The Frontal sinus and the skeletal jaw relationships

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Abstract:

The possibility of employing the frontal sinus in orthodontic diagnosis and treatment planning has been verified. The frontal sinus width, maxillary, and mandibular base lengths have been determined cephalometrically from a sample of 73 Iraqi orthodontic patients aged 11 – 15 years, ranked into skeletal classes I, II and III. The results showed increased frontal sinus width in class II and III subjects, in addition to a significant correlation between frontal sinus enlargement and the increased jaw bone length. It has been concluded that the frontal sinus, as seen on lateral cephalogram, can be utilized clinically as an aid in orthodontic diagnosis and treatment planning.

Keywords:

Frontal sinus, skeletal jaw relation, frontal sinus enlargement, laterals cephalogram.

Introduction:

The prediction of the skeletal jaw patterns is a progressing subject. The efforts to find the indicators that have a correlation with the maxillary and mandibular growth changes will improve the orthodontic diagnosis and treatment planning.

The frontal sinus originates from the anterior ethmoidal cells that start their migration into the frontal bone at the end of the first year of life. With increasing pneumatization, the frontal sinus becomes radiographically evident around the age of 8 years when it projects above the orbital rim.[1,2]

Rossouw et al. have investigated the correlation between the frontal sinus size and mandibular growth prediction in subjects with class I and III malocclusions. They concluded that the frontal sinus is a valuable indicator of excessive mandibular growth.[3]

In other cephalometric investigations, it was found that the frontal sinus development showed a growth rhythm similar to body height development with a well – defined pubertal peak.[4,5]

The aim of this study was to verify the presence of a relation between the frontal sinus width and skeletal jaw patterns, and the possibility of using the frontal sinus as an indicator for jaw bones discrepancy.

Materials and Methods:

The sample consisted of 73 healthy Iraqi orthodontic patients between 11 and 15 years of age, none of them had received previous orthodontic treatment. True lateral radiograph has been taken for every subject, and the following measurements have been done (Fig. 1).

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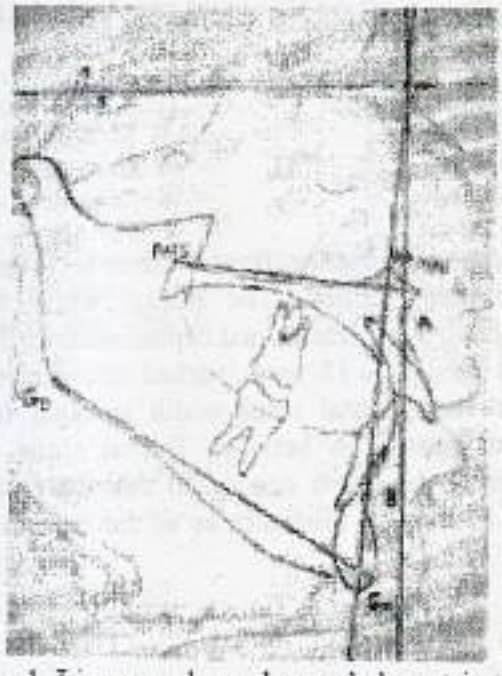

Fig. 1: Linear and angular cephalometric tracing.

* SNA, SNB, and ANB angles.
* Mandibvbghnb56+lar base length: From Gonion to Gnathion[6].
* Maxillary base length: from AP Max (a point determined by drawing a perpendicular line from point A to the palatal plane) to the posterior nasal spine (PNS)[6].

The peripheral border of the frontal sinus was traced, and the highest (Sh) and lowest (Sl) points of sinus extension (relative to the Nasion – Sella line) were marked. Perpendicular to the interconnecting line (Sh – S1), the maximum width of the frontal sinus was assessed (Fig. 2)[4].

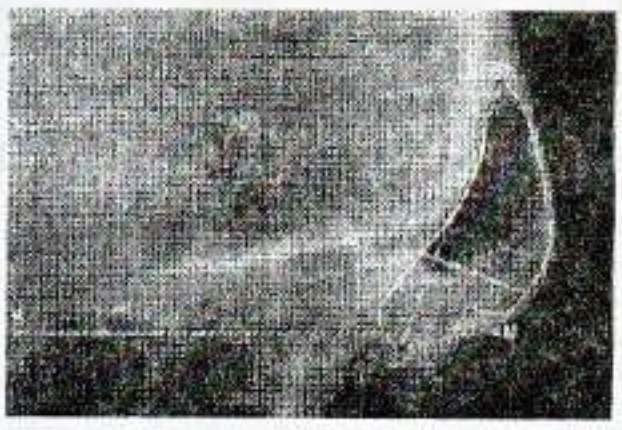

Fig. 2: Assessment of the maximal frontal sinus width perpendicular to the interconnecting line Sh – Sl.[4]

The sample subjects have been ranked into 3 skeletal classes according to the ANB angle measurements (Table1). Measurements that represented borderline cases have not been included.

Table (1): Classification of the sample subjects.

Skeletal Class	ANB Measurement	No. of Subjects
I	2-4	26
II	More than 5	25
III	Less than 1	22

The statistical analyses included:

*Descriptive statistics (mean, standard deviation, minimum, and maximum values).

*Inferential statistics (ANOVA test, LSD test, and Pearson Correlation).

Results:

Table (2) shows the descriptive statistics of the frontal sinus width measurements for class I, II, and III subjects. The lowest mean value was found in class I subjects, while class III subjects demonstrated the highest mean value. The frontal sinus width mean value of class II subjects was close to that of class III subjects.

Table (2): Descriptive statistics of the frontal sinus width measurements (in mm) for the 3 skeletal classes.

Class	No.of Subjects	F.S.Width Mean	S.D.	Minimum	Maximum
I	26	8.17	1.81	5	12.5
II	25	10	2.36	6.5	16
III	22	10.32	2.18	7.5	17

In order to verify the mean difference in frontal sinus width between the 3 skeletal classes, ANOVA test has been applied. This test showed the presence of a significant mean difference between at least 2 of the skeletal classes (Table 3).

Table (3): ANOVA test between the 3 skeletal classes for the frontal sinus width.

	Sum of Squares	d.f.	Mean Square	F	P-level	C.S.*
Between Groups	67.67	2	33.83	7.479	.001	Sig.
Within Groups	316.7	70	4.52			
Total	384.37	72				

*Comparison of Significance.

For specific determination of the mean difference, the ANOVA test was followed by the LSD test which compared between each pair of the 3 skeletal classes. This test showed significant mean difference in class I versus II, and Class I versus III; while a non – significant mean difference was found in class II versus III (Table 4).

Table (4): LSD test between the 3 skeletal classes for the frontal sinus width.

Variable	Mean Difference	S.E.	P-level	C.S.
Class I vs. II	-1.867	0.596	0.003	S
Class I vs. III	-2.145	0.616	0.001	S
Class II vs. III	-0.278	0.622	0.656	NS

In order to be able to correlate the frontal sinus width with the maxilla and mandible, the descriptive statistics of the maxillary and mandibular base lengths for the 3 skeletal classes have been determined (Table 5). It is clear from the mean values that the maxilla was the most responsible factor for the skeletal discrepancy in class II cases, while it was the mandible in class III cases.

Table (5): Descriptive statistics of the maxillary and mandibular base lengths (in mm) for the 3 skeletal classes.

Variable	Class	N	Mean	S.D.	Minimum	Maximum
Maxilla	I	26	49	2.73	42	53
	II	25	52.3	1.99	49	56
	III	22	47.7	4.44	41	55
Mandible	I	26	74	3.56	65	79
	II	25	73.9	4.6	66	83
	III	22	77	5.6	63	89

Table (6) shows the Pearson correlations between the frontal sinus width and the maxillary and mandibular base lengths in class II and III subjects. A significant correlation has been found between the frontal sinus width and maxillary base length in class II subjects, while a highly significant correlation was found between the frontal sinus width and mandibular base length in class III subjects.

Table (6): Simple correlations between the frontal sinus width and the maxillary and mandibular base length.

Class	Statistic	F.S. vs. Maxilla	F.S. vs. Mandible
II	Pearson Correlation	0.428*	0.354
	P-value	0.033	0.083
	N	25	25
III	Pearson Correlation	0.264	0.554**
	P-value	0.235	0.007
	N	22	22

*Correlation is significant at the 0.05 level.

**Correlation is significant at the 0.01 level.

Discussion:

Several investigations on the enlargement of the frontal sinus from childhood to adulthood and on the physiological variability of the sinus size have been published. [1, 2, 7-12] However, studies that correlate the frontal sinus growth with the jaw bone growth and/or skeletal and somatic maturity are relatively few. [3-5, 13]

Table (2) shows 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 frontal sinus width in relation to skeletal class II malocclusion has not been studied previously, whereas the increased frontal sinus width in skeletal class III malocclusion was reported in previous studies and was proposed to be associated with excessive mandibular growth.[3,13] The factors contributing to sinus enlargement have not been completely understood. However, individual differences in the growth and resorption processes of the mucosa, the quality of the frontal bone which is to be pneumatized, the pressure of the growing brain on the internal lamina of the frontal sinus area, the various pressure and hydrodynamic conditions of the endocranium affecting the blood supply of the frontal sinus area, hereditary and hormonal factors, have been suggested to be responsible for sinus enlargement [4].

Tables (3) and (4) reveal a statistically significant mean difference in frontal sinus width between class I and II, class I and III; while there was a non – significant mean difference between class II and III. This finding indicates that the frontal sinus enlargement accompanied the skeletal discrepancy between the maxilla and mandible and/or the discrepancy between the jaw bone and the anterior cranial base. Furthermore, it necessitates the verification of the correlation between frontal sinus enlargement and the jaw bones in skeletal classes II and III. Therefore, the maxillary and mandibular base lengths have been determined for the 3 classes (Table 5). The purpose of estimating the jaw base lengths for class I subjects was to serve as a reference of comparison to enable the determination of the increased jaw base length in skeletal classes II and III. It was found that the maxilla showed an increased mean value in class II subjects, while the mandible showed the increased mean value in class III subjects.

The frontal sinus width showed a significant correlation with the maxillary base length in class II subjects, and a highly significant correlation with the mandibular base length in class III subjects (Table 6). This finding enables the frontal sinus to serve as an indicator for the presence of a skeletal jaw discrepancy through the establishment of standard values. Again, the explanation for this association can not be fully precise because the factors contributing to sinus enlargement have not yet been completely understood. Baer and Harris interpreted the development of the frontal sinus as a process of structural adaptation to the forward and downward growth of the mid face with the forward growth of the external lamina of the frontal bone being essential to keep the contact with the nasal bone and the maxilla.[14] While such an explanation is acceptable for class II cases, it can not be applied for class III cases. A more acceptable explanation is that as it has been found that the increase in frontal sinus size follows the same general body growth curve during puberty, [4, 5, 10, 15] so we suggest that the frontal sinus may

become under the control of the same genetic and/or hormonal factors influencing the maxilla and mandible during puberty.

Conclusion:

The frontal sinus can serve as an additional diagnostic indicator, enabling the orthodontist to make more accurate prediction and diagnosis for the skeletal jaw growth pattern.

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