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A CEPHALOMETRIC EVALUATION OF FRONTAL SINUS DIMENSIONS IN SKELETAL CLASS I AND CLASS II MALOCCLUSIONS AND ITS RELATIONSHIP TO CRANIOFACIAL DIMENSIONS

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ABSTRACT

This study was done to evaluate the frontal sinus dimensions in skeletal Class I and Class II malocclusions and its relationship to craniofacial dimensions which includes the anterior and posterior cranial base lengths, maxillary length and the mandibular length.

METHODOLOGY:

This study was conducted using the lateral cephalograms procured from the orthodontic records submitted in the department of orthodontics at the School of Dental Sciences, Sharda University.

A total of 120 lateral cephalograms were obtained from the orthodontic records submitted in the department of orthodontics at the School of Dental Sciences, Sharda University, which comprised of male and female patients with skeletal class I and Class II malocclusion.

CONCLUSION: Frontal sinus dimensions in males are larger as compared to females in both Class I and Class II malocclusion but the ratio of frontal sinus height to widthremained same in both males and females.

Frontal sinus height to width ratio was found to be different in both Class I and Class II malocclusions in males as well as females. In males, frontal sinus ratio in patients having Class II malocclusion was greater than Class I malocclusion. Frontal sinus width was smaller in Class II but frontal sinus height remained the same inboth the groups.

Keywords: Cephalometric, Frontal Sinus, Craniofacial Dimensions, Malocclusions, Skeletal Class

INTRODUCTION

The frontal sinus isone of the paranasal sinuses. [1] It is a cavity in the frontal bone, that is formed following pneumatization of the frontal bone and is directly influenced by the interactions between respiratory epithelium and adjacent osteoclasts.

The dimensions of the frontal sinus are influenced by race, gender, bioenvironmental factors, diseases, and growth patterns. At birth, this sinus is either very small or nonexistent. Vertical growth of the sinus begins at 2 years of age, and it becomes visible on cephalograms by the age of 8 years. [2]

Frontal sinus reaches its peak growth roughly one year after the body's overall growth peak. According to Brown et al., the primary growth of the frontal sinus typically stops around the age of 16 years in boys and 13 years in girls.[3]

Late mandibular growth upto the age of 20 years and 18 years in females can lead to treatment failure in patients with Class III malocclusion, thus accurately predicting the final jaw size in these patients is crucial. [5]

Precise treatment timing plays a significant role in the success of orthodontic treatment for class II and class III skeletal malocclusion.

Skeletal class III patients with larger frontal sinuses are more likely to need orthognathic surgery in addition to orthodontic appliances in the future. Patients having wide symphysis and longer condyle have also been linked to large frontal sinuses .[6]

In a study examining cases with skeletal Class I, II, and III relationships measured the frontal sinus area on their lateral cephalograms. It was found that large frontal sinuses had a positive correlation with large mandibles regardless of their positional relationship. [1]

For an Orthodontist it is absolutely essential to draw differences and similarities between different malocclusions. We took skeletal class I and class II malocclusions into our study. In order to obtain a thorough comparative study of thefollowing parameters, i.e., frontal sinus, cranial base and the jaws all the measurements are important. Therefore this study was done to evaluate the frontal sinus dimensions in skeletal Class I and Class II malocclusions and its relationship to craniofacial dimensions.

METHODOLOGY

Lateral cephalograms were procured from the orthodontic records submitted in the department of orthodontics at the School of Dental Sciences, Sharda University.

A total of 120 lateral cephalograms were obtained from the orthodontic records submitted in the department of orthodontics at the School of Dental Sciences, Sharda University, which comprised of male and female patients with skeletal class I and Class II malocclusion.

Patients within 15–20 years of age without any syndrome associated having skeletal class I and Class II malocclusions will be included in the study**.** Lateral cephalograms were selected based on the following criteria ; skeletal Class I (1°< ANB ≤4°, beta angle 27°-34°), skeletal Class II (ANB >4°, beta angle <27°)

Patients with Poor-quality radiographs, patients undergone Orthodontic treatment, maxillofacial surgery or trauma and pathology involving Frontal Sinus were excluded from the study. Evaluation of the frontal sinus was done on the basis of following points :-

Height- **SH -** highest point in frontal sinus**, SL** - lowest point in frontal sinus**, SH-SL** - Distance between SH and SL represents the height of frontal sinus.

Width- **SPP**-most posterior point of frontal sinus**, SAP**-most anterior point of frontal sinus**, SPP-SAP**-Distance between SPP and SAP represents them width of frontal sinus. Frontal sinus ratio-Height to width Ratio of the frontal sinus. Anterior cranial base length-Distance between Sella (S) and Nasion (N). Posterior cranial base length-Distance between Articulare (Ar) and Sella(S)

Maxillary length was calculated by measuring the distance between anterior nasal spine(ANS) to posterior nasal spine(PNS) and mandibular dimensions by measuring between, Co-Gn: Effective mandible length, Go-Gn: Mandibular body length, Co-Go: Mandibular ramus height.

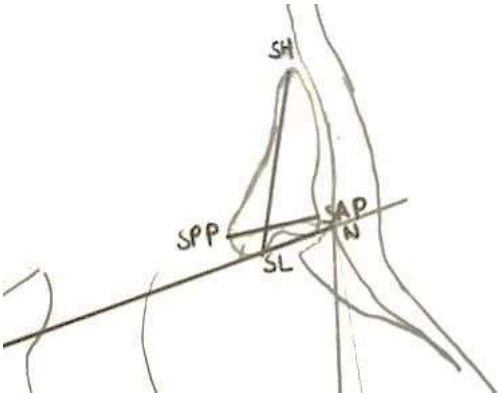


Fig 1: Frontal sinus dimensions

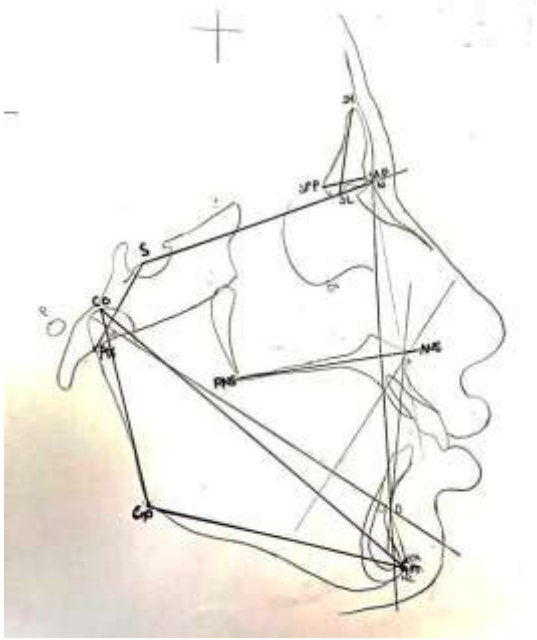


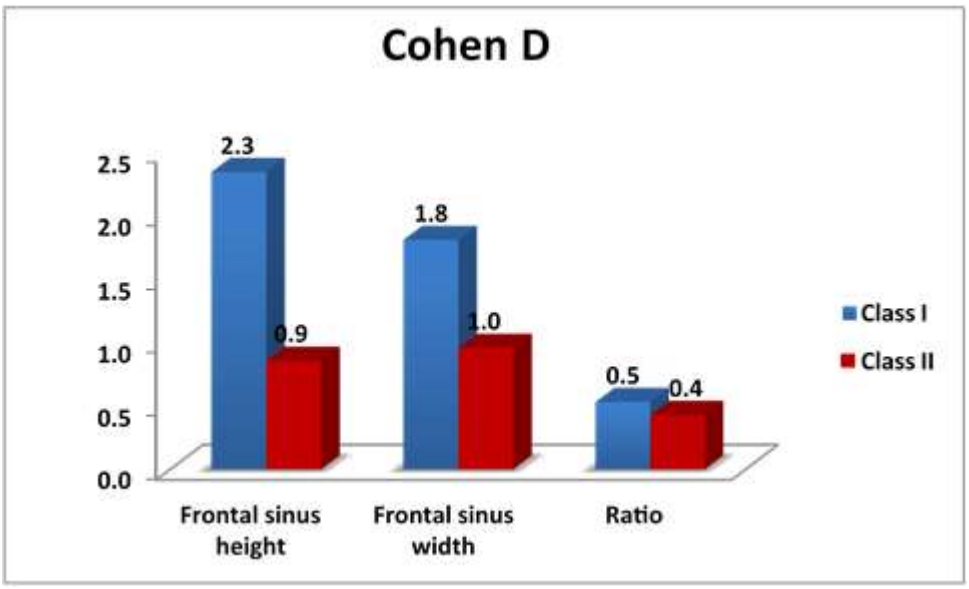
Fig 2: Tracing showing the cephalometric variable

RESULTS

Table 1 and graph 1 shows the effective size difference of frontal sinus parameters in Skeletal Class I and Class II males and females. The effect size is large for Frontal sinus height and width in Skeletal Class I and Class II males and females. The effect size is medium for Frontal sinus ratio in Skeletal Class I males and females. The effect size is small for Frontal sinus ratio in Skeletal Class II males and females.

Table 1- Effective size difference of frontal sinus parameters in Skeletal Class I and Class II males and females.

Parameter	**Class I**	**Class II**
Frontal sinus height	2.3	0.9
Frontal sinus width	1.8	1.0
Ratio	0.5	0.4



Graph 1- Effective size difference of frontal sinus parameters in Skeletal Class I and Class II males and females.

Table 2 : Correlation of Frontal sinus height, width and Ratio with ACBL by Pearson correlation coefficient

Gender		**Frontal sinus height**		**Frontal sinus width**		**Ratio**	
		r value	**p value**	**r value**	**p value**	**r value**	**p value**
Males	Class I	0.01	0.959	0.265	0.157	-0.333	0.072
	Class II	0.412	0.024*	0.188	0.319	0.115	0.546
Females	Class I	0.086	0.651	0.337	0.068	-0.237	0.207
	Class II	0.042	0.824	-0.326	0.078	0.34	0.066

Note: * significant at 5% level of significance (p<0.05)

Table 3: Correlation of Frontal sinus height, width and Ratio with PCBL by Pearsoncorrelation coefficient

Gender		**Frontal sinus height(mm)**		**Frontal sinus width (mm)**		**Ratio**	
		r value	**p value**	**r value**	**p value**	**r value**	**p value**
Males	Class I	0.43	0.018*	0.243	0.195	0.074	0.697
	Class II	0.154	0.416	-0.021	0.913	0.085	0.654
Females	Class I	0.124	0.515	-0.162	0.392	0.311	0.094
	Class II	0.063	0.742	0.236	0.21	-0.116	0.54

Note: * significant at 5% level of significance (p<0.05)

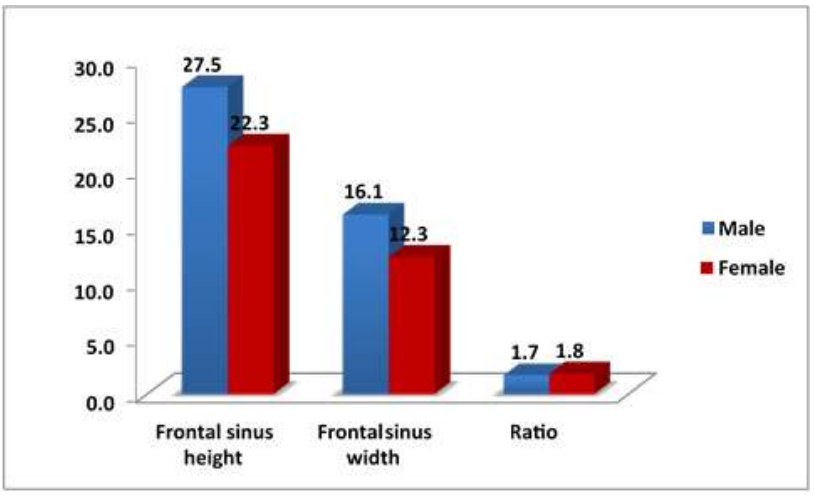
Table 4 : Comparison of Frontal sinus height, width and ratio between Skeletal Class I Males(n=30) and Females(n=30).

Parameter	**Male**		**Female**		**t**	**df**	**p value**
	Mean	**SD**	**Mean**	**SD**			
Frontal sinus height(mm)	27.5	2.1	22.3	2.4	9.074	58	<0.001*
Frontal sinus width(mm)	16.1	2.1	12.3	2.0	7.007	58	<0.001*

Ratio	1.7	0.6	1.8	0.8	0.578	58	0.57

Note: * significant at 5% level of significance (p<0.05)

Table 4 and Graph 2 present a comparison of the frontal sinus height, width, and height-to-width ratio between Skeletal Class I males and females. The results indicate a statistically significant difference in both the frontal sinus height and width between these groups, with males showing greater values in both dimensions compared to females. However, no significant difference is observed in the frontal sinus height-to-width ratio between Skeletal Class I males and females.



Graph 2: Comparison of Frontal sinus height, width and ratio between Skeletal Class I Males and Females.

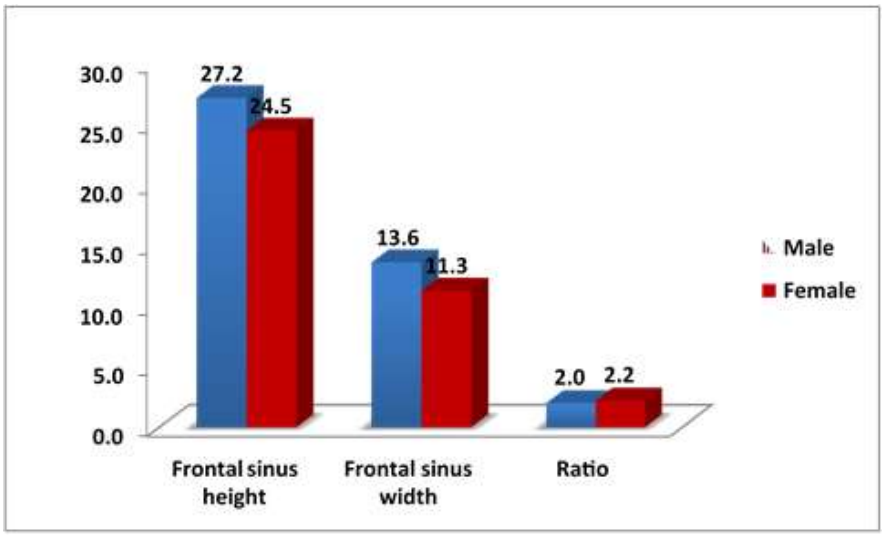
Table 5: Comparison of Frontal sinus height, width and ratio between Skeletal Class IIMales(n=30) and Females(n=30)

Parameter	Male		Female		t	df	p value
	Mean	SD	Mean	SD			
Frontal sinus height(mm)	27.2	3.1	24.5	3.2	3.319	58	0.002*
Frontal sinus width(mm)	13.6	2.7	11.3	2.2	3.715	58	<0.001*
Ratio	2.0	0.4	2.2	0.6	-1.667	58	0.101

Note: * significant at 5% level of significance (p<0.05)

Table 5 and Graph 3 present a comparison of the frontal sinus height, width, and height-to-

width ratio between Skeletal Class II males and females. The analysis reveals a statistically significant difference in both the frontal sinus height and width between these groups, with males exhibiting greater values in both dimensions compared to females. However, no significant difference is observed in the frontal sinus height-to-width ratio between males and females in Skeletal Class II.



Graph 3: Comparison of Frontal sinus Parameters between Skeletal Class II Males and Females

Table 6: Correlation of Frontal sinus height, width and Ratio with Maxillary length by Pearson correlation coefficient

Gender		Frontal sinus height(mm)		Frontal sinus width(mm)		Ratio	
		r value	p value	r value	p value	r value	p value
Males	Class I	0.023	0.904	-0.129	0.496	-0.124	0.512
	Class II	0.059	0.757	0.052	0.786	-0.021	0.913
Females	Class I	0.113	0.552	0.244	0.193	-0.138	0.468
	Class II	-0.155	0.412	-0.059	0.758	-0.059	0.759

Note: * significant at 5% level of significance ($p<0.05$)

Table 7 : Correlation of Frontal sinus height, width and Ratio with Mandibular lengthby Pearson correlation coefficient

Gender		**Frontal sinus height(mm)**		**Frontal sinus width(mm)**		**Ratio**	
		r value	**p value**	**r value**	**p value**	**r value**	**p value**
Males	Class I	0.198	0.294	0.098	0.606	-0.109	0.565
	Class II	0.42	0.021*	0.217	0.25	0.084	0.659
Females	Class I	0.225	0.231	0.308	0.098	-0.14	0.461
	Class II	0.125	0.511	0.229	0.224	-0.08	0.673

Note: * significant at 5% level of significance ($p<0.05$)

Table 8 : Correlation of Frontal sinus and Ratio with Ramal length by Pearsoncorrelation coefficient

Gender		**Frontal sinus height(mm)**		**Frontal sinus width(mm)**		**Ratio**	
		r value	**p value**	**r value**	**p value**	**r value**	**p value**
Males	Class I	0.457	0.011*	-0.011	0.952	-0.19	0.316
	Class II	0.518	0.003*	0.318	0.087	-0.035	0.853
Females	Class I	0.204	0.279	0.23	0.222	-0.083	0.664
	Class II	0.319	0.086	0.175	0.356	0.042	0.825

Note: * significant at 5% level of significance ($p<0.05$)

Table 9 : Correlation of Frontal sinus and Ratio with Mandibular body length by Pearson correlation coefficient

Gender		Frontal sinus height(mm)		Frontal sinus width(mm)		Ratio	
		r value	p value	r value	p value	r value	p value
Males	Class I	0.303	0.103	0.045	0.814	-0.158	0.403
	Class II	0.258	0.168	0.182	0.337	0.111	0.558
Females	Class I	0.117	0.538	0.058	0.762	0.037	0.846
	Class II	0.095	0.617	0.109	0.565	-0.012	0.948

Note: * significant at 5% level of significance ($p<0.05$)

There was no correlation between frontal sinus dimensions and the variables studied i.e. ACBL, PCBL, Maxillary length, Mandibular body length, Mandibular ramal length, Mandibular length in both Class I and Class II males and females except showing significant correlations ($p<0.05$) of FH (frontal sinus height) only in males with Mandibular ramal length in both Class I and II malocclusions whereas that with ACBL and Mandibular length in Class II malocclusion only and that with PCBL in Class I malocclusion only. (Table 6-9)

DISCUSSION

Lateral cephalograms are essential in orthodontics for accurate diagnosis and effective treatment planning. Malocclusions are viewed as significant deviations from normal alignment, and their morphological characteristics have been extensively studied through lateral cephalogram analysis.

Preuschoft et al. reported that paranasal sinuses develop in response to the biomechanical demands of skull architecture.[33] The frontal sinuses, located in the frontal bone above the eyes, are particularly important for diagnosing and treating various malocclusions. The frontal sinus bud is present at birth in the ethmoidal region but is not radiographically visible until around the age of 5 years.[15] It migrates into the frontal bone by the end of the first year of life.[3]

Manual tracing was used for calculating the maximum height, width, and frontal sinus height to width ratio. Although some studies used the digital method to measure these factors, the manual technique has demonstrated similar accuracy to the digital method in this context.[3]

The results of this study show that the mean width of the frontal sinus in Skeletal Class I males is significantly greater than Skeletal Class II males whereas in Skeletal Class II females the frontal sinus height is significantly greater than Skeletal class I females.

The results of our study show Skeletal Class II males have significantly greater frontal sinus ratio than Skeletal Class I males and Class II females have significantly greater frontal sinus ratio than Skeletal Class I females.

The results also shows that frontal sinus height and width in males are larger as compared to females in both Class I and Class II malocclusion but the ratio of frontal sinus height to width remained same in both males and females.

Yassaei, et al [1] concluded that the mean height and surface area of the frontal sinus had a positive correlation with the linear distances of SN and Ar-S, which showed patients with larger cranial base have a larger frontal sinus, which was not in line with our results.

Yassaei et al. included only mandibular body length (Go-Gn) in their study. However, in the current study, we included mandibular body length along with ramal length (Co-Gn) and mandibular length (Go-Gn) [1] This difference is likely because we classified patients based on the ANB angle and Beta angle, whereas they classified patients based on the size of the mandible.

This finding contrasts with our current study. Rossouw et al. (1991) compared the frontal sinus area between adult skeletal Class III and Class I growth patterns but did not examine Class II growth patterns. In our study, we considered skeletal Class I and Class II malocclusions and did not include the frontal sinus area.[5]

CONCLUSION

Ratio of frontal sinus height to width was found to be different in both Class I and Class II malocclusions in males as well as females. In males, frontal sinus ratio in Class II was greater than Class I malocclusion as frontal sinus width was smaller in Class II but frontal sinus height remaining the samein both the groups. In females, frontal sinus ratio in Class II was greater than Class I malocclusion as frontal sinus height was greater in Class II but frontal sinus width remaining the same in both the groups. There was no correlation between frontal sinus dimensions and variables studied i.e. ACBL, PCBL, Maxillary length, Mandibular body length, Mandibular ramallength, Mandibular length in both Class I and Class II males and females except showing significant correlations of frontal sinus height only in males with Mandibular ramal length in both Class I and II malocclusions whereas that with ACBL and

mandibular length in Class II malocclusion only and that with PCBL in Class I malocclusion only.

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