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"Frontal sinus: Indicator of growth pattern"

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Abstract: *OBJECTIVE: To determine the interrelationship between the frontal sinus size and growth pattern of an individual.*
MATERIAL AND METHODS: The patient database was collected at the department of orthodontics. Total sample size 135 patients including both male and female were selected applying inclusion and exclusion criteria. Lateral cephalometric radiographs were obtained from the department of oral medicine and radiology and examined for each sample using Nemoceph software. Growth pattern of an individual was determined in the software. Samples were classified into three groups according to the growth pattern. The frontal sinus area on the lateral cephalometric radiograph was measured and comparison between the growth pattern and frontal sinus size was done using statistical analysis.
RESULTS: Mandibular plane angle has a significant effect on frontal sinus size (P<0.05). Frontal sinus seems to be larger in horizontal growth pattern as compared to average and vertical growth pattern. There is significant correlation between horizontal and average growth pattern with sinus size after statistical analysis.
CONCLUSION: Frontal sinus size significantly differ according to growth pattern of an individual. Frontal sinus size: Horizontal > Vertical > Average.

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I. Introduction:

Paranasal sinuses are bony chambers embedded in bones around midfacial sutures. Preuschoft et al. reported that paranasal sinuses have been developed in response to the biomechanical necessities of the skull architecture.[1] The frontal sinus is one of the paranasal sinuses located in the skull, is formed following pneumatization of the frontal bone, which is directly influenced by the interactions of the respiratory epithelium and activity of adjacent osteoclasts.[2] It was stated that a septum in the frontal sinus seems to be a consequence of stress distribution in the midline, which implies that these masticatory stresses reach the frontal sinus.[3] Maxillary sinus and frontal sinus can be depicted in lateral cephalograms of almost all patients.

Many studies showed frontal sinus is more reliable for growth prediction. The growth patterns of the mandible, maxilla, and other craniofacial structures should be taken into consideration as essential components to determine the time of occurrence, duration, and prognosis of malocclusions. Rossouwet al[4] found a correlation between frontal sinus area on lateral cephalometric radiographs and maxillary length, mandibular length, symphysis width, and condylar length. These all structures contribute in the determination of mandibular growth pattern.In other cephalometric investigations, it was found that the frontal sinus development showed a growth rhythm which is similar to body height development with a well-defined pubertal peak[5-6]. Hence it is suggested to use frontal sinusas an indicator for mandibular growth pattern.

This study was designed to assess the possible associations between the frontal sinus dimensions and growth pattern in sagittal plane using pretreatment lateral cephalometric radiographs in a group of the regional population.

II. Materials And Method:

A search was conducted through the Database at department of orthodontics. Ethical clearance was obtained from ethical committee. Patients were included according to inclusion and exclusion criteria mentioned below,

Inclusion criteria:

- No history of orthognathic surgery
- Good quality of radiographs.

- No gross facial asymmetry.

Exclusion criteria:

- Patients with signs of infection or sinus pathology based on radiographs
- Congenital syndromes involving craniofacial bones, palatal clefts, hemifacialmicrosomia or hypertrophy
- History of trauma to the nasomaxillary complex

Procedure methodology:

The sample size (n) was calculated by using a software developed by Dr AP Kulkarni; using formula –

$$n = \frac{2\, s2\, (z1 + z2)2}{(m1 - m2)2}$$

A total of 135 adult patients were included in study among which 50 patients had horizontal growth pattern, 50 patients had average growth pattern and 35 patients had verticle growth pattern. Vertical growth pattern sample group was small due to the low incidence of vertical growth pattern in population. Growth patterns of these samples were determined by analyzing lateral cephalometric radiographs in Nemoceph Software (fig 1 A). Also size of the frontal sinus was determined using same software (Fig 1 B).The peripheral border of the frontal sinus was traced, and the highest and lowest points of sinus extension were marked in nemoceph software.

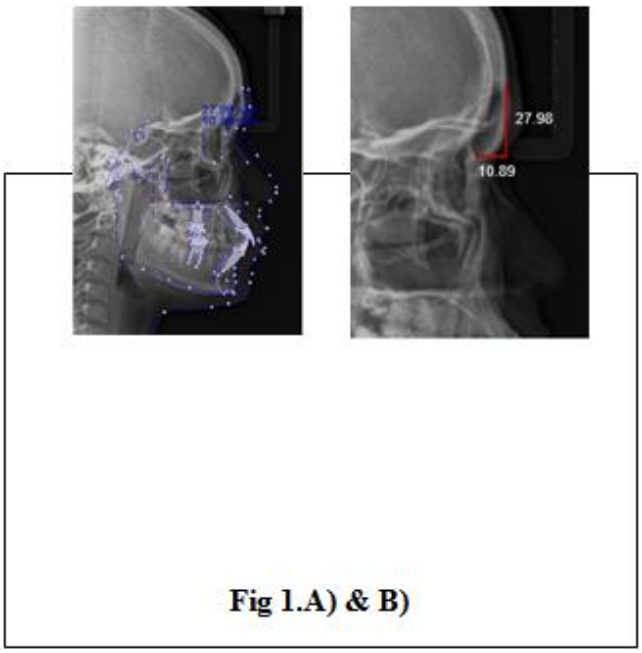

Fig 1.A) & B)

Statistical analysis:

Data was collected by using a structure proforma. Data entered in MS excel sheet and analysed by using SPSS 19.0 version IBM USA. Quantitative data was expressed in terms of Mean and Standard deviation (Fig 2).

Descriptive statistics like mean, SD, Std. error, range are calculated between three groups with SPSS software. (Fig 3 and table 1).

Comparison of mean and SD between all groups was done by using One way ANOVA test. Post Hoc test (Tukeys HSD) performed to assess whether the mean difference between groups is significant or not. (Table 2). A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant. (table 3)

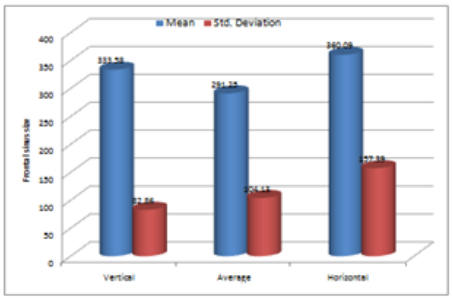

Fig.2

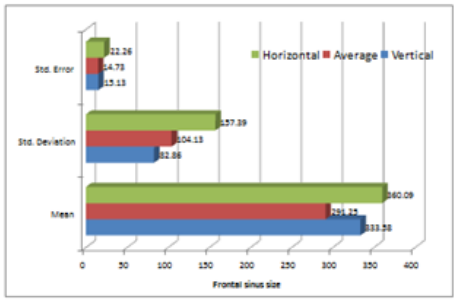

Fig 3

	N	Mean	Std. Deviation	Std. Error	Range	Minimum	Maximum
Vertical	30	333.58	82.86	15.13	363.63	191.70	555.33
Average	50	291.25	104.13	14.73	535.82	57.07	592.89
Horizontal	50	360.09	157.39	22.26	706.65	131.16	837.81

Table 1.

	Average	Horizontal
Vertical	42.32	-26.51
Average		-68.83*

*indicates that the mean difference is significant at 0.05 level

Table 2.

	N	Mean	Std. Deviation	F	df	p	Inference
Vertical	30	333.58	82.86	3.916	2	0.022 (<0.05)	Significant
Average	50	291.25	104.13				
Horizontal	50	360.09	157.39				
Total	130	327.50	126.50				

Table 3.

III. Results

- Mandibular plane angle commonly has a significant effect on frontal sinus size. (P<0.05)
- Frontal sinus seems to be larger in horizontal growth pattern as compared to average and vertical growth pattern.

IV. Discussion

Growth prediction is defined as the estimation of alterations in speed and direction of future growthas it is important factor in treatment planning[7]. Abnormal skeletal relationships which hamper normal function and esthetics of an individual can be corrected if they are diagnosed in growing age, severity of such abnormality can be decreased or controlled.And requirement of future surgeries can be prohibited. Apart from surgical intervention, growth modulation can be done using myofunctional, fixed functional or orthopedic appliances to

correct abnormal skeletal relationships.This study is conducted to determine the correlation of frontal sinus size and growth pattern of an individual using lateral cephalograms.

Different methods are used since decades for growth prediction like hand wrist radiograph, maturation of cervical vertebrae, size of maxillary sinus as well as size of frontal sinus. Frontal sinus is a part of paranasal sinuses that originate from the anterior ethmoidal cells that start their migration into frontal bone at the end of the first year of their life.Maxillary sinus and frontal sinus can be depicted in lateral cephalogram of almost all patients.Dhimanet al[8] studied a reliability of frontal sinus with that of maxillary sinus in assessment of different types of skeletal malocclusion. He concluded that the frontal sinus is more reliable compared to maxillary sinus.
In the present study, statistical results showed that frontal sinus seems to be larger in horizontal growth pattern followed by average and vertical growth pattern in regional population (Table 1).Bustani[9] conducted a study to verify the presence of a relation between the frontal sinus width and skeletal jaw patterns. He concluded that class III subjects recorded the greatest frontal sinus width, a slightly less mean value was recorded by class II subjects, while class I subjects demonstrated the least frontal sinus width mean value. The Findings of the present study are in accordance with study done by Bustani[9] and it states that, horizontal growth of mandible is most commonly seen in the class III skeletal pattern and hence larger frontal sinus size can be correlated with horizontal growth pattern.A study done by Prashar[10] in 2012 states that the frontal sinus area did not vary significantly between hypodivergent and normodivergent and hyperdivergent group. The non-significance of the frontal sinus area in these groups might be due to the fact that all skeletal classes of I, II, and III malocclusions were distributed in the hypodivergent, normodivergent, and hyperdivergent groups.Results shown in the study conducted by Nathani R. et al[11] were contradictory to the present study. Nathani R. et al[11]concluded that maximum size of the frontal sinus is seen in vertical growth pattern followed by horizontal and average growth pattern. This difference in results might be due to difference in environment or ethnicity of population. Also study conducted by Said et al[12] states that there is significant effect of MP-SN on frontal sinus size. MP-SN is the angle between cranial base to the mandiblular plane which indicates the growth pattern.
Limitation of this study is only 2D measurement considered on lateral cephalograms whereas frontal sinus is 3D structure. Hence further studies should be conducted using 3D information about size of frontal sinus.

V. Conclusion

- Growth pattern of an individual has a significant effect on frontal sinus size.
- Frontal sinus size: Horizontal > Vertical > Average
- Larger frontal sinus found in horizontal growth pattern according to this study does not mean it will be smaller in vertical or average growth pattern.

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