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Assessment of frontal sinus area with different variables in predicting different types of sagittal skeletal pattern

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Abstract

Introduction: Frontal sinus is present in the frontal bone, Its shape and size are influenced by race, gender, bioenvironmental factor, disease, and growth pattern. The bud of frontal sinus is present during birth and not seen projecting above the orbital rim radiographically until 5th year. Vertical growth of the sinus starts at 2 years of age it is visible on cephalogram at the age of eight.

Aim: To make an assessment of frontal sinus area with different variables in predicting different types of sagittal skeletal pattern.

Materials And Methods: A Cross Sectional Study was conducted to assess frontal sinus area with different variables in predicting different types of sagittal skeletal pattern.180 lateral cephalograms of patient reporting to Outpatient Department at the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College, Raipur are distributed according to skeletal pattern 60 Class I, 60 Class II and 60 Class III radiographs were collected with an equal distribution between males and females.

Result: The mean value of FSA for class I was 294.56, class II was 331.23 and class III was 404.45 on comparing between each class the mean value of frontal sinus area was highest in class III than other class and value is least in class I.

Conclusion: Dimensions and surface area of FSA highest in class III malocclusion and least in class I. Dimensions and surface area of Frontal sinus in male were greater than those in female irrespective of different classes; however frontal sinus not showed any significant correlation with gender.

Keywords: Frontal Sinus Area, Sagittal Skeletal Pattern, Cephalometric Analysis.

Introduction

Paranasal sinuses are air containing cavities in embedded in to the bones around the nasal cavity.[1] There are four pair of anatomical paranasal sinus present in human skull are the maxillary sinus ,frontal sinus ,ethmoidal sinus ,and sphenoidal sinus.[2] Of these maxillary and frontal sinuses are seen in lateral cephalogram in maximum number of patients. [3] Frontal sinus is present in the frontal bone, Its shape and size are influenced by race, gender, bioenvironmental factor, disease ,and growth pattern. [4] The bud of frontal sinus is present during birth and not seen projecting above the orbital rim radiographically until 5th year.[5]vertical growth of the sinus starts at 2 years of age it is visible on cephalogram at the age of eight. Exponential growth of the sinus continues until the age of 12 years.[6] Tanner found that the annual height increments in children reached a plateau at 16 years in boys and 14 years in girls ,they thought that at this age frontal sinus enlargement ceased[7].Rossouw et al found frontal sinus enlargement associated with prognathic subjects.[8]

Lateral cephalograms have become an essential diagnostic tool in orthodontic assessment and treatment planning since the introduction of radiography by Broadbent in 1931.[9,10]Various anatomical landmarks can be seen in a lateral cephalogram that can be used in assessment of malocclusion.

Aim

To make an assessment of frontal sinus area with different variables in predicting different types of sagittal skeletal pattern.

Materials and Methods

A Cross Sectional Study was conducted to assess frontal sinus area with different variables in predicting different types of sagittal skeletal pattern.180 lateral cephalograms of patient reporting to Outpatient Department at the Department of Orthodontics and Dentofacial Orthopaedics, Government Dental College, Raipur are distributed according to skeletal pattern 60 Class I, 60 Class II and 60 Class III radiographs were collected with an equal distribution between males and females.

Classification of skeletal type into class I, Class II and Class III was based on ANB angle.

1. Angle 0-4˚ – Class I
2. Angle >4˚ – Class II
3. Angle <0˚ – Class III

Inclusion criteria

1. No History of previous Orthodontic treatment.
2. Patients having Class I, Class II and Class III Skeletal Patterns.
3. Patients who are willing to participate in the study after giving written informed consent.

Exclusion criteria

1. Patient underwent previous orthodontic treatment.
2. Patient underwent previous orthognathic surgery.
3. Patients with major illness or medical conditions.
4. History of head and neck trauma, vertebral column and craniofacial anomaly or syndrome.

Armamentarium

For Clinical Evaluation

- Mouth mirror
- Explorer or probe

For Radiographic Evaluation

- Radiographic machine
- Digital lateral cephalogram (Planmeca, Proline XC Dimax 3 Ceph)
- Trimaxprinter.

For Tracing

- Digital Lateral cephalogram.
- Acetate tracing paper of 0.003-inch matte finish.
- 0.3mm HB lead pencil.
- Geometry box –(scale, protractor, eraser , sharpener.)
- Illuminator, cellotape.
- Graph Sheet.
- Calculator.

Cephalometric Analysis

A pre-structured preformed was used to collect the relevant information and record cephalometric measurement of each subject. Each subject was examine clinically and revaluated to check inclusion criteria. Then patient were sent to the department of Oral Medicine and Radiology, Government Dental college and hospital and digital lateral cephalogram were taken.

The cephalogram of the patients were obtained by positioning the patients head in cephalostat with teeth in maximum interception with relaxed lip in order to maintain standardization of radiograph with the Frankfort horizontal plane parallel to the floor and ensured that (NHP) natural head position this obtained by positioning the ear rods and forehead positioning the knobs. Distance from the tube to patients was standardized at 5 feet.

- 180 subjects comprising of 60 Class I, 60 Class II and 60 Class III malocclusion
- Each 60 subjects further divided in to 30 males and 30 females.
- Classification of skeletal type into class I, Class II and Class III was based on ANB angle. Skeletal class was categorized as follows:

Angle 0-4˚ – Class I

Angle >4˚ – Class II

Angle <0˚ – Class III

- Lateral cephalogram was traced upon a 0.003-inch thick acetate paper with O.3 mm HB pencil over well-illuminated viewing screen by the same investigator to reduce intra operator variability.
- The measurements were recorded with a measuring scale up to a precision of 1mm and angular measurements were analyzed with a protractor up to a precision of 1 degree.
- The following landmarks were used for cephalometric analysis: -

Point ANS: The most anterior point of the bony hard palate in the mid-sagittal plane.

Point PNS: The most posterior point of the bony hard palate in the mid-sagittal plane.

Point A (Subspinale): The most posterior midline point in the concavity between the anterior nasal spine and the prosthion .

Point B (Supramentale): The most posterior midline point in the concavity of the mandible between the most superior point on the alveolar bone overlying the lower incisors and pogonion .

Point S (Sella): The midpoint of the hypophysial fossa .

Point N. (Nasion): The most anterior point on the nasofrontal suture in the medial plane

Point GO(Gonion):a constructed point the intersection of the lines tangent to the posterior margin of the ascending ramus and mandibular base.

Point AR (articulare): the point of intersection of the posterior margin of the ascending ramus and the outer margin of the cranial base.

Point MN(Menton):most inferior point on the bony chin in themid sagittal plane.

Point Or(Orbitale): lower most point on bony orbit.

Point PO(Porion): most superior point of the external auditory Meatus.

Point SH-most highest point on peripheral borders of the frontal Sinus.

Point Sl-most lowest point on the the peripheral border of theFrontal sinus.

Area Measurements

Frontal sinus –upon tracing the area of high radiopacity on periphery, the highest (Sh) and lowest (Sl) points of its extensions were marked. A perpendicular to the interconnecting line Sh-Sl was drawn to determine the maximal width of frontal sinus. Frontal sinus area was then calculated by multiplying height with width

Linear Measurements

Mandibular body length: distance from GO to MENTON was measured.

Maxillary length: from ANS to PNS.

Anterior cranial base length: from Sella to Nasion.

Posterior cranial base length: from sella to articulare.

Overall cranial base length: from nasion to articulare.

Angular Measurements

SNA angle: Angle formed between SN TO N to point A.

SNB angle: Angle formed between SN TO N to point B.

ANB angle: Angle formed between point N to point A and point N to point B.

Saddle angle: This angle is formed by joining sellanasion and articulare (N-S-Ar).

Gonial angle: This angle is formed by joining Articulare- Gonion and Menton (Ar-Go-mn

Statistical Analysis

All statistical analysis were carried out using the statistical package for social sciences (SPSS) version 18 for windows.(SPSS Inc., Chicago, Illinois, USA). Mean and standard deviation was calculated for groups Pearson's correlation was used to find relationship between frontal sinus areas with other craniofacial patterns. P-value of less than 0.05 was considered as statistically significant difference. Analysis of variance test was performed to study the relationship between different skeletal patterns.

Parameter	Class I, N=60	Class I, N=60	Class I, N=60	Total, N=180
Mandibular Body Length (Mean ± SD)	67.53333±6.30	63.21667± 4.6	70.2±4.98	66.98±6.070
Maxillary Length (Mean ± SD)	55.73333±6.17	60.9± 6.33	52.15± 4.36	56.59444±5.68
Anterior Cranial Base Length (Mean ± SD)	68.18±4.731	68.06±4.782	68.63±4.33	68.29±4.60
Posterior Cranial Base Length(Mean ± SD)	36.3± 5.20	34.71±4.36	35.3± 3.40	35.43±4.41
Overall Cranial Base Length(Mean ± SD)	91.93±10.93	91.3±5.012	91.06±6.10	91.43± 7.92
SNA(Mean ± SD)	83.08±4.44	83.2667±4.16	82.73 ± 3.51	82.93± 4.040
SNB(Mean ± SD)	80.77± 4.09	76.15± 6.97	84.70± 3.39	80.54±6.135
Saddle Angle(Mean ± SD)	123.23±6.64	125.2± 6.50	122.36±5.005	123.6±6.17
Gonial (Mean ± SD)	126.1±6.007	126.8±6.29	126.2±5.47	126.3±5.91

Table 1: Showed mean value of different variables used in assessment of frontal sinus in class I ,class II and class III skeletal pattern

Correlations											
	Pearson Correlation	Mandibular Body Length	Maxillary Length	Anterior Cranial Base Length	Posterior Cranial Base Length	Overall Cranial Base Length	SNA	SNB	Saddle Angle	Gonial Angle	FSA
FSA	CLASS I	.096	.120	.349**	.331**	.271*	-.084	-.125	-.117	-.132	1
	CLASS II	.157	.196	.420**	.480**	.441**	-.151	-.060	.011	-.010	1
	CLASS III	.301*	.206	.310*	.204	.153	-.222	-.181	-.196	-.007	1
**. Correlation is significant at the 0.01 level (2-tailed).											
*. Correlation is significant at the 0.05 level (2-tailed).											

Table 2- showed correlation of frontal sinus area with different variables in different skeletal malocclusion.

FSA	CLASS I N=60	CLASS II, N=60	CLASS III N=60	Total, N=180
MEAN± SD	294.5667±64.65695	331±71.2822	404.45±112.2351	343.3389± 96.46195

Table3: showed relation between size of frontal sinus in different skeletal malocclusion.

Results

Mandibular Body Length

The mean value of mandibular body length for class I was 67.53,class II was 63.21and class III was 70.25 on comparing between each class the mean value of mandibular body length was highest in class III as effective mandibular body length would be more in relative prognathic mandibular cases and lowest in class II as effective mandibular body length would be less because of relatively retrognathic mandible.

Maxillary Length

The mean value ofmaxillary length for class I was 55.73,class II was 60.9and class III was 52.15 on comparing between each class the mean value of maxillary length was highest in class II as effective mandibular body length would be more in relative prognathic maxillary cases and lowest in class III as effective maxillary length would be less because of relatively retrognathic maxilla.

Anterior Cranial Base Length

The mean value ofAnterior Cranial Base Length for class I was 68.14, class II was 68.06 and class III was 68.63 on comparing between each class the mean value of Anterior Cranial Base Length was more in class III than others.

Posterior Cranial Base Length

The mean value ofposterior Cranial Base Length for class I was 36.3, class II was 34.71 and class III was 35.33 on comparing between each class the mean value of posterior Cranial Base Length was more in class I than others.

Overall Cranial Base Length

The mean value ofOverall Cranial Base Length for class I was 91.93, class II was 91.33 and class III was 91.43 on comparing between each class the mean value of Overall Cranial Base Length was more in class I than others.

SNA

The mean value of SNA angle for class I was 83.08, class II was 83.26 and class III was 82.93 on comparing between each class the mean value of SNA angle was more in class II than other class as in most class II cases have prognathic maxilla and value is less in class III corresponding to retrognathic maxilla.

SNB

The mean value of SNB angle for class I was 80.77, class II was 76.15 and class III was 84.70 on comparing

between each class the mean value of SNB angle was more in class III than other class as in most class III cases have prognathic mandible and value is less in class II corresponding to retrognathic mandible.

ANB

The mean value of ANB angle for class I was 2.50, class II was 6.13 and class III was -1.94 on comparing between each class the mean value of ANB angle was more in class II than other class as in most class II cases may have prognathic maxilla and retrognathic mandible or both hence maxillary mandibular discrepancy was more and value is negative in class III corresponding mostly due to prognathic mandible and retrognathic maxilla.

Saddle Angle

The mean value ofSaddle Anglefor class I was 123.23, class II was 125.25 and class III was 122.36 on comparing between each class the mean value of Saddle Angle was more in class II than others.

Gonial Angle

The mean value ofGonial Anglefor class I was 126.1, class II was 126.8 and class III was 126.3 on comparing between each class the mean value of Gonial Anglewas more in class II than others.

FSA (Frontal Sinus Area)

The mean value of FSA for class I was 294.56, class II was 331.23 and class III was 404.45 on comparing between each class the mean value of frontal sinus area was highest in class III than other class and value is least in class I.

Discussion

Paranasal sinuses develop as out pouching from the mucous membrane of lateral wall of nose. at birth ,only the maxillary and ethmoidal sinuses are present and are large enough to be clinically significant.Growth of sinuses continues during childhood and early adult life. Radiologically, maxillary sinuses can be identified at 4-5 months. The frontal sinus bud is present at birth in the ethmoid region but is not evident radiographically until the fifth year, when it projects above the orbital rim . Rapid growth of the sinus continues until the age of 12 years .

Tanner found that the annual height (stature) 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. This suggests that the increase in the sinus size very closely follows a growth trend similar to that of other bones.Joffe ,Rossouw et al found frontal sinus enlargement to be associated with prognathic subjects.

Lateral cephalometry is often requested as a necessary record for orthodontic diagnosis and assessment of treatment results. Various anatomical landmark can be seen in lateral cephalogram that can be used in assessment of malocclusion. Stability of the results of orthodontic treatment is a concern for many orthodontists. Final size of the mandible is one of the most important factors affecting the treatment outcome. This is particularly important inpatients with Class III malocclusion. limited studies have assessed the size of frontal sinus in different malocclusions.

The present study was done to assess the frontal sinus area with different variables in different types of sagittal skeletal patterns and results obtained were the mean value of frontal sinus area for class I was 294.56,class II was 331.23 and class III was 404.45 on comparing between each class the mean value of frontal sinus was highest in class III than others and value is least in class I ,which is similar as study done by yasaaei[11] et al.in 2018 furthermore the dimensions and surface area of frontal sinus showed significant correlation with mandibular body length and gonial angle .

Rossouw et al. and also salehi[12] et al. reported that the surface area of frontal sinus may play a role in final size of the mandible and they found a significant correlation between the size of the frontal sinus and mandibular body length .in our study frontal sinus showed significant correlation with mandibular body length ,anterior cranial base length and posterior cranial base length and overall cranial base length which is similar as study done by prashar[20] A. et al in 2012 and yassai et al.

Joffe found frontal sinus enlargement to be associated with prognathic subjects. In a similar study reported by Rossouw et al. (1991) who compared area of the frontal sinus between adult skeletal Class III and Class I growth pattern cases excluding Class II growth pattern[2]. in the present study ,class III malocclusion showed largest FSA.

Tehranchi[13] et al. showed that the mean height width, and surface area area of the frontal sinus on lateral cephalograms in males were greater than those in female. This finding was in line with results of our study showed that mean surface area of frontal sinus in males were greater than those in females.

Limitations

Since present study has been performed retrospectively on lateral cephalogram which is 2D image of 3D structures, future studies can be planned on recent CBCT and MRI modalities to make study more relevant in long term.

Conclusion

The present study was to determine the assessment of frontal sinus area with different variables in different types of sagittal skeletal patterns. Total 180 samples were assessed and correlation was found with each skeletal patterns from the results and following conclusions are drawn.

Dimensions and surface area of FSA highest in class III malocclusion and least in class I

Dimensions and surface area of Frontal sinus in male were greater than those in female irrespective of different classes; however frontal sinus not showed any significant correlation with gender.

Frontal sinus area had significant correlation with mandibular body length, anterior cranial base length, posterior cranial base length and overall cranial base length.

Hence from the present study it was concluded that certain parameter in class I class II and class III seems to have significant positive correlation with frontal sinus area which aids in prediction of skeletal malocclusion.

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