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Evaluation of the Basal and Sphenobasion Angles using CT Scan in the Iranian Population

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Abstract

Objectives: This study aimed to find the difference in the values of the cranial base angles among Iranian adults and investigate the relationship between the Basal and Sphenobasion angles.

Methods: 100 individuals (50 males and 50 females) aged between 18 to 60 participated in this cross-sectional study which was carried out from September 2018 to September 2019 in the imaging centers affiliated with the Faculty of Medicine, Tehran University of Medical Sciences and Basal and Sphenobasion angles were measured in all of the participants.

Results: A significant correlation was observed between age and Sphenobasion angle in the male group ($P = 0.0001$, $r = 0.439$), but no positive relation was observed between Sphenobasion angle and age in the female group ($P = 0.309$). The results of this study exhibited the significant relations between the Basal and Sphenobasion angles in the females and males ($P = 0.001$, $r = 0.396$ and $P = 0.0001$, $r = 0.534$ respectively).

Conclusion: This study showed positive correlations between the Basal angle and age in the females and males and significant relations between the Basal and Sphenobasion angles in the two genders.

Keywords: Basal angle, sphenobasion angle, anthropometry, iranian population

Introduction

Anthropometry is a branch of Physical Anthropometry that studies the dimensions and sizes of the human body.[1-3] In modern countries, anthropometry is regularly used in forensic medicine, maxillofacial, brain and plastic surgeries, medical engineering, dental orthopedics, and even the shoe, clothing and eyewear industries and also it can be used in the clinical diagnosis of growth retardation in children and the diagnosis of carriers of certain genes (for example, the X-linked hypohydrotic ectodermal dysplasia gene).[4-6] The most complex structure of the craniofacial skeleton is the ventral part of the cranium, known as the cranial base or basicranium, whose main function is to protect and support the brain and help with facial growth.[7,8] The cranial base has been intriguing researchers for a long time as a phylogenetically ancient and conserved structure in the craniofacial skeleton.[9] The cranial base is a major subject of ontogeny and phylogeny. Anthropologists have found substantial interest in the cranial base due to its distinctive flexion in human beings and its crucial position between the neurocranium and the face.[10] 14 till 32 weeks of fetal life marks the first growth spurt, while the second spurt takes place at 1 year of age onwards.[11] The growth of the cranial base by 90% occurs until 13 years of age and carries on during the growth of the face. The internal (basal angle) and external (Sphenobasion angle) angle of the cranial base plays a key role in the spatial and functional development of the nasal and oral cavity and pharynx. Moreover, cosmetic surgeries, orthogenetic surgeries and forensic medicine to identify the sex and age benefits from craniofacial anthropometry.[12,13] Due to the proximity of cranial base to the maxilla and mandible, the presence of key elements in this region and the relationship between the angles of the cranial base with craniofacial anomalies any Angle changes and associated abnormalities are related with some diseases such as Obstructive Sleep Apnea (OSA), Down's syndrome, Turner syndrome, craniosynostosis syndromes, cleidocranial dysplasia (CCD) and cleft palate.[7,14]

On a number of occasions, it has been suggested that the cranial base is a leading cause of craniofacial abnormalities such as craniosynostosis secondarily. The internal and external anatomical structure of the head and the face can be quantified by means of the Computer Tomographic Cephalometric technique, which can't be assessed by the customary morphometric tools.[15,16] Data obtained have found application in forensic medicine, corrective jaw, maxillofacial and plastic surgery.[17,18] Nevertheless, in an attempt to discover the credible relationship between the skeletal patterns of individuals, numerous studies have been conducted to evaluate and compare the values of the cranial base angle of each normal and abnormal skeletal group.[19,20] However, very few studies have been conducted on the external cranial base angle and categorize this information in Iran. Therefore taking into account that the degree of its slope is a function of the race or the area in which the research was conducted, the present cephalometric study was carried out to find the difference in the values of the cranial base angles among Iranian adults and to

investigate the relationship between the basal angle and Sphenobasion angle.

Materials and Methods

As many as 100 individuals (50 males and 50 females) aged between 18 to 60 who had signed the informed consent form participated in this cross-sectional study which was carried out from September 2018 to September 2019 in the imaging centers affiliated with the Faculty of Medicine, Tehran University of Medical Sciences. The ethics committee approved this study with the ID of IR.MEDICINE.TUMS.REC.1398.602. Subjects were selected on a random basis with the following exclusion criteria:

- Those suffering from skull bone anomalies (congenital or acquired);
- Those with a history of trauma and skull fractures;
- Those with a history of maxillofacial surgery, including cosmetic surgery;
- Non-Iranian nationals.

The measurement of the parameters in the whole scans was based on the following definitions:

Nasion: The middle point of the junction between the nasal bones with the frontal bone.
Basion: The midpoint of the anterior margin of the foramen magnum.
Pituitary point: The anterior edge of the sella turcica.
Nasion-Basion line: A line connecting the nasion and basion.
Sphenoid plane: A plane passing over the jugum of the sphenoid bone.
Basion-Pituitary line: A line connecting the basion and pituitary point.
Prosthion: The point on midway of alveolar arch between the upper incisor teeth.
Sphenobasion: The point on the middle line of the basilar process.
Prosthion-basion line: A line connecting the Prosthion and basion.
Sphenobasion line: A line connecting the Sphenobasion and basion.
Internal Cranial base angle (basal angle): An angle between the sphenoid plane and basion-pituitary point.
External Cranial base angle (Sphenobasion angle): An angle between the Sphenobasion line and Prosthion-basion.

First, a line was drawn from the nasion to the basion. Then, to take into account a plane that passes over the jugum of the sphenoid to be the sphenoid plane, the cranial base angle was measured (Figure 1). Finally, a line was drawn from the basion to the pituitary point. The angle between these two lines was named as the internal cranial base angle, tabulated according to age and sex.

In the next step, the cranial base parameter was determined by the three-dimensional reconstructions of CT scans by measuring the angle between the lines from prosthion to basion and from Sphenobasion to basion (Figure 2).

Results

The average of basal angle was 121.927 and 122.245 in women and men respectively. In this study based on the chi-square test, there was no significant difference between the two genders in the Basal angle ($P = 0.735$) (Table 1).

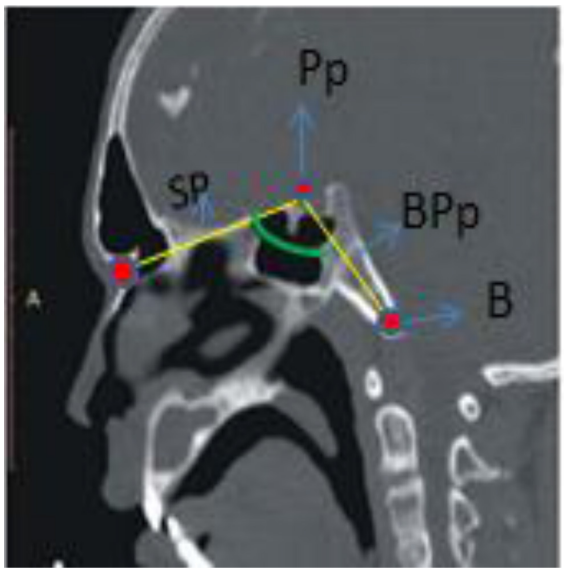

Fig. 1 **Cranial base angle. This angle is between the Sphenoid plane and the Basion-Pituitary point line. B: Basion, Pp: Pituitary point, Sp: Sphenoid plane, BP: Basion-Pituitary point, Ba: basal angle.**

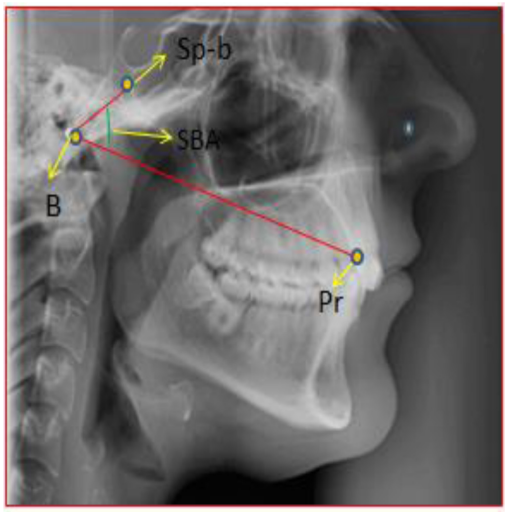

Fig. 2 **Sphenobasion angle. This angle is between the Sphenobasion line and the basion-Prosthion line. SpB: Sphenobasion, B: Basion, Pr: Prosthion, B-SpB: Sphenobasion line, BPr: Basion-Prosthion line, SBA: Sphenobasion angle.**

The average angle of Sphenobasion in women was 123.274 and in men with a difference of about 1 degree was 124.669. The analysis of the chi-square test exhibited that there was no meaningful difference between the females and males in the Sphenobasion angle ($P = 0.362$) (Table 2).

A meaningful relation was observed between Basal angle and age in females ($P = 0.035$). Analysis of the Pearson correlation showed a positive correlation between the Basal angle and age in the female group ($r = 0.253$). In the Sphenobasion parameter, no positive relation was observed between Sphenobasion angle and age in the females ($P = 0.309$) (Table 3). With aging, the volume of the Basal angle increases by a factor of 0.253 in females. By using the following formula, by entering the age (x), the Basal angle can be predicted with 25 percent accuracy.

Table 1. **The correlation between Basal angle and gender**

		Number	Mean	Standard deviation	Mean difference	*P*-value
Basal angle	Female	70	121.927	5.8316	0.3183	0.735
	Male	77	122.245	5.5671		

Table 2. **The correlation between Sphenobasion angle and gender**

		Number	Mean	SD	Mean difference	*P*-value
Sphenobasion angle	Female	66	123.274	9.6116	1.0013	0.362
	Male	77	124.669	8.6103		

Table 3. **The correlation of age with Basal and Sphenobasion angles**

		Age
Basal angle in females	*r*	0.253
	P-value	0.035
Sphenobasion angle in females	*r*	0.127
	P-value	0.309
Basal angle in males	*r*	0.276
	P-value	0.015
Sphenobasion angle in males	*r*	0.439
	P-value	<0.001

Table 4. **The correlation between Basal and Sphenobasion angles**

		Sphenobasion angle
Basal angle in females	*r*	0.396
	P-value	0.001
Basal angle in males	*r*	0.534
	P-value	<0.001

$$y = 0.74x + 46.55$$

A significant relation was seen between Basal angle and age in the male group ($P = 0.015$). Analysis of the Pearson correlation showed a positive correlation between the Basal angle and age in the male group ($r = 0.276$). Statistically, a significant correlation was observed between age and Sphenobasion angle in the male group ($P = 0.0001$, $r = 0.439$) (Table 3). The volume of the Basal angle increases in males with age and the following formula can predict the size of the Basal angle based on the age in males.

$$y = 0.9x + 70.02$$

The volume of the Sphenobasion angle increases in males with age by a factor of 0.439 and the following formula can predict the size of the Sphenobasion angle based on the age in males.

$$y = 0.93x + 75.56$$

The analysis of the results of this study showed a significant relationship between the Basal and Sphenobasion angles in the female group ($P = 0.001$, $r = 0.396$) (Table 4). With increasing the volume of the Sphenobasion angle, the volume of the Basal angle increases by a factor of 0.396 in females. By using the following formula, by entering the age (x), the Basal angle can be predicted with 39 percent accuracy in females.

$$y = 0.67x + 41.27$$

A significant relation was seen between the Basal and Sphenobasion angles in the male group ($P = 0.0001$, $r = 0.534$) (Table 4). Same as females, with increasing the volume of the Sphenobasion angle, the volume of the Basal angle increases by a factor of 0.534 in males and the following formula can predict the size of the Basal angle based on the age in males.

$$y = 0.83x + 23.7$$

Discussion

Several factors like gender, ethnicity, and age can be effective in the growth of human skulls. It has been shown that each ethnicity has its own characteristics and by using the anthropometric information we can guess several cranial features, like gender, age, and race.[21]

The aim of this study was to evaluate the basal and Sphenobasion angles in Iranian men and women by using the CT-scan.

Our data showed the average of the basal angle was 121.927 and 122.245 in women and men respectively and the mean angle of Sphenobasion in women is 123.274 and in men with a difference of about 1 degree is 124.669. In this study based on the chi-square test, there was no significant difference between the two genders in these two angles. Based on our search, there was no similar study that compares these two angles between the two genders but this comparison was done in other craniofacial parameters. Our results were in line with the results of the Netto study in 2014.[22] Netto et al. presented that there was no statistical correlation between the value of basal sphenoid angle and sex. Song et al.[23] presented that the head height was approximately 5% greater in males than in females and also the results of the Esomono study in 2012[24] showed significant differences between the two genders in head length, head breadth and cephalic index and the results of our study were against the two mentioned studies. Based on the results of the present study and other mentioned studies, it

can be concluded that craniofacial parameters can be similar or different between the two genders and the key point is that these differences in the results are very predictable because these parameters depend on many factors like ethnicity and genetic influence.

Platybasia is a spinal disease of a malformed relationship between the occipital bone and the cervical spine. Previous studies demonstrated that the basal angle above 133° is indicative of platybasia which the patients with platybasia have greater craniocervical kyphosis and more intense brainstem ventral compression.[25] As mentioned before, the mean basal angle was more in men as compared to the women but this difference was not significant. Similar to our study, the quantification of this angle was done by Koenigsberg et al.[26] and Karagoz et al.[27] Koenigsberg et al.[26] in 2005 measured the basal angle of 200 adults and 50 children with MRI and found a normal value of 129 ± 6. Karagoz et al.[27] studied the basal angles of 84 patients and the mean value for this parameter was 121 ± 6.

Age is one of the main factors which impacts on the growth and development of humans and it is explained that gender differences between girls and boys start after 12 years.[28] A meaningful relation was observed between Basal angle and age in females and males ($P = 0.035$, $r = 0.253$ and $P = 0.015$, $r = 0.276$ respectively). A significant correlation was observed between age and Sphenobasion angle in the male group ($P = 0.0001$, $r = 0.439$) but this comparison was not significant in the female group. Based on our search, there was no similar study that determines the correlation of these two angles with age in males and females but the correlation of other craniofacial parameters with age was presented in other studies. Farkas et al.[29] exhibited that the face length of Caucasian males raised about 15 mm up to 16 years of age and also the face breadth of Caucasian females raised about 13 mm up to 16 years of age. Yeo et al.[30] study identified the morphological characteristics in the growth proportion of the craniofacial parameters in Korean people. In their study, a total 1,255 were divided into childhood (8~10 years), adolescence (14~16 years), and young adult (20~24 years) groups. Their results showed that the head height raised 29 mm (14.9%) in males and 22 mm (11.6%) in females from childhood to young adult and these mentioned findings demonstrated the correlation between craniofacial parameter and age which was in line with the results of the present study.

Our findings indicate the positive correlations between the Basal angle as an important cranial index and age in two genders but it is necessary to collect morphometric information in different races and population.

Conclusion

The results of this study showed positive correlations between the Basal angle and age in the females and males and significant relations between the Basal and Sphenobasion angles in the two genders.

Conflict of Interest

None.

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