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Lateral cephalogram study of frontal sinus dimensions in different skeletal patterns based on ANB angle

Nasim Shams[1], Fataneh GhorbanyJavadpour[2*], Sana Sangashekan [3], Fatemeh Shahsanaei [4]

[1] *Associated professor, Department of Oral and Maxillofacial Radiology, Faculty of Dentistry, Ahvaz Jundishapur University Of Medical Sciences, Ahvaz, Iran*
[2] *Assistant Professor, Department of Orthodontics, School of Dentistry, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[3] *Dental Students, School of Dentistry, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran*
[4] *Faculty of Engineering, Shohadaye Hoveizeh University of Technology, Susangerd, Iran*

Abstract

Frontal sinus is one of the most important paranasal sinuses in the skull. After pneumatization of the frontal bone this sinus develops, and is directly affected by the interactions of the respiratory epithelium and activity of the adjacent osteoclasts. We propose to declare, "is there relationship between the frontal sinus and craniofacial askeletal pattern"? The aim of this study was to assess relation between the frontal sinus dimensions anteroposterior (AP) and superior-inferior (SI) with craniofacial skeletal pattern by using lateral cephalogram. 84 lateral cephalograms (55 females and 29 males) selected from archive of orthodontic department and divided in to three groups: class I, II and III skeletal based on Angle classification and by using the Steiner analysis. lateral cephalograms were traced manually on 0.003-mm matte acetate paper (Ortho-organizer, USA). The anteroposterior (AP) and superior-inferior (SI) dimensions of the frontal sinus were measured by a digital ruler (Model l99702411 ACCUD 60cm) and a digital caliper (ACCUD digital caliper 11100612) and then analyzed statistically by one-way ANOVA and LSD test. AP dimension of the frontal sinus in the all of skeletal patterns were significant (P< 0.045);but there wasn't in the SI dimension (P>0.05).In comparison between CLII and CLIII skeletal the AP dimension was significantly greater in Cl III (P< 0.117).Based on sex dimorphism, the AP dimension of the frontal sinus were significant in the males (P<0.05). This study demonstrated that larger AP dimension of the frontal sinus can be seen in the class III skeletal pattern that was in relation to mandibular prognathism or maxillary retrognathism. According to the sex dimorphism, males had larger AP dimension of the frontal sinus.

Keywords: Frontal bone, Dental arch, skeletal, Adult, Cephalometry.

Full length article*Corresponding Author*, e-mail: Fa.ghorbanyjavad@gmail.com

1. Introduction

Craniofacial structures are interrelated together, their growth and development influenced by a lot of factors. Development one-part can affect the others [1]. The frontal sinus is one of the most important paranasal sinuses in the skull. It develops following pneumatization of the frontal bone and is directly affected by the interactions of the respiratory epithelium and activity of the adjacent osteoclasts [2,3]. Asymmetry in size of sinuses are common because the right and left sinuses develop independently. Moreover, some variations exist in the permeability, morphology, shape and capacity [4]. Since the septum between the sinus often deviates toward one side frontal sinuses are rarely symmetrical [5]. The frontal sinuses are part of the lateral sinuses located within the frontal bone behind the brow ridges and are most often two in number. They are commonly detectable between the ages of 7 to 20 years old [6]. The craniofacial structures can affect morphology of the paranasal sinuses [7]. Rossouw et al. [8] used the frontal sinus dimensions to predict the growth pattern of the mandible and concluded that class III patients with larger frontal sinuses would be in greater need for orthognathic surgery in addition to orthodontic treatment. They found conspicuous relations between the maxillary and mandibular lengths, symphyseal width, and condylar length with frontal sinus dimensions [8]. According to another study on lateral cephalogram frontal sinus dimensions in

skeletal CLIII were larger than in CLI and CLII patterns. According to, their findings larger frontal sinuses are in relation to larger mandibles [9]. In another study about relationship between frontal sinus development and height ratio, they concluded that frontal sinus can be a useful index for evaluation these factors[10-12].Evaluation of this sinus could be down in the sagittal and coronal plane on cephalograms (LC and AP), which ordered for orthodontic purposes[13].Lateral cephalogram is a standard radiograph in sagittal plane, which is simple, cost-effective, accessible, and reproducible radiograph[14,15].The aim of this study was, evaluation relation between frontal sinus dimensions and different skeletal pattern according to the ANB angle in Iranian by using lateral cephalograms. We couldn't find similar study for patients referred to this faculty thus try to evaluate this relationship and compared with other studies in this topic.

2. Materials and methods

This descriptive analytical study evaluated 84 eligible digital lateral cephalograms retrieved from the archives of the Orthodontics Department in dental school of Ahwaz Jundishapur University of Medical Sciences during April 2019 until June 2019.The mean age of patients was 21.25 years (range 16 to 32 years). There were,65.5% females and 34.5% males (55 females and 29 males). The exclusion criteria were frontal sinus aplasia, craniofacial anomaly, history of orthodontic or orthognathic surgery, and poor-quality of radiographs. The cephalograms were traced manually on 0.003-mm matte acetate paper (Ortho-organizer, USA) by using Steiner analysis. (Fig1) First the anatomical landmarks were identified manually (S, N, A and B according to the following definitions) (Fig 1):

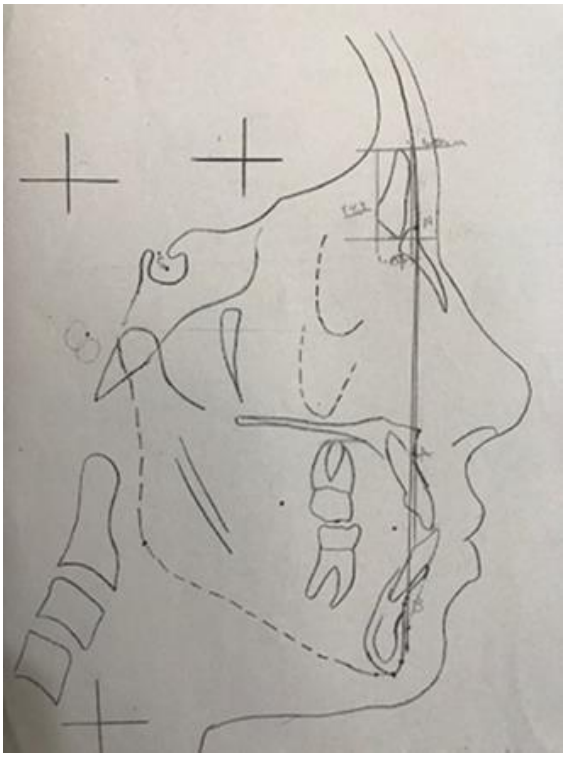

Figure 1: Sample of cephalomertic tracing.

Point A: The deepest point on the curvature of the anterior border of maxilla.

Point B: The deepest point on the concavity of the anterior border of the mandible.

Nasion (N): The most concave point of the nasofrontal suture.

Sella (S): The midpoint of Sella-turcica region.

The ANB, SNB, and SNA angles were detected and landmarking errors minimized by identifying landmarks and measurements 2 weeks later by the same author and controlled by orthodontist. According to the Angle classification the samples were divided in the 3 groups (n=28) of skeletal patterns: CLI(ANB=2), CLII(ANB>2) and CLIII(ANB<0). The frontal sinuses were detected, with the line's tangent to the borders (in the most superior, most inferior, most anterior, and most posterior) of the sinus.(Fig2) After the measurements of distances, the Kolmogorov-Smirnov test were applied to assess the normality of data distribution, which showed normal distribution of all variables. Thus, the parametric tests were applied for data analysis.

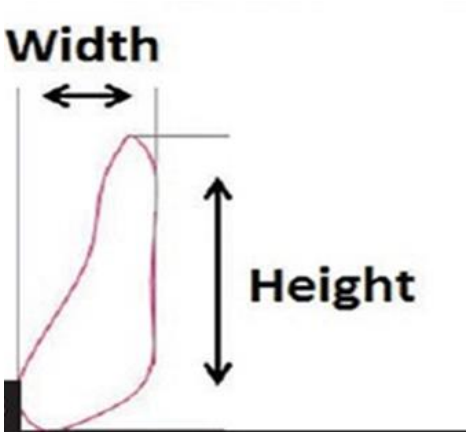

Figure 2: Diagram for evaluation frontal sinus dimensions.

Table 1 shows comparison of frontal sinus dimensions according to the one-way ANOVA analysis. The Levene's test was used to assess the homogeneity of variances.

3. Results and discussions

According to one-way ANOVA, there were significant difference between individuals in terms of (PA) posterior anterior variable (The significance level is 0.045.) (Table 1). But there is no significant difference in terms of (SI) superior-inferior variables (The significance level is 0.117.) (Table 1).

Table1: Comparison of frontal sinus dimensions according to the one-way ANOVA analysis.

Variables	Source of changes	Sum of Squares	Df	Mean Square	F	Sig
Anterior-posterior length	Between Groups	39.830	2	19.915	3.215	0.045
	Within Groups	501.793	81	6 .195		
	Total	541.622	83			
superior-inferior height	Between Groups	76.580	2	38.290	2.203	0.117
	Within Groups	1407.603	81	17.378		
	Total	1484.183	83			

According to the Table 2, Based on the AP dimension of the frontal sinus there was significant difference between all groups (P<0.05). But, wasn't in the superior-inferior (SI) dimension (P>0.05). According to the LSD post-hoc test for pairwise comparisons the AP dimension of the frontal sinus was significantly greater in class III in comparison with class II(P=0.013).

Table 2: Comparison of frontal sinus dimensions according to the LSD analysis.

class	**class**	**Mean Difference**	**Sig.**
I	II	0.79286	0.237
	III	-0.89286	0.183
II	III	-1.68571	0.013

In the Table 3, males and females in regarding to the SI dimension of the frontal sinus were not significant (P>0.05), but the AP dimension were significantly greater in the men (P<0.05).

Table3: Comparison of frontal sinus dimensions between males and females using independent groups t test.

	Sex	N	Mean	Std. Deviation	Std. Error Mean
AP	female	55	11.3036	2.49844	.33689
	male	29	13.1069	2.25831	.41936
SI	female	55	19.6800	3.80557	.51314
	male	29	21.4241	4.79722	.89082

AP= Length

SI= Height

The results of this study revealed greater AP dimension of the frontal sinus in class III pattern in comparison with class II,but doesn't in the SI dimension of sinus. According to the sex dimorphism there was significant difference in regarding to the AP dimension of sinus and males had greater AP dimension, but there wasn't significant difference in the SI dimension.

Development of the frontal sinus starts around 5 to 6 years old. The right and left parts of frontal sinuses develop independently [16]. Growth and development of the craniofacial sinuses occur simultaneous with the craniofacial growth. Growth and development of the sinuses is influenced by the physiological processes. The frontal bone growth occurs anteriorly and also towards the midline in connection with the nasal bone and maxilla. The maximum growth of the frontal sinus occurs in AP dimension [17]. Dimensions of the frontal sinus are influenced by the number of genetic and environmental factors [18]. According to one study the frontal sinus forms by 14 years old [19]. Thus, in this study we selected patients older than 16 years old. Yassaei et al. [20] found that the maxillary and frontal sinus dimensions in class III patients were larger than CL I and II, and were significantly correlated with AP length of the base of skull and the length of the mandibular body. They also reported larger sinus dimensions in males than females these are in accompany with this research. Marsya et al. [21] found that frontal sinus dimensions were generally greater in males than females. Also, they showed that the AP dimension of the frontal sinus increased with age in both males and females. They founded that the frontal sinus dimensions can be used as a predictor of age during the prepubertal period. Nathani et al. [21] found a significant difference in frontal sinus dimensions among different facial growth patterns. According their research, frontal sinus dimensions may be used as a predictor of the facial growth pattern. Dhiman et al. [15] founded that the frontal sinus dimensions had a more prominent role than the maxillary sinus dimensions in skeletal malocclusions and they concluded that frontal sinus dimensions in class III patients were greater than other malocclusions. Frontal sinus dimensions were significantly different between males and females in all skeletal facial patterns that were in accompanies with this research. Differences between the aforementioned studies and the present results may be due to different age range and ethnicity of patients or the sample size. Growth prediction of facial structures in diagnostic and treatment planning phase necessary in achieve optimal and stable results in orthodontic treatment. Thus, dentists and specialists must be considering these available tools. The frontal sinus dimensions which can be determined on the lateral cephalograms that are routine in orthodontic treatment may be used as an index for evaluation of growth pattern of the jaws [10-12]. Tehranchi et all concluded that larger frontal sinus is associated with lesser slope of anterior cranial base, greater anterior face height in men, and larger gonial angle in women [1].

The results of this cross-sectional study showed significant correlation between the frontal sinus dimensions and some cephalometric indices in adults. Since the patients were classified based on their skeletal pattern of the jaws, we concluded that larger AP dimension of the frontal sinus was in relation with mandibular prognathism and maxillary retrognathism that it was greater in class III patients. According to the sex dimorphism, AP dimension of the frontal sinus was larger in the males than females.

4. Conclusions

This study demonstrated that larger anteroposterior (AP) dimension of the frontal sinus was seen in the mandibular prognathism and maxillary retrognathism and in comparison, with CLI and CLII cases it was greater in class III skeletal pattern. Based on sex dimorphism AP dimension of the frontal sinus was significantly larger in males.

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Conflict of interest: There is no conflict of interest.

Suggestions: The authors suggest more extensive research with more radiographs belong to other religions and comparison with them.

Ethical approval: This study performed according to the ethical standards of the 1964 Helsinki declaration and based on institutional and national research committee.

Data availability: All data is available.

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