Original Article

Frontal Air Sinus Volume as Mandibular Growth Pattern Predictor?

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Abstract

From ages, various anatomical landmarks have been used for assessment of various malocclusions and its treatment planning. Growth prediction has been controversial topic ever since it has been discussed by Ricketts. Prediction would involve forecasting a change in direction of the landmarks used in this study which is paranasal sinuses. Paranasal sinus plays an important role in the formation of the face, and thus, the knowledge of its formation and size is important in diagnosis and treatment of various malocclusions. The aim of this study is to evaluate difference in volume of the frontal air sinus in different growth pattern patients. This Study consisted of 90 lateral cephalograms (30 of each growth pattern). The patients are divided into three groups with 30 patients of each group depending on the mandibular plane angle. The frontal air sinus can be used as an indicator when one is predicting mandibular growth.

Keywords: Frontal air sinus, Growth predictor, Growth pattern, Orthodontics.

Introduction

Lateral cephalograms have become a vital tool in orthodontic assessment and treatment planning since the introduction of radiography by Broadbent in 1931. Various anatomical points are used in assessment of different malocclusions which can be precisely and accurately depicted in a lateral cephalogram, but presently different other points are also derived which are used to reach definite point of diagnosis in orthodontics.[1,2] One of these landmarks are the paranasal sinuses which can be easily assessed by radiographic method such as lateral cephalogram and panoramic radiographic view, but lateral cephalogram is more preferred since other radiographs provide duplicate information.[3]

Paranasal sinuses are the bony chambers embedded in the bones around the mid facial structure. Maxillary sinus, ethmoidal sinus, frontal sinus and sphenoidal sinus are the four anatomical sinus presents in the human body. Of these, maxillary sinus and frontal sinus can be depicted in the lateral cephalogram of almost all the patients. Development and growth of these sinuses effect different orthodontic malocclusion is hypothesized in different studies.[4-7] Maxillary sinus which lies in close proximity to the maxillary posterior teeth might be affected by different skeletal malocclusions. Similarly, Rossouw *et al.* found enlarged frontal sinus in subjects having prognathism. Increase in the bone growth follows same growth pattern in paranasal sinuses. Different studies have done to investigate paranasal sinus development in patients by lateral cephalograms. The frontal sinus is an aeric cavity located within the frontal bone. It develops during the 4th or 5th weeks of intrauterine life and continues to grow after birth until early adulthood by anterosuperior pneumatisation of the frontal recess into the bone.[8] It contains two chambers which are typically asymmetrical, due to the independent development of each sinus and which are separated by a bone septum. The human skull has been extensively studied ante and postmortem for identification purposes both in anatomical and radiological assessments. Schuller was a pioneer in establishing the important role of the frontal sinus for sex determination.

The frontal air sinus is present from birth but is not evident radiographically until the 5th year, when it projects above the orbital rim. Rapid growth of sinus continues until the age of 12 years, until it reaches its adult size. Joffe observed frontal air sinus enlargement with the prognathic subjects, but no

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correlation was given.[9] The aim of this study was to assess whether a large frontal air sinus could be related to mandibular growth pattern [Figures 1 and 2].

Materials and Methods

A random selection of 90 lateral cephalograms, consisting of horizontal, average and vertical growth patterns, were analysed and grouped into three groups, Group I: Horizontal growth pattern (n = 30), Group II: Average growth pattern (n = 30) and Group III: Vertical growth pattern (n = 30).

Criteria for selection of the cephalograms are as follows:

- Participants should have no systemic diseases, sign of trauma, or a congenital disease
- Participants should not have any paranasal sinus pathology
- Participants should not show any signs of the previous orthodontic treatment
- Participants should be of average age between 16 and 30 years.

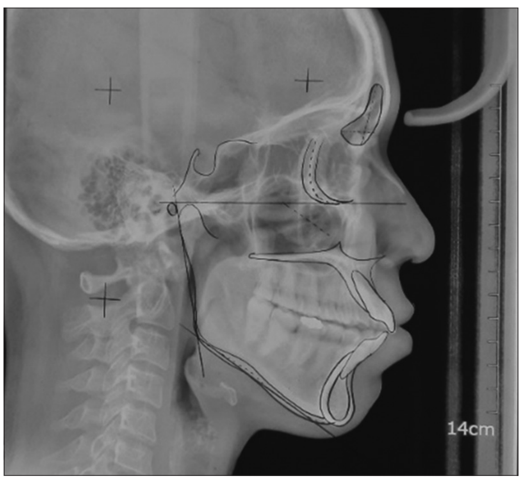

Figure 1: Traced lateral cephalogram

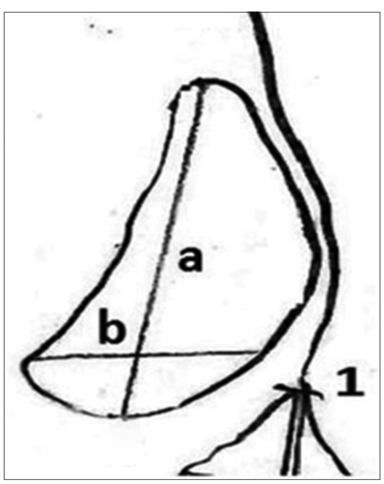

Figure 2: The points in the figure show the maximum height and width of the frontal air sinus. a: Denotes maximum height; b: Denotes maximum width of the sinus. 1 is point Nasion

Methods

- Cephalograms were grouped mainly into three groups: Group 1 – Horizontal growth pattern (n = 30), Group 2 – Average growth pattern (n = 30) and Group 3 – Vertical growth pattern (n = 30).
- All lateral cephalograms were taken by skilled and experienced technicians in a standard natural head position as recommended by Broadbent.
- The ethical approval was obtained from the Institutional Ethical Committee. Being a retrospective study, the patients were informed that their lateral cephalograms will be used for further studies and consent was obtained during that time.
- The cephalograms were manually traced by a single researcher with the help of a 0.5-mm thick lead pencil and a millimetre scale for the planes on orthodontic tracing paper.
- For the linear measurements, a millimetre precision digital Vernier calliper for the registration of the reading.
- The frontal sinus area was calculated by superimposing the frontal sinus drawn acetate paper over a standard graph paper sheet and counting the number of squares present within the inner outline of frontal sinus.
- It was measured as square millimetres.
- When more than half area of the square was within the perimeter of the frontal sinus, it was also counted as full square, whereas squares having less than half of the areas inside the perimeter were excluded from the count.

Statistical analysis

All data were entered into a computer by giving coding system, proofed for entry errors

- Data obtained was compiled on a Microsoft Office Excel Sheet (v 2019, Microsoft Redmond Campus, Redmond, Washington, United States).
- Data were subjected to statistical analysis using the Statistical Package for the Social Sciences (SPSS v 26.0, IBM).
- Descriptive statistics such as mean and SD for numerical data has been depicted.

Normality of numerical data was checked using Shapiro–Wilk test and was found that the data followed a normal curve; hence, parametric tests have been used for comparisons.

- Inter group comparison (>2 groups) was done using one-way ANOVA followed by pair-wise comparison using *post hoc* test.

For all the statistical tests, $P < 0.05$ was considered to be statistically significant, keeping α error at 5% and β error at 20%, thus giving a power to the study as 80%.

There was a statistically non-significant difference seen for the values between the groups ($P > 0$).

There was a statistically non-significant difference seen ($P > 0.05$) for the values between all the pairs of groups.

Table 1: Inter group comparison of outcome

	N	Mean	Standard deviation	Standard error	95% confidence interval for Mean		Minimum	Maximum	F value	*P* value of one-way ANOVA
					Lower bound	Upper bound				
1	30	271.33	107.430	19.614	231.22	311.45	80	500		
2	30	320.43	125.954	22.996	273.40	367.47	136	600	1.614	0.205#
3	30	277.47	111.832	20.418	235.71	319.23	100	528		
Total	90	289.74	116.136	12.242	265.42	314.07	80	600		

*Statistically significant difference (P<0.05). **Statistically highly significant difference (P<0.01). #Non-significant difference (P>0.05)

Table 2: Inter group pair-wise comparison using Games-Howell post hoc test

(I) group	(J) group	Mean difference (I-J)	Standard error	*P* value	95% confidence interval	
					Lower bound	Upper bound
1	2	−49.100	30.225	0.244#	−121.85	23.65
	3	−6.133	28.312	0.974#	−74.24	61.97
2	3	42.967	30.752	0.349#	−31.03	116.96

*Statistically significant difference (P<0.05). **Statistically highly significant difference (P<0.01). #Non-significant difference (P>0.05)

Results

The frontal air sinus volume has been compared among various growth pattern individuals and there was a statistically non-significant difference seen for the values between the groups ($P > 0.05$) [Table 1]. Also using the *post hoc* test, there was a statistically non-significant difference seen ($P > 0.05$) for the values between all the pairs of groups [Table 2].

Discussion

The frontal air sinuses are one of the four pairs of paranasal sinuses that are situated behind the brow ridges. Sinuses are mucosalined airspaces within the bones of the face and skull. Each Air sinus opens into the anterior part of the corresponding middle nasal meatus of the nose through the frontonasal duct which traverses the anterior part of the labyrinth of the ethmoid. The frontal sinus bud is present during the birth in the ethmoidal region, but it is not evident radiographically until the age of 5 years when it projects above the orbital rims.[10] The sinus grows until the age of 12 years. Tanner found that the annual height increments in children reached a plateau at 16 years in boys and 14 years in girls, and it was thought that these, too, were the ages at which frontal sinus enlargement ceased.[11] This suggests that the increase in the sinus size very closely follows a growth trend similar to that of other bones. The development and size of frontal sinus can be crucial for diagnosing and treating various malocclusions. Joffe[12] and Rossouw *et al.*[13] found the frontal sinus enlargement to be associated with prognathic patients. The lateral cephalograms are widely used to study morphologic characteristics in various growth pattern individuals. The present study was carried out to analyse the correlation of frontal air sinus in various growth pattern individuals.[14-18] According, to the results, we can state that there is no significant correlation between dimensions of frontal air sinus and different growth patterns

Apart from this, previously various studies have been carried out, and it was suggested that acromegaly is associated with prominent frontal sinus and overgrowth of the jawbone, and one usually finds a Class III type prognathic mandible in these cases.[19,20] Another study conducted by Ricketts *et al.* cephalometrically analysed the skeletal growth patterns of 103 patients with Class I and Class III malocclusions to assess abnormal mandibular growth. The results indicate that there is a significant correlation between maxillary length, mandibular length, condylar length and frontal sinus size on a lateral cephalogram. Thus, the frontal sinus can possibly be used as an additional indicator when one is predicting mandibular growth.

In the present study, manual tracing was used for calculation of the maximum height, maximum width and frontal sinus area of the frontal sinus. Although in some studies, the digital method was used to measure these factors, the manual technique has accuracy similar to that of digital technique in this regard. Thus, considering its affordability, the manual technique was used. It seems that further investigations in several centres with larger sample sizes can increase the accuracy of the obtained data and standards. The correlation of the frontal air sinus and growth pattern can be helpful in prediction of growth pattern from other radiographic method with less radiation exposure to the patient.

Conclusion

The study had been carried out to relate the volume of frontal air sinus in horizontal, vertical and average growth pattern individuals. There had been no statistical significance between the frontal air sinus volume of the various growth pattern individuals reporting randomly to the department of the orthodontics and dentofacial orthopaedics.

The limitation of the present study must be acknowledged as the study is carried out on limited number of individuals and results may vary from the present study.

References

1. Sabharwal A, Patil AS, Shinde S, Swami V. Analysis of frontal sinus in

various malocclusions. Int J Orthod Rehabil 2019;10:116.
2. Albarakati SF, Kula KS, Ghoneima AA. The reliability and reproducibility of cephalometric measurements: A comparison of conventional and digital methods. Dentomaxillofac Radiol 2012;41:11-7.
3. Atchison KA, Luke LS, White SC. Contribution of pretreatment radiographs to orthodontists' decision making. Oral Surg Oral Med Oral Pathol 1991;71:238-45.
4. Endo T, Abe R, Kuroki H, Kojima K, Oka K, Shimooka S, *et al.* Cephalometric evaluation of maxillary sinus sizes in different malocclusion classes. Odontology 2010;98:65-72.
5. Axelsson S, Storhaug K, Kjaer I. Post-natal size and morphology of the sella turcica. Longitudinal cephalometric standards for Norwegians between 6 and 21 years of age. Eur J Orthod 2004;26:597-604.
6. Brown WA, Molleson TI, Chinn S. Enlargement of the frontal sinus. Ann Hum Biol 1984;11:221-6.
7. Devereux L, Moles D, Cunningham SJ, McKnight M. How important are lateral cephalometric radiographs in orthodontic treatment planning? Am J Orthod Dentofacial Orthop 2011;139:e175-81.
8. Durão AR, Pittayapat P, Rockenbach MI, Olszewski R, Ng S, Ferreira AP, *et al.* Validity of 2D lateral cephalometry in orthodontics: A systematic review. Prog Orthod 2013;14:31.
9. Kullman L, Eklund B, Grundin R. Value of the frontal sinus in identification of unknown persons. J Forensic Odontostomatol 1990;8:3-10.
10. Harris AM, Wood RE, Nortjé CJ, Thomas CJ. Gender and ethnic differences of the radiographic image of the frontal region. J Forensic Odontostomatol 1987;5:51-7.
11. Tanner JM. Growth at Adolescence. 2nd ed. Oxford: Blackwell Scientific Publications; 1962.
12. Joffe BM. Frontal sinus enlargement associated with mandibular prognathism. J Dent Assoc S Afr 1964;33:127-9.
13. Rossouw PE, Lombard CJ, Harris AM. The frontal sinus and mandibular growth prediction. Am J Orthod Dentofacial Orthop 1991;100:542-6.
14. Jacobson A. The "Wits" appraisal of jaw disharmony. Am J Orthod 1975;67:125-38.
15. Nijkamp PG, Habets LL, Aartman IH, Zentner A. The influence of cephalometrics on orthodontic treatment planning. Eur J Orthod 2008;30:630-5.
16. Ruf S, Pancherz H. Development of the frontal sinus in relation to somatic and skeletal maturity. A cephalometric roentgenographic study at puberty. Eur J Orthod 1996;18:491-7.
17. Salehi P, Heidari S, Khajeh F. Relationship between frontal sinus surface area and mandibular size on lateral cephalograms of adults. J Isfahan Dent Sch 2012;8:244-50.
18. Steiner CC. Cephalometrics for you and me. Am J Orthod 1953;39:729-55.
19. Ruf S, Pancherz H. Frontal sinus development as an indicator for somatic maturity at puberty? Am J Orthod Dentofacial Orthop 1996;110:476-82.
20. Shafer WG, Hine MK, Levy BM. A Textbook of Oral Pathology. 3rd ed. Philadelphia: WB Saunders; 1974. p. 606-7.