

Assessment of maxillary sinus area with different variables in predicting different types of sagittal skeletal pattern in Chhattisgarh population.

¹Dr. Priyanka Sahu, ²Dr. Arvind Nair, ³Dr. Virendra Vadher, ⁴Dr. Gangesh Bahadur Singh, ⁵Dr. Shalabh Baxi, ⁶Dr. Chhaya Barapatre, ⁷Dr. Shweta Singh

¹⁻⁷Government Dental College, Raipur.

Corresponding Author: Dr. Arvind Nair, Government Dental College, Raipur.

Citation of this Article: Dr. Priyanka Sahu, Dr. Arvind Nair, Dr. Virendra Vadher, Dr. Gangesh Bahadur Singh, Dr. Shalabh Baxi, Dr. Chhaya Barapatre, Dr. Shweta Singh, “Assessment of maxillary sinus area with different variables in predicting different types of sagittal skeletal pattern in Chhattisgarh population”, IJDSIR- April - 2023, Volume – 6, Issue - 2, P. No. 430 – 440.

Copyright: © 2023, Dr. Arvind Nair, et al. This is an open access journal and article distributed under the terms of the creative commons’ attribution non-commercial License. Which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Paranasal sinuses are air containing cavities in embedded into the bones around the nasal cavity. The maxillary sinus is the largest among the all-paranasal sinuses. The development of the maxillary sinus begins at the ethmoidal bone in 3rd month of fetal life.

Aims and objective: To make an assessment of maxillary sinus area with different variables in different types of sagittal skeletal pattern in Chhattisgarh population.

Result: Mandibular body length: the mean value of mandibular body length for class i was 67.53, class ii was 63.21 and class iii was 70.25. Maxillary length: the mean value of maxillary length for class i was 55.73, class ii was 60.9 and class iii was 52.15. Anterior cranial base length: the mean value of anterior cranial base length for class i was 68.14, class ii was 68.06 and class

iii was 68.63. Posterior cranial base length the mean value of posterior cranial base length for class i was 36.3, class ii was 34.71 and class iii was 35.33. Overall cranial base length: the mean value of overall cranial base length for class i was 91.93, class ii was 91.33 and class iii was 91.43.

Conclusion: Dimensions and surface area of MSA highest in class II malocclusion and least in class III. Dimensions and surface area of maxillary sinus in male were greater than those in female irrespective of different classes; however, both maxillary sinus not showed any significant correlation with gender.

Keywords; maxillary sinus, paranasal sinus

Introduction

Paranasal sinuses are air containing cavities in embedded into 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 The maxillary sinus is the largest among the all-paranasal sinuses. The development of the maxillary sinus begins at the ethmoidal bone in 3rd month of fetal life. After birth maxillary sinus grows continues and extend laterally and inferiorly during two growth spurts periods i.e., from birth to 3year and from 7 to 12 year of the age.⁴ The subsequent inferior growth of the maxillary sinus is related to its invasion of alveolar process and follow the eruption of permanent teeth. The invasion of maxillary posterior teeth due to downward growth of maxillary sinus may influence orthodontic treatment planning for mal occlusion cases.⁵

Lateral cephalograms have become an essential diagnostic tool in orthodontic assessment and treatment planning since the introduction of radiography by Broadbent in 1931.⁶ Various anatomical landmarks can be seen in a lateralcephalo gram that can be used in assessment of mal occlusion.⁷

Paranasal sinuses are one of such anatomical landmarks seen in lateral cephalogram as they can be easily assessed by radio graphic method like lateralcephalo gram and panoramic view but lateral cephalogram is more preferred since it does not provide duplicate in formation.⁸

After extensive exploration of available literature there is scarcity of adequate information available in Chhattisgarh subjects. Therefore, the purpose of this study was to evaluate of size of maxillary sinuses in males and females and analyze with different variables with respect to different sagittal skeletal patterns with the use of lateral cephalometry in Chhattisgarh population.

Aims and objective

To make an assessment of maxillary sinus area with different variables in different types of sagittal skeletal pattern in Chhattisgarh population.

Material and methods

The subjects were collected from Patient Reporting to Outpatient Department at The Department of Orthodontics and Dentofacial Orthopedics, for treatment of their malocclusion. at Government Dental College, Raipur, After Obtaining Informed Written Consent Form. Of all the patients those who were subjected to prescription of lateral cephalogram and those who satisfy the inclusion criteria were takes as subjects. Among those chosen subject who already had their own radio graph were not exposed twice, rather the existing radio graph were used.

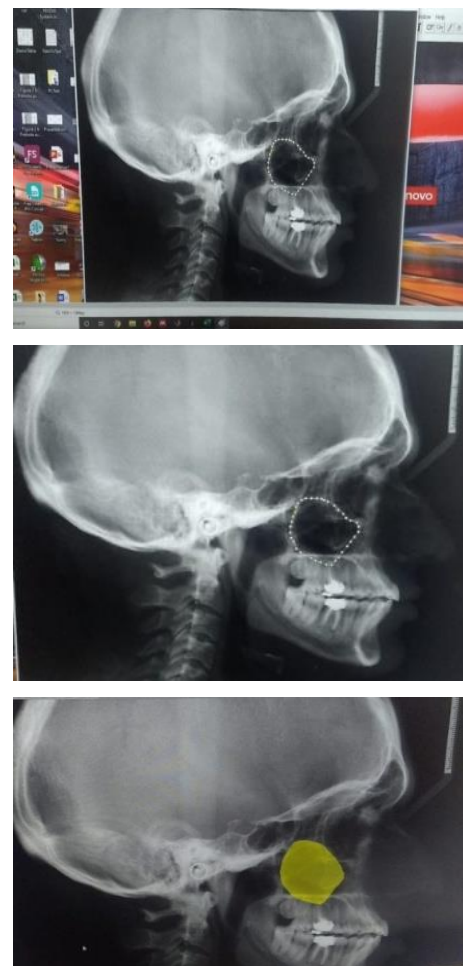


Fig 1: Area Measurement with software.

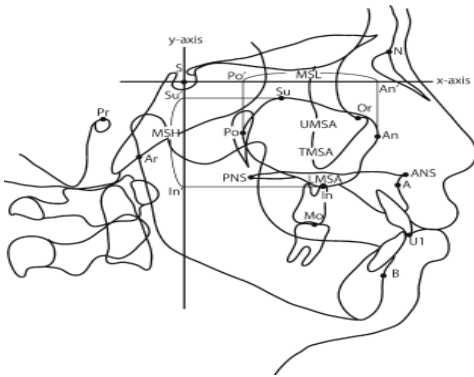


Fig 2: landmark used for tracing.

Inclusion criteria

- Patient age between 15-30 years.
- All permanent teeth should be present.
- No history of orthodontic treatment.
- No paranasal sinuses pathology.
- No visible facial asymmetry.
- Patient with digital lateral cephalogram taken in natural head position where clearest reproduction of paranasal sinus (frontal and maxillary sinus)

Exclusion criteria

- Patients undergone orthodontic treatment.
- Any missing teeth except third molar.
- Patients with immune-compromised diseases.
- Patients with malignancy

Armamentarium for clinical evaluation

- mouth mirror
- explorer or probe

Armamentarium for radiographic evaluation

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

- Trimax printer.

Armamentarium for tracing

- Digital Lateral cephalogram.
- Acetate tracing paper-0.003-inch matte finish.
- 0.3mm HB lead pencil.

- Geometry box – (scale, protractor, eraser, sharpener.)
- Illuminator, cello tape.
- Graph Sheet.
- Calculator.

A pre-structured proforma was used to collect the relevant information and record cephalometric measurement of each subject. Each subject was examined clinically and reevaluated to check inclusion criteria. then patients 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 intercuspation with relaxed lip in order to maintain standardization of radiograph with the Frank fort 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 malocclusions.

➤ Each 60 subjects further divided in to 30 males and 30 females.

➤ Each 30-subject divided according to their growth pattern 15 vertical group, and 15 horizontal group.

➤ Classification of skeletal type into class I, Class II and Class III was based on ANB angle. Skeletal class was categorized as follows:

Angle $0-4^\circ$ – Class I

Angle $>4^\circ$ – Class II

Angle $<0^\circ$ – Class III

➤ Growth pattern decided by Jarabak ratio as follows:

If $\geq 62\%$ - vertical growth pattern.

If $\leq 65\%$ - horizontal growth pattern.

If its 62-65 consider as normal growth pattern

➤ Lateral cephalogram was traced upon a 0.003-inch-thick acetate paper with 0.3 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 area of sinus calculated through MATLAB or equivalent software. The various area (region of interest) ROIs will be taken and computed with reference standard and error will be calculated.

➤ image tracer (x, y) will be done by tracing the contour on the x-ray image, further the total number of pixels counted in the closed curve will be the base for calculating in area measurement.

➤ The following landmarks were used for cephalometric analysis:

1. Point An: The most anterior point of anterior wall of maxillary sinus.
2. Point An': Point projected vertically from An to the x-axis
3. Point Po: Posterior most point of maxillary sinus.
4. Point Po': Point projected vertically from Po to the x-axis
5. Point Su: Superior most point of maxillary sinus.
6. Point Su': Point projected vertically from Su to the y-axis.
7. Point In: Inferior most point of maxillary sinus.
8. Point In': Point projected vertically from In to the y-axis
9. Point ANS: The most anterior point of the bony hard palate in the mid-sagittal plane.
10. Point PNS: The most posterior point of the bony hard palate in the mid-sagittal plane.

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

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

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

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

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

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

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

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

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

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

21. Point SI-lowest point on the peripheral border of the Frontal sinus.

22. point SPP-most posterior point of the frontal sinus.

23. Point SAP-most anterior point of the sinus.

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 sella nasion and articulare (N-S-Ar).
- Gonial angle: This angle is formed by joining Articulare- Gonion and Menton (Ar-Go-Mn)

Area measurement

Maxillary Sinus

- Maxillary sinus length (MSL): The line extends from An to Po.
- Maxillary sinus height (MSH): The line extends from Su to In
- Upper maxillary sinus area (UMSA): The area above maxillary plane
- Lower maxillary sinus area (LMSA): the lower area of maxillary sinus from the palatal plane
- Total maxillary sinus area (MSA): The sum total of UMSA and LMSA.

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.
- Jarabak index: (%) (Sella- Gonion / Nasion – Menton).

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 area with other craniofacial patterns as well as maxillary sinus 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.

Table 1: showed correlation of maxillary sinus area with different variables in different skeletal malocclusion.

Parameter	Pearson correlation	MSL	MSH	UMSA	LMSA	TMSA
Mandibular Body Length	CLASS I	.176	.212	.337**	.134	.271*
	CLASS II	.158	.189	.224	.343**	.355**
	CLASS III	.177	.087	.435**	.108	.441**
Maxillary Length	CLASS I	.187	.218	.285*	.116	.230
	CLASS II	.238	.294*	.343**	.255*	.396**
	CLASS III	.430**	.172	.311*	.124	.343**
Anterior Cranial Base Length	CLASS I	.310*	.292*	.495**	.184	.393**
	CLASS II	.243	.254*	.346**	.191	.413**
	CLASS III	.176	.243	.459**	-.035	.401**
Posterior Cranial Base Length	CLASS I	.356**	.320*	.365**	.107	.273*
	CLASS II	.258*	.316*	.529**	.072	.449**
	CLASS III	.214	.085	.290*	-.136	.222

Overall	CLASS I	.322*	.183	.434**	.210	.332**
Cranial Base Length	CLASS II	.273*	.269*	.430**	.253	.480**
	CLASS III	.319*	.254	.287*	-.062	.243
SNA	CLASS I	-.016	-.369**	-.338**	-.180	-.410**
	CLASS II	.158	.047	.079	.081	.120
	CLASS III	-.013	.072	-.064	-.139	-.089
SNB	CLASS I	-.014	-.340**	-.306*	-.191	-.368**
	CLASS II	.042	.050	.090	.012	.099
	CLASS III	.038	.125	.062	-.116	.024
Saddle Angle	CLASS I	.055	.183	.092	-.006	.059
	CLASS II	-.048	-.125	-.099	.130	.006
	CLASS III	.108	-.220	-.234	-.075	-.238
Gonial Angle	CLASS I	-.025	.086	-.031	.135	.077
	CLASS II	-.162	-.085	-.253	-.001	-.246
	CLASS III	-.007	.214	.104	.234	.174
**. Correlation is significant at the 0.01 level (2-tailed).						
*. Correlation is significant at the 0.05 level (2-tailed).						

Result

The present study was conducted to make an assessment of frontal and maxillary sinus area with different variables in different types of sagittal skeletal pattern based on values obtained from lateral cephalograms. A total 180 individuals satisfying the selection criteria were selected. 60 samples in each group of skeletal malocclusions such as Class I, Class II, Class III based on the ANB angle.

Parameters

Mandibular body length

The mean value of mandibular body length for class I was 67.53, class II was 63.21 and 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 of maxillary length for class I was 55.73, class II was 60.9 and 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 of Anterior 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 of posterior 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 of Overall 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 of Saddle Angle for 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 of Gonial Angle for 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 Angle was more in class II than others.

MSA (maxillary sinus area)

The mean value of MSA for class I was 1075.05, class II was 1166.73 and class III was 1150.46 on comparing between each class the mean value of frontal sinus area was highest in class II than other classes.

Correlation of craniofacial patterns with MSA

on checking the correlation with pearsons's correlation coefficient showed significant correlation of MSA with mandibular body length for class I & class II and class III & also showed significant correlation with maxillary length & Anterior cranial base length and posterior cranial base length and overall cranial base length for class I class II & class III.

others parameter in class I class II and class III skeletal pattern don't exhibit a significant correlation with the maxillary sinus area.

Correlation of MSA with gender

on checking the correlation with two-way ANOVA showed significant correlation of maxillary with gender in class I skeletal pattern.

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

Radio logically; 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.⁹

Of these, the maxillary sinuses are the largest of the paranasal sinuses. The floor of the maxillary sinuses is formed by the alveolar process of the maxilla, and its contiguity with the upper posterior teeth continues throughout life. It could be hypothesized that the development of the maxillary sinuses, which have a close relationship with the maxilla structure and with the upper posterior teeth, might be affected by dental and skeletal malocclusions.³

This close relation with posterior maxillary teeth plays a very important role in orthodontic treatment planning, e.g., in deciding mesialization of second molar when first molar is absent. In this case due to absence of first molar, maxillary sinus might have moved inferiorly into the alveolar process at that place and thus making mesialization of second molar difficult due to close proximity of cortical sinus wall with second molar roots. With the advent of temporary anchorage devices study of maxillary sinus became more important to prevent complications such as sinus perforation and injury to roots. Various factors like age, sex do influence the relative size of maxillary sinus. Literature is highly

varied when it comes to relation of maxillary sinus size with malocclusion.³⁸

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 in patients with Class III malocclusion. limited studies have assessed the size of frontal and maxillary sinuses in different malocclusions.¹⁰

After extensive exploration of available literature there is scarcity of adequate information available in Chhattisgarh subjects. Therefore, the purpose of this study was to evaluate of size of maxillary sinuses in males and females and analyze with different variables with respect to different sagittal skeletal patterns with the use of lateral cephalometry in Chhattisgarh population.

In current study, Digital lateral cephalograms and Matlab software were used for assessment of the dimensions of the sinuses area. Digital lateral cephalometry provides high-quality images; thus, errors in localization of landmarks are minimized.

The present study was done to assess the frontal and maxillary 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 yasaai¹¹ et al.in 2018 furthermore , the dimensions and

surface area of frontal sinus showed significant correlation with mandibular body length and gonial angle .

Tehranchi³¹ et al. showed that the mean height width, and surface 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.

Omar Tsaid carried out research to determine the relationship between anterior occlusion and frontal sinus size and he concluded that The frontal sinus size could be used as an indicator of harmonious anterior occlusion. There were no differences among the subgroups of each skeletal malocclusion. The anterior cranial base, facial height, and maxillary incisor inclination appear to have a significant effect on frontal sinus size.¹²

Merve goymen¹³ et al. carried out research to investigate the frontal and maxillary sinus sizes of individuals with different vertical growth pattern by using lateral and posteroanterior (PA) cephalometric radiographs. And result showed. The differences between the groups for all measurements in both lateral and PA radiographs were not statistically significant. Lateral and PA cephalometric radio graphs can be used in the calculation of sinus sizes as an effective material, and no significant difference with respect to the effect of different vertical growth tendencies on maxillary and frontal sinus sizes was found.

The mean value of MSA for class I was 1075.05, class II was 1166.73 and class III was 1150.46 on comparing between each class the mean value of maxillary sinus area was highest in class II than other class and value is least in class I. Oktay¹ found that malocclusions and sex factor had no effect on the maxillary sinus size by two-way ANOVA. also reported a significant interaction

between malocclusion class and sex in the magnitude of maxillary sinus size. In this study female with class II malocclusion showed larger maxillary sinus than others female with class I or class III or male with class II or class III malocclusion. The difference in these results from ours may be explained by the fact that the maxillary sinus size is age-specific, as shown by several lines of evidence.¹⁴

In present study maxillary sinus size is larger in males among class I, class II and class III but there is no significant correlation in MSA in males and females. This finding was similar study carried out by Dhiman et al³.

Mariya et al found Maxillary sinus length is significantly larger in Class II group in males. Overall maxillary sinus size does not vary significantly with different sagittal malocclusion classes. Males showed larger maxillary sinus measurements than females. This finding was in line with results of our study.

Endo¹⁵ et al. found no significant association between maxillary sinus size and the sagittal skeletal jaw relationship in patients, but those patients with larger cranial bases and Naso maxillary complexes tended to have larger maxillary sinuses.

In present study MSA showed significant positive correlation with mandibular body length and maxillary length anterior cranial base length, posterior cranial base length, overall cranial base length. In present study MSA shows significant correlation with gender in class I skeletal pattern. Whereas FSA showed significant correlation with gender in class I and class III skeletal pattern.

Kunigal¹⁶ S et al evaluated the difference in dimensions of maxillary sinus among males and females using lateral cephalography and to correlate differences in dimensions among males and females to determine if it

can be used for gender differentiation. And they found dimensions of maxillary sinus showed no statistically significant difference in height and length of maxillary sinus among males and females. That is different in findings of our result. Goyman et al found no significant correlation in vertical growth pattern and maxillary sinus area Xu yili¹⁷ et al. compared the dimensions of the maxillary sinus in patients with different vertical growth patterns and investigated the correlation between the maxillary sinus and craniofacial parameters. They found the variables of the maxillary sinus, including the volume, length, and width, among different groups, were significant. The variables of mandibular body length were significantly correlated with the volume of the maxillary sinus. they concluded that the maxillary sinus volume, length, and width were larger in low-angle patients. The mandibular body length had a significantly positive correlation with the maxillary sinus volume.

Oksayan¹⁸ et.al evaluated maxillary sinus volume and dimensions in patients with high-, low-, and normal-angle vertical growth patterns, they found the high-angle subjects showed statistically lower values in terms of maxillary sinus length and width than the low-angle subjects. There were no effects of vertical face development on right and left maxillary sinus volumes.

In present study MSA was not showed significant correlation with growth pattern that finding is similar with study done by goymen et al.

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. Further study can be performed on larger scale in longitudinal pattern to provide more clinical data.

Conclusion

The present study was to determine the assessment of frontal and maxillary sinus area with different variables in different types of sagittal skeletal patterns in Chhattisgarh population. 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 MSA highest in class II malocclusion and least in class III
- Dimensions and surface area of maxillary sinus in male were greater than those in female irrespective of different classes; however, Both maxillary sinus not showed any significant correlation with gender.
- Significant correlation found of maxillary sinus area with SNA, SNB, 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 seem to have significant positive correlation with frontal and maxillary sinus area which aids in assessment of skeletal malocclusion. study may be used are the reference standards for Chhattisgarh subjects.

References

1. Oktay husametdin. The study of maxillary sinus area in different ortho dontic malocclusions. Erzurum, Turkey: AM J Orthod Dentofac Orthop ;1992;102:143-5.
2. Ahuja S, Gupta S, Bhambri E, et al. Reliability of Frontal Sinus with Different Variables in Predicting different Skeletal Jaw Relations. Journal of Contemporary Ortho dontics; 2018,2(2), p 48-56.
3. Dhiman Indu, Singla A, Mahajan V et al. Reliability of frontal sinus with that of maxillary sinus in assessment of different types of skeletal malocclusions. J Indian Orthod Soc; 2015; 49:96-103.

4. Akhlaghi M, Bakhtavar K, Mo are fdoost J, Kamali A, Rafeifar S. Frontal sinus parameters in computed Tomo graphy and sex determination. *Leg Med (Tokyo)*; 2016; 19: 22–7.
5. Goyal M, Acharya AB, Satur AP, Naik masur VG. Are frontal sinuses useful indicators of sex? *J Forensic Leg Med*. 2013; 20:91–4.
6. Guevara YV, Watanabe N, Yamaki M, Saito I. The frontal sinus enlargement as an indicator of growth maturity in class III patients – A pilot study. *Int J Med Sci Public Health*. 2013; 2:451–5.
7. Dolan KD. Paranasal sinus radiology. Part IA. Introduction and the frontal sinuses. *Head Neck* 1982; 4:301-11.
8. Tanner JM. Growth at adolescence. 2nd ed. Oxford: Black well Scientific Publications;1962;3.
9. Rossouw P.E, Lombard C.J, Harris A. M.P. The frontal sinus and mandibular growth prediction. Tyger berg, South Africa; *AM J Orthod Dento fac Orthop*; 1991; 100: 5 42-6.
10. Emirzeoglu M, Sahin B, Bilgic S, Celebi M, Uzun A. Volumetric evaluation of the paranasal sinuses in normal subjects using computer Tomo graphy images: a stereo logical study. *Auris Nasus Larynx*. 2007; 34:191–5.
11. Yassai et al. Cephalo metric association of mandibular size length to the surface area & dimensions of the frontal & maxillary sinus. vol12. issue April June 2018. *Euro pean journal of dentistry*
12. Graney DO, Rice DH. Anatomy. In: Cummings CW, Fredrickson JM, Harker LA, Krause CJ, et al.2nd ed. St. Louis: *Otolaryngology: head and neck surgery*, Mosby Year Book; 1993, p. 901–6.
13. Goymen M etal. A effect of vertical growth pattern on maxillary and frontal sinus size. *Eur j Ther* 2019;25(3): 197-200.
14. Devereux L, Moles D, Cunningham SJ, McKnight M. How important are lateral cephalometric radiographs in ortho dontic treatment planning? *Am J Orthod Dento facial Orthop*. 2011;139: e175-81.
15. Endo T, Abe R, Kuroki H, Kojima K, Oka K, Shimooka S. Cephalo metric evaluation of maxillary sinus sizes in different malocclusion classes. *Odontology* 2010; 98:65-72
16. Kunigal S Praveen et al. Gender Differenti ation using Maxillary Sinus. *International Journal of Oral Care and Research*, January-March 2017; 5(1): 19-22.
17. Xu Yili et al. Correlation between the size of the maxillary sinus and vertical growth patterns: a 3 - dimensional cone beam computed tomographic study. Research article January 16th, 2020
18. R. Oks Ayan Et Al. Evaluation of Maxillary Sinus Volume and Dimensions in Different Vertical Face Growth Patterns: A Study of Cone-Beam Computed Tomo graphy. *Acta Odonto logica Scand in avica*, 2017