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Research Paper: The relation between frontal sinus dimension and maxillary and mandibular prognathism/retrognathism among Iranian youth and adults

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ABSTRACT

Introduction: Estimating the appropriate time for orthodontic treatment is a crucial factor. Given the earlier maturation of sinuses rather than maxillomandibular growth, finding the exact relationship between the growth of the jaws and frontal sinuses is considered to be a helpful element in Orthodontic treatment.

Materials and Methods: This is a descriptive-analytical study, conducted on 60 lateral cephalometric radiographs (18 male-42 female) to estimate the relation between frontal sinus dimension and prognathism/retrognathism of jaws. The ANB-SNB-SNA angles and Wit's analysis of the samples were divided into three- jaw I, II, and III classes, indicating the prognathism or retrognathism. The area of Frontal sinus was plotted on the tracing paper and transferred to the Auto CAD software.Independent samples t-test and Kruskal-Wallis test were used to compare the area of frontal sinus to the mandibular and maxillary position.

Results: The statistically difference between frontal sinus area and gender, between the mean area of the frontal sinus and maxillomandibular anterior-posterior orientation, was reported as p=0.294 and p=0.352/p=0.261, respectively.

Conclusion: There was no significant relation between the frontal sinus dimension and maxillary and mandibular prognathism/retrognathism. Consequently, frontal sinus dimension cannot be used for estimating maxilla and mandibular growth.

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Introduction

Frontal sinuses are one of the four pairs of paranasal sinuses located along the anterior aspect of the frontal recess. Although these sinuses begin to form 12 to 16 weeks after conception, they are not visible until the age of 5 years in radiography. (1-4) In most individuals, the development of the frontal sinuses is generally completed at the age of 20 years, and after this age, their capacity remains constant throughout life. Fractures, neoplasia, severe infection, serum levels of growth hormones ,and mucoceles can lead to anatomical deformation of the sinus. (5, 6)

The cranial base plays a crucial role in craniofacial development and helps with the structural and functional improvement of the frontal sinus. Since the upper jaw is connected to the anterior part of the skull base and the rotation of the lower jaw is affected by the upper jaw, skull base variables may be correlated with the sagittal displacement of both jaws. (7, 8)

There is a significant difference in the longitudinal growth of both jaws based on gender, as the longitudinal growth of the maxilla and mandible continues every year until the age of 14 in females and 16 in males, after which time it reaches a plateau state. (9) The growth of the frontal sinuses also stops at the same age. Nonetheless, mandibular growth occurs vertically for some years afterward until age 18 years in females and 20 in males . (10) Occasionally mandibular growth reaches its final length at higher ages, in which case the orthognathic surgery treatment plan may be affected. The more or less ultimate maturity of the frontal sinuses may be considered in the estimation of the mandibular final dimension. Researchers have suggested that the sinus dimension may follow the growth algorithm of other craniofacial bones and that frontal sinus growth is correlated with maxillomandibular anterior displacement. (1, 11)

The appropriate timing of malocclusion treatment in skeletal classes II and III is very effective in the efficacy of orthodontic treatments. The ability to predict sustained growth can thus help determine an appropriate treatment time. Research has shown that the cervical vertebrae, the morphology of mandibular symphysis, and carpus radiography are valid for estimating sustained growth. (12)

Given the earlier maturation of sinuses, finding the exact relationship between the growth of the jaws and the frontal sinuses could help estimate future jaw malformations for appropriate treatment timing .(13)

CBCT is one of the best choices for getting an accurate measurement of the frontal sinuses; otherwise, it provides a higher dose/higher cost .(14, 15) Furthermore, the anterior-posterior and mesiodistal dimensions of the frontal sinuses can be identified properly in, respectively, lateral cephalometry and PA cephalometry, especially since lateral cephalometric radiographs(LCR) are the most frequent projection used in orthodontic treatments.

Given the lower required dose, lower costs, and accurate detection of the frontal sinuses, this study applied LCR. (16)

Considering the results of several studies on the correlation between paranasal sinuses and the craniofacial structure and the clear view offered of the frontal sinus in lateral cephalogram and the earlier maturation of the frontal sinus in comparison with the mandible, this study was conducted to explain any possible correlations between frontal sinuses and maxillomandibular prognathism and retrognathism.

Materials and Methods

After obtaining institutional ethical clearance the present descriptive-analytical study was conducted with the ethics code IR.GUMS.REC.1397.271 on 60 patients for whom lateral cephalometric radiography(LCR) had been prescribed. All the measurements were performed by a single oral and maxillofacial radiologist. The inclusion and exclusion criteria were: age range of 25-30 years, having a high-quality LCR providing NHP without positioning errors, no history of growth modification treatment, and no history of orthognathic surgery, trauma, and pathologic disorders.

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The patients' consent was taken before beginning the study. A total of 60 lateral cephalometric radiographic images were selected based on the inclusion criteria. Sampling was a full-census.

The Wits Analysis and ANB angle measurement (normal =2 degrees) were used to classify the angle of the jaws. The SNA(normal =82 degrees) and SNB(normal =80 degrees) angles were also assessed to detect retrognathism and prognathism.(17) All the measurements were performed manually afterward samples with discrepancies. In the Wits analysis, the ANB angle were excluded. The samples were categorized mainly into seven groups, as follows:

1. Class I with maxillomandibular orthognathism
2. Class I with maxillomandibular prognathism
3. Class I with maxillomandibular retrogenathism
4. Class II with maxillary prognathism
5. Class II with mandibular retrogenathism
6. Class III with mandibular prognathism
7. Class III with maxillary retrognathism

The sagittal jaw relationship was determined using the following anatomic points:

S(sella): The center of the hypophyseal fossa

N(nasion): The most anterior point in the frontal suture

A: The most posterior point on the curve of the maxilla between the anterior nasal spine and superdentale

B: The most posterior point of a line from the infradentale to the pogosymphyseal on the anterior surface of the symphyseal outline of the mandible

All x-ray images were taken by Cranex-D(Soredex) with good resolution and contrast(70 kvp, 10 ma, 12 s). The frontal sinus area was thus drawn on a tracing paper with a magnification of *1 in square millimeter.

Statistical Analysis

The data were analyzed using the mean, standard deviation, and ranges as well as Mann-Whitney's U-test and the Kruskal-Wallis test. $P<0.05$ was taken as the level of statistical significance.

Results

A total of 62 participants were enrolled, including 42 females and 18 males. The average age of the participants referred to the Guilan Faculty of Dentistry was 26.78 years according to the malocclusion classification.

Out of the 60 participants attending this study, 32(53.3%) were categorized as class 1, 22(36.7%) as class 2 ,and six(10%) as class 3. The mean and standard deviation of the frontal sinus area was measured as 264.04± 111.65.

According to Mann Whitney's U-test, there were no statistically significant differences in frontal sinus area(p=0.294) between the genders(Table1).

Table1.comparing frontal sinus area between males and females

sex	male	female	Statistical test result
number	18(30%)	42(70%)	
Frontal sinus area	298.63±89.059	249.21±89.059	P=0.294 No significant differences

The Kruskal-Wallis test also revealed no statistically significant relationship(p=0.152) between the frontal sinus area and malocclusion classification(Table2).

Table2. relationship between the frontal sinus area and malocclusion classification

variable	I	II	III	Statistical test result
Mean rank	28.98	35.34	20.83	P=0.152 No significant differences
Mean and standard deviation	247.07 ± 82.335	304.15 ± 141.648	207.38 ± 89.630	

The relationship between the frontal sinus area and anterior-posterior orientation of the maxilla was not significant (P=0.352) based on the Kruskal-Wallis test. The relationship between the frontal sinus area and the mandibular anterior-posterior orientation was not significant either(P=0.261)(Table 3).

Table3.comparing the mean area of frontal sinus among three maxillary and mandibular position to cranial base

Anterior Posterior orientation	R		P		O		Total		Statistical test result	
	maxilla	mandible	maxilla	mandible	maxilla	mandible	maxilla	mandible	maxilla	mandible
									P=0.352	P=0.261
Average	20.83	34.30	29.75	16.00	31.72	28.99				
Mean and standard deviation	204.95 ± 117.517	294.20 ± 137.470	275.15 ± 168.858	183.60 ± 51.195	270.24 ± 106.674	250.07 ± 91.978	264.04 ± 111.655	264.04 ± 111.655		
Number	6	22	4	2	50	36	60	60		

Discussion

This study examined possible relations between frontal sinus area and orthodontic malocclusion classification.

A total of 60 patients participated in this study; their average age was 26.78±4.59 years and they included 42 women and 18 men who had been referred to Guilan Faculty of Dentistry in Rasht, Iran, in 2019.

One of the crucial factors when choosing the most appropriate time for orthodontic treatment is the prediction of sustained growth. Given the earlier maturation of the frontal sinus, if we could find an exact relationship between the growth of the jaws and the frontal sinus, prediction of sustained growth would be possible.

Saumya Verma, Indu Dhiman, Kavita Verma, and Chetan Belaldavar investigated the correlation between frontal sinus area and sex in four different studies. The results of the first two studies were similar to the present findings and contradictory to those reported by Kavita Verma and Chetan Belaldavar, in which the frontal sinus area was greater in men. The number of participants in these studies was 100(50 men and 50 women), 120(60 men and 60 women), 80(40 men and 40 women), and 300(150 men and 150 women), respectively. (1, 4, 8, 18) The discrepancy in the findings may be due to the heterogeneity of the participants in terms of gender, their different age ranges, and racial diversity.

Indahoma and Anil Prashan analyzed the correlation between frontal sinus area and orthognathic malocclusion classification and obtained similar results that were in contrast to the findings of the present research.

In the cited studies, the frontal sinus area was greater in class 3 malocclusion; however, in the present study, no significant differences were found in the frontal sinus area among the different malocclusion classifications. This discrepancy may have occurred due to the different study procedures.

In their study, Indahoma classified malocclusions using only the ANB angle, while in the present study, SNA, SNB, and ANB angle measurement and Wits analysis were also applied. It is worth noting that malocclusion classification based on different cephalometric analyses tends to be more accurate.

Furthermore, in the present study, retrognathic and prognathic maxillomandibular complexes were also investigated, whereas Indahoma and Anil Prashan did not investigate these cases.

The other reasons for the discrepancy in the results could be the different age ranges and sample sizes of the studies. (6, 8)

Yessenia Valverde investigated the correlation between the enlargement of the frontal sinus area and body height growth of the mandible and revealed a close link between the enlargement of the frontal sinus and body height growth during puberty. (19)

According to the study by Parisa Salehi, there is a significant direct relationship between the frontal sinus area and body length, and mandibular length.

Despite the probable correlation between the body height of the mandible and mandibular prognathism, it is also likely for the condylar

position, ramus height, body of mandible, anterior-posterior position, and facial height to affect mandibular prognathism. (20)

The number of participants in the present study was larger than that in Valverde's study (62 vs. 20) and the age range was also higher in the present study (x vs. 7-17). In addition, the current research included both genders and all malocclusion classes. (12, 13)

In another study, Bilal Abd investigated the lateral cephalometric images of 75 patients with different malocclusion classes. Similar to the present findings, they also reported no significant differences in cranial base angle and cranial base length in malocclusion class (3).

Also consistent with the present findings, Cudovial reported that the cranial base dimension and frontal part of the face do not play a statistically significant role in mandibular prognathism.(21)

Our limitation in this study was the inhomogeneity in the number of samples in the three-jaw I, II, III classes due to lack of class III samples.

Conclusion

It can be concluded that the frontal sinus area and anterior-posterior orientation of the maxilla and mandible do not correlate significantly with each other.

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