation and trauma, orthodontic treatment or maxillofacial surgery.

The sample size was calculated using an equation to be N > 42 per malocclusion group based on; a study confidence level of 95%, a study power level of 90%, standard deviation of 2° and difference in mean values within 2° between all 3 malocclusion groups under investigation.

The following equation was used for sample size calculation:[1]

$$N > \frac{(U+V)^2 \times \left(\sigma1^2 + \sigma2^2\right)}{(\mu1 + \mu2)^2}$$

2.1. *Cephalometric analysis*

All radiographs were coded and traced accurately by the same investigator and a group of cephalometric landmarks were plotted on each radiograph (Table 1) as suggested in the literature [12–14]. Subjects were then allocated into the three groups of malocclusion on the basis of their ANB angulations according to the cephalometric norms for the Egyptian population [15] where;

- In skeletal Class I subjects, 2° < ANB < 4°.
- In skeletal Class II subjects, ANB > 4°.
- In skeletal Class III subjects, ANB < 2°.

[1] where **N** is the calculated sample size per malocclusion group, **U** is one sided percentage point of the normal distribution corresponding to 100% – the power of the study – (if the power is 90%, U = 1.28), **V** is the percentage point of the normal distribution corresponding to the two sided significance level (if significance level is 5%, V = 1.96), $\sigma1^2$ **and** $\sigma2^2$ are standard deviations, $\mu1 - \mu2$ is the difference between the mean values between all 3 malocclusion groups.

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