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Assessment and comparison of cranial base morphology in individuals with long face and short face

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Abstract

OBJECTIVES: The objectives of the study was to assess and compare the cranial base morphology in long face and short face.

METHODOLOGY: The study comprises 64 individuals (32 in each group). Group I consists of individual's with long face and group II comprises individuals with short face. Individuals were classified into groups with the help of lateral cephalometric parameters like Gonial Angle, Anterior facial height, Posterior facial height, Jarabak's Ratio, and Y-axis. Linear and angular measurement in the cranial base was taken.

RESULT: The results showed statistically significant difference in Sella-Nasion, Sella-Basion and Nasion-Sella-Basion between the two groups. Sella-Spinoethmoidal suture, Nasion-Spinoethmoidal suture, Spinoethmoidal suture-Sella-Basion, Frankfurt Horizontal-Sella-Nasion, Frankfurt horizontal-Sella-Basion, Frankfurt horizontal-Sella-Spinoethmoidal suture showed no statistically significant difference among the groups.

CONCLUSION: The study concluded that individuals with long face have a greater Sella-Nasion, Sella-Basion, Nasion-Sella-Basion compared to individuals with short face.

Keywords:

Cranial base morphology, long face, short face

Introduction

Cranial base is the centre where skull grows and has developmental and morphological conservatism in mammals. it forms the floor of the cranial vault. It is essentially a midline structure compromising of nasal, orbital, ethmoid, sphenoid, and occipital bone. Sella turcica is in the centre of cranial base.[1]

Cranial base plays an important role in growth of craniofacial structures such as brain, nasal cavity, oral cavity, and pharynx[2] Postnatal growth of anterior portion is mainly due to frontal sinus enlargement and surface remodeling in nasion area whereas posterior segment is by growth at spheno-occipital synchongrosis.[1]

Flexion of anterior and posterior cranial base occur at the sella turcica in mid sagittal plane. Thus, it influences the sagittal relationship and type of malocclusion.[3] Basicranial morphology, head and neck posture and soft tissue stretching are thought to influence the occurrence of a skeletal malocclusion.

Post-natally, there is a decline in the growth rate starting around the age of 7 years.[4] Thus, it could be possible that changes altering the development of the cranial base could also have an effect on the development of the face. Ricketts and Moyers also stated cranial base influence facial prognathism and anteroposterior jaw relationship.[5,6]

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Enlow in 1993 mentioned that cranial base as a template for development of face. Cranial base directly influences the facial structure, the angles, the size, and positioning of the various parts of the face.[7] Brodie emphasized the importance of understanding the growth of the cranial base for orthodontists, since the successful treatment of malocclusions depends on the entire craniofacial growth.[8]

The current study aims to better understand and evaluate the cranial base morphology in individuals with long face and short face.

Materials and Methods

This study was carried out in the department of Orthodontics and Dentofacial Orthopaedics, after obtaining ethical clearance with the certificate number–ABSM/EC/61/2018, with the aim of assessing the cranial base morphology in subjects with long face and short face. 64 individuals were selected with age group 18-30 years and grouped as group I and group II. Group I comprises individuals with long face and group II comprises individuals with short face. Lateral cephalograms were to be taken from the archives of the Department of Orthodontics.

Exclusion criteria were patients with an average growth pattern, patients with an incomplete record, previous history of orthodontic treatment/orthognathic surgery and patients with previous history of trauma, multiple missing teeth, and multiple large restoration.

Institutional ethics committee consent was obtained for the study. The sample size was decided with the help of the following formula: $N = 2\ \sigma^2\ (Z_{1-\alpha} + Z_{1-\beta})/\Delta^2$ Where α is the level of significance (5%), 1-β is the power of test (80%), Δ is the effective size (2.5), σ is the standard deviation (5).

Sample size was calculated as 32 individuals in each group. Lateral cephalograms were made in Planmeca PM 2002 cc (Proline, Finland) under standardized conditions. The cephalograms were traced on 0.003-inch cellulose acetate sheet with 0.5 mm lead pencil.

Under Long and short face will be determined using the following parameters: Gonial angle (Group 1: Individuals with a gonial angle more than 55^0, Group 2: Individuals with a gonial angle less than 52^0), Anterior facial height, Posterior facial height, Y axis (Group 1: Individuals with Y axis more than 66^0, Group 2: Individuals with Y axis less than 53^0), Jarabak's ratio (Group 1: Individuals with a ratio less than 58%, Group 2: Individuals with a ratio more than 64%).

The following linear measurements (in mm) were taken [Figure 1] Sella-Nasion (S-N), Sellabasion (S-Ba), Sella-Sphenoethmoidal point (S-Se) and Nasion-sphenoethmoidal (N-Se).

The following angular measurements (in degree) were taken [Figure 2] Nasion-Sella-Basion (N-S-Ba), Sphenoethmoidal-Sella-Basion (Se-S-Ba), Frankfurt horizontal to sella-nasion plane (FH-SN), Frankfurt horizontal to sella-basion plane (FH-S-Ba), Frankfurt horizontal to sella-spheno-occipital plane FH-S-Se (degree).

Statistical analysis

The collected data were summarized by using frequency, percentage, mean, and standard deviation. Independent sample "t" test and Mann–Whitney test. "P" values less than 0.05 was considered as statistically significant.

Results

The present study was undertaken in the Department of Orthodontics and Dentofacial orthopaedics, with aim of assessing cranial base morphology in individuals with long and short face. 64 individuals of age group 18-30 years with no history of previous orthodontic treatment and orthognathic surgery, congenital or developmental anomalies, gross asymmetry were selected as group I and group II. Group I comprises individuals with long face and group II comprises individuals with short face. Data were computed and subjected to statistically analysis. Following results were obtained.

Comparison of mean S-N (mm) between long face and short face

The linear measurement S-N (mm) in long face was 64.15 with the standard deviation of 2.39 whereas the mean S-N of short face was 62.0 with the standard deviation of

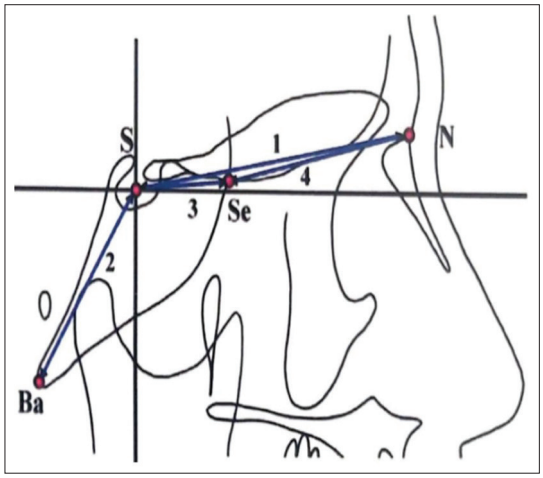

Figure 1: Linear measurements

2.384. By applying students unpaired t test the difference was found to be significant (p = 0.007) [Table 1].

Comparison of mean S-Ba (mm) between long face and short face

The mean S-Ba (mm) of the long face was 39.40 with the standard deviation of 4.083 and the same measurement in short face was 42.35 which is more than long face. While comparing the mean value it was found that the difference was found to be statistically significant (p = 0.009). The values in the long face ranges from 33 to 45 whereas in short face it ranges from 37 to 47 [Table 2].

Comparison of mean S-Se (mm) between long face and short face

The mean S-Se (mm) in the long face was 22.65 with the standard deviation of 1.785 which ranges from 20 to 27. In case of short face the mean values were 23.45 with the standard deviation of 2.35 and the values ranges from 21 to 29. But the difference between the short face and the long face was not statistically significant (p-0.233) [Table 3].

Comparison of mean N-Se (mm) between long face and short face

The mean N-Se (mm) in long face was 40.55 which varies from 37 to 46. And in short face, the values vary from 35 to 45 with the mean value as 40.0 a slight difference from long face. Hence, the difference between the long face and short face with regard to mean N-Se was insignificant [Table 4].

Comparison of mean N-S-Ba between long face and short face

The angular measurement N-S-Ba cranial base flexure was estimated for both long face and short face. The mean value at long face was131.15 with the standard deviation of 4.158. In short face, the mean angular measurement N-S-Ba was 127.35 which is less than long face. The values range from 120 to 139 and the difference between these two groups was found to be significant (p = 0.008) [Table 5].

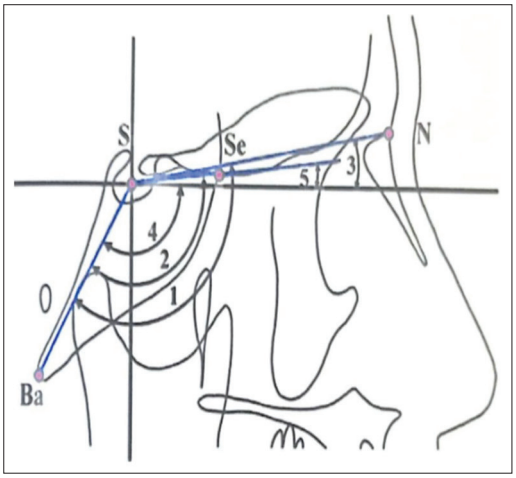

Figure 2: Angular measurements

Comparison of mean Se-S-Ba between long face and short face

Se-S-Ba, angle formed by the sphenoid and occipital bones was estimated for Long face and short face. At long face, the mean value was 131.4 with the standard deviation of 6.082 and the values ranges from 122 to 146. In case of short face, the mean value was132.5 with the standard deviation of 7.957 and the values ranges from 116 to 144. The difference between the long face and short face with regard to the angle Se-S-Ba, there was no significant value (p = 0.426) [Table 6].

Comparison of mean FH-SN between long face and short face

The inclination of anterior cranial base FH-SN was estimated for both long face and short face. The angle

Table 1: Comparison of mean S-N (mm) between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	64.15	2.390	60	68	2.737	0.009**
Short face	62.00	2.384	57	66		

Table 2: Comparison of mean S-Ba (mm) between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	39.40	4.083	33	45	2.737	0.009**
Short face	42.35	2.562	37	47		

Table 3: Comparison of mean S-Se (mm) between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	22.65	1.785	20	27	1.212	0.233
Short face	23.45	2.350	21	29		

Table 4: Comparison of mean N-Se (mm) between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	40.55	2.762	37	46	0.674	0.504
Short face	40.00	2.384	35	45		

Table 5: Comparison of mean N-S-Ba between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	131.15	4.158	122	139	2.782	0.008**
Short face	127.35	4.475	120	135		

was ranging from 1 to 12 in both the faces. The mean value in long face was 6.7 and in short face it was 6.75, a small difference. Even the standard deviation of the two groups was somewhat similar. While comparing the two we could see that there was no significant difference between those two groups (p = 0.961) [Table 7].

Comparison of mean FH-S-Ba between long face and short face

The inclination of posterior crane base was estimated and the mean value at short face was 58.6 with the standard deviation of 4.893. The values range from 51 to 69. Whereas in case of long face, the mean value was 59.7 with the standard deviation of 3.672 and it ranges from 53 to 66. The mean difference between the long face and short face with regard to the angle FH-S-Ba was not significant (p = 0.426) [Table 8].

Comparison of mean FH-S-Se between long face and short face

The angle formed by Sphenoid bone to the Frankfort horizontal was estimated for both the long face and short face. The values were distributed from 2 to 16. The mean FH-S-Se angle in long face was 9.15 with the standard deviation of 3.167. Similarly, the mean angle of short face was 8.9 with the standard deviation of 3.329. The difference between the mean angle was not statistically significant (p = 0.809) [Table 9].

Table 6: Comparison of mean Se-S-Ba between Long face and Short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	131.40	6.082	122	146	0.491	0.426
Short face	132.5	7.957	116	144		

Table 7: Comparison of mean FH-SN between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	6.70	3.246	1	12	0.05	0.961
Short face	6.75	3.217	2	12		

Table 8: Comparison of mean FH-S-Ba between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	59.70	3.672	53	66	0.804	0.426
Short face	58.60	4.893	51	69		

Table 9: Comparison of mean FH-S-Se between long face and short face

	Mean	Standard Deviation	Minimum	Maximum	*t*	*P*
Long face	9.15	3.167	2	15	0.243	0.809
Short face	8.9	3.329	3	16		

Discussion

Cranial base is considered very important in for growth of itself and the surrounding bones. Growth of maxilla occurs in forward and down ward direction because of secondary displacement. Various studies have stated that anterior cranial base as a reference plane as growth of Sella-Nasion plane completes first and is stable throughout growth.

Skeletal malocclusion can be classified in anteroposterior plane that is class I, class II, and class III whereas in vertical direction they are growth pattern such as average, vertical, and horizontal growth pattern. There have been various studies to correlate the cranial base morphology with the sagittal relationship of the maxilla and mandible. This study deals with correlating the cranial base morphology with the growth pattern of the patient.

In the current study it was found that the linear measurements: Sella-Nasion and Sella-Basion were found to be statistically significant. Greater measurements were found in long face compared to short face. This is in accordance with the Kasai *et al*., who found a positive corelation between that anterior cranial base length and anterior facial height. The lateral cranial base is mostly correlated with posterior facial height in males and females. Kasai *et al*.[9] also reported that the lateral cranial base (S-Ar) and the posterior cranial base (S-Ba) may have analogous effects with the craniofacial morphology.

In a study done by Yassir *et al*.,[10] in the year 2008, comparison was done to correlate the anterior and lateral cranial base lengths with mandibular morphology and facial heights. They concluded that the ratio of anterior cranial base should be in a 1:1 ratio with the mandibular body length. It was also stated that anterior cranial base was significantly positively correlated with mandibular body, total mandibular length, total anterior, and lower facial heights in females, while it was significantly positively correlated with ramal height, mandibular body, total mandibular length, total anterior facial height, lower anterior facial height, and posterior facial height in males.

In a study done by Kazuto *et al*. to assess the cranial base morphology of the craniofacial system in human populations, Europeans, Asians, and Africans were chosen. The study considered five angular and two linear measurements from the cranial base and six angular and six linear measurements from the facial skeleton. The study concluded that the European sample presented dolichofacial individuals with increased face height and a smaller face depth derived from a raised cranial base and facial cranium orientation tended to be similar

to the Asian sample. The African sample presented brachyfacial individuals with shorter facial height and large face depth as a result of lowered cranial base and facial cranium orientation. The findings of this study suggest that cranial base orientation and posterior cranial base length appear to be valid discriminating factors between individuals' cranial base orientation and posterior cranial base length appear to be valid discriminating factors between individuals.[11]

Markus Bastir *et al*.,[12] correlated variation between the lateral basicranium and the face. The aim of this study was to explore and compare patterns of morphological co-variation between the face and the lateral basicranium (anterior and middle cranial fossae) with co-variation patterns between the face and the midline cranial base. The lateral basicranium is correlated with facial variation than the midline cranial base.

A study done by Mohammed Monirifard *et al*.,[13] in the year 2020, the study determined the relationship between anteroposterior cephalometric indicators and the cranial base cephalometric indicators in an Iranian population. Smaller cranial base angle in the skeletal class III malocclusion compared to skeletal class II malocclusion was demonstrated in this study. A significant correlation between the cranial base angle, the cranial base dimension, and the effective length of the maxilla was observed, and the smaller cranial base angle in class III malocclusion was also confirmed. These findings indicated that the cranial base can affect the development of maxilla and mid-face.

The current study reported statistically significant difference between cranial base angle in individuals with long face and short face. The above findings are in agreement with those of *Amit Bhattacharya in which it was reported that an* influence exists between of cranial base angle and rotation of the mandible, correlation suggests that increase in the cranial base flexure can cause a clockwise rotation of the mandible.[14]

In a study done by Willian Bacon, it was reported that Saddle angle and divergence showed a correlation which is in accordance with the current study where cranial base angle showed statistical difference among the two groups.[15]

The cranial base angle correlates with facial form: a more obtuse cranial base angle being associated with a more divergent facial type.[9] This is again in accordance with the current study.

The cranial base morphology also shows certain variation with change in sagittal skeletal relationship as reported in the literature. Angle's class II and class III malocclusions shows a significant variation in both angular and linear measurements of the cranial base.

A more detailed picture could be obtained if sampling was done taking subjects, gender into account as well and hence could be considered as the limitation of the present study. Hence, further studies encompassing larger samples that are classified based on gender are required to clarify and prove or disapprove the role played by the cranial base morphology in long face and short face.

Conclusion

The following conclusions can be drawn from the present study:

- Individuals with long face have a greater S-N (linear measurement) compared to short face.
- A greater S-Ba (linear measurement) was found in long face when compared to short face.
- The angular measurement N-S-Ba was found to be greater in long face and short face.
- The following measurements N-Se, S-Se, Se-S-Ba, FH-S-Ba, FH-S-Se, did not show any statistically significant difference between long face and short face.

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Conflicts of interest
There are no conflicts of interest.

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