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A Prospective Study on the Morphometry of Maxilla Using Orthopantogram (OPG) in Telangana Population

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ABSTRACT

The maxilla bone is the most important bone in the middle of the face which is located in the middle of the viscerocranium and provides structural support for the face. It is a functional and cosmetic component of the facial structure, separating the nasal and oral cavities, forming the upper jaw and containing the maxillary sinus. Human teeth are organized into four distinct ridges: incisors, canines, premolars and molars, each with their own purpose. The incisors slice the food, the canines tear it, and the molars and premolars crush it for digestion. The study was carried out on 100 digital orthopantogram (OPG'S). A total number of patient's time of life selected between ranges for 10-50 years of age group. The sample was of 100 subjects. The methodological study was conducted under stratified sampling based on age interval, side and gender and the data obtained was subjected to statistical analysis. The Chi-square test was used to evaluate the P-value. Males had an average right maxillary sinus capacity of 18.63 cm3 with a ±SD of 8.43 cm3, whereas females had an average of 11.93 cm3 with a ±SD of 4.19 cm3. The average left volume was 19.54±7.39 cm3 for men and 12.14±3.69 cm3 for women. The rank test revealed no significant changes in volume between the right and left sides of the same subject (P=0.353). The participants exhibited considerably shorter maxillary depth and narrower inter-tooth spacing at all four levels. In patients, the palatal index was considerably higher at the second inter-premolar and first inter-molar regions than in controls. The measurement of the Maxillary sinus and the research of its architecture are relevant for surgical approaches in clinical dentistry as well as in forensic medicine for ease of access. A categorisation was proposed that allows for the investigation of sinus morphology., however, higher sample sizes are required to obtain more conclusive results.

INTRODUCTION

The most important bone in the mid face is the maxilla. It provides structural support and is situated in the middle of the viscerocranium. It forms the upper jaw, houses the maxillary sinus[1] and divides the nasal and oral cavities, making it a functional and aesthetically pleasing part of the face. The maxilla is formed by the fusion of the left and right maxillary bones at the midline. Each maxillary bone has a pyramidal shape, with the maxillary sinus at the base[2], the zygomatic process at the top, and the base close to the nasal cavity. The alveolar process holds the teeth of the upper denture in place. It has a horseshoe-like shape, with the bent part facing the front. It starts beneath the hard palate and ends at the maxillary tuberosity after extending posteriorly behind the maxillary sinuses[3]. The alveolar arteries, alveolar nerves and periodontal ligaments all travel through channels inside the alveolar process to irrigate, innervate and fix the upper teeth[4]. The maxilla is connected to the surrounding facial tissues by the frontal, alveolar, palatine and zygomatic processes. It attaches to the frontal bone superiorly, the zygomatic bone laterally, the palatine bone posteriorly[5] and the upper teeth inferiorly through the alveolar process. It forms the inferior and lateral margins of the pyriform aperture and medially articulates with the nasal bones at the anterior edge of the frontal process. The median maxillary suture is formed by the palatine processes[6], which join the left and right maxilla at the midline. The confluence of the palatine processes forms the anterior nasal floor and the inferior border of the pyriform aperture at its most anterior aspect. The incisive canal is located inferiorly, where the anterior portion of the hard palate originates[7]. This osseous channel connects the nasal and oral chambers and is traversed by the nasopalatine nerve and the sphenopalatine artery. It starts superiorly at the superior nasal foramina on both sides of the nasal septum and moves inferiorly to the oral cavity's incisive fossa[8], behind the medial incisors and under the incisive papilla in the osseous channel which attaches the nasal and the oral chambers[9]. The nasal septum at the superior aspects the nasal foramina (stensens) foramina lies beneath the incisive papilla behind medial incisors[10]. The positioning of human teeth helps for breaking down food in order to swallow and digest food material accordingly[11]. Teeths are made up of variety of main tissues with variable toughness and hard density[12]. Single-image panoramic radiograph, the orthopantomogram (also known as a panotomogram, orthopantomograph, or OPG) aids in a number of procedures involving the mandible, maxilla and teeth. It is a convenient, affordable and rapid method of evaluating the general architecture of the jaws and related pathologies that aids in the surgical approach in oral procedures[13].

MATERIALS AND METHODS

Study Setting: The study was carried out on 100 digital orthopantogram (OPG'S).

Sample Size: A total number of patient's time of life selected between ranges of 10-50 years of age group. The sample was of 100 subjects.

Data Collection: Information was collected from hospital those who will attend OPD for examination purposes.

- Sociodemographic information and physical test results at admission were noted.
- Patient information was documented, including age, gender and parity.

Inclusion Criteria:(The following criteria were included for the study).

- Patients aged group 10-50 years were included in study.
- High-quality OPG'S concerning angulation and contrast procedures.
- Patients undergoing conventional OPG for diagnostic, surgical, periodontal and oral surgeries were included.

Exclusion Criteria: (The following criteria were excluded from the study). Patients were excluded from the study if there was evidence of bony disease involving in traumatic history and improperly developed anomalies.

- Patients who are disabled with developmental abnormalities are also excluded from the study.
- Patients who have undergone surgical intervention were not included.
- Patients with hemifascial malformation were also excluded from study.

Methods:

- The methodological study used stratified sampling based on gender, age interval and side. The data collected was then statistically analyzed and the P value was assessed using the chi-square test. Additionally, the retrospective study was chosen and split up into different groups.

I.e. Group I-IV with the Age Range:

- **Group I-** 10-20 years.
- **Group II-** 21-30 years.
- **Group III-** 31-40 years.
- **Group IV-** 41-50years.
- All the OPG'S was recorded by suitable form of panoramic components orthophos method.

The Radiograph thus obtained was subjected to assess various morphometric analysis of maxilla. The method for measurement of the maxillary process with sinuses was performed by using Vernier calipers.

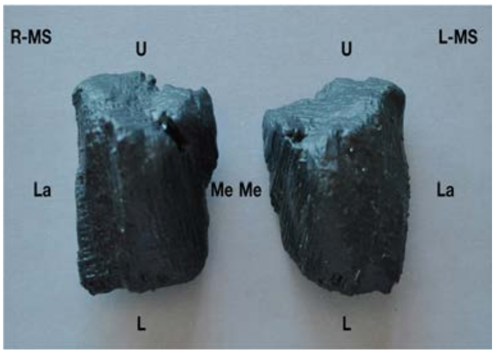

Fig. 1: Frontal View of the Right and Left Maxillary Sinuses with a Quadrangular Base. R-MS: Right Maxillary Sinus, L-MS: Left Maxillary Sinus, U: Upper Area, L: Lower Area, La: Lateral Area, Me: Medial Area

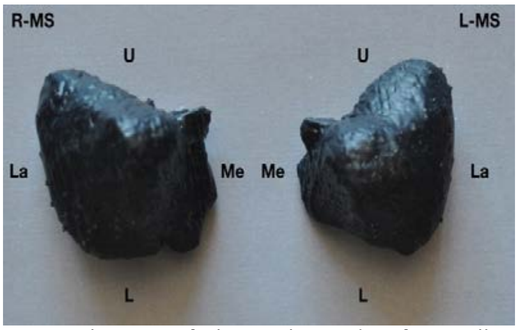

Fig. 2: Frontal View of the Right and Left Maxillary Sinuses with a Pyramidal Base. R-MS: Right Maxillary Sinus, L-MS: Left Maxillary Sinus, U: Upper Area, L: Lower Area, La: Lateral Area, Me: Medial Area

With the use of the Ez3D 2009 program in cavo3D images and later the Slicer 4.4 program, orthopantogram images are used to precisely identify the anatomy and the boundaries of the maxillary sinus on the three axes (coronal, axial and sagittal). The Pax Zenith imaging equipment was used to take the pictures in each instance. The pictures were processed as virtual models and exported as Digital Imaging and Communications in Medicine (DICOM) files.

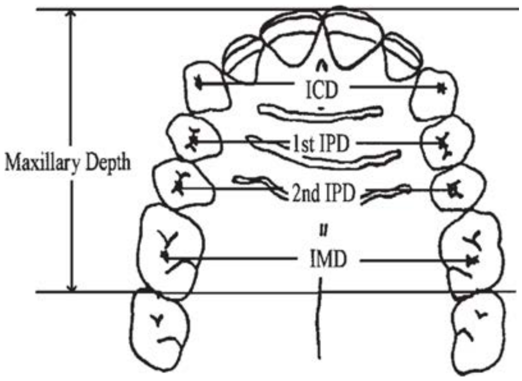

Fig. 3: Schematic Diagram of the Maxillary Dental Arch Illustrating the Linear Measurements Taken from Study Models. ICD, Inter-Canine Distance., 1st IPD, First Inter-Premolar Distance., 2nd IPD, Second Inter-Premolar Distance., IMD, Inter-Molar Distance

- Inter-canine distance, defined as the distance between the centroid of the canines.
- Inter-premolar distance at the first and second premolar regions, defined as the linear distance between the centroids of the first and second premolars, respectively.
- Inter-molar distance, defined as the linear measurement between the centroids of the first permanent molars.
- The depth of the maxilla was measured with a pair of three-dimensional Bow dividers and was defined as the distance from the mid-point of the most labial point of the central incisors to the point bisecting the line joining the distal midpoints of the maxillary first molars.
- The corresponding palatal height was then measured off the profile gauge with a steel ruler. The palatal index was defined as the ratio of the palatal height to the lateral dimension at the level of the canines, first and second premolars and first molars.

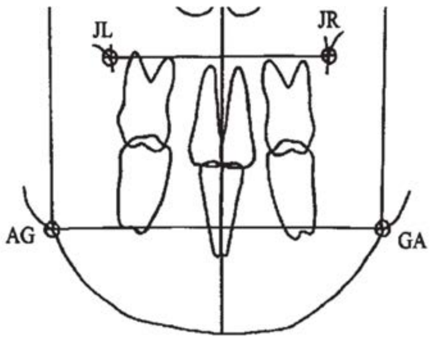

Fig. 4: Schematic Diagram of the Postero-Anterior Cephalogram Illustrating the Linear Measurements Used in the Analysis., JL, Left., JR, Right. AG/GA, Points at Lateral Inferior Margin of Antegonial Protuberances., AG, Left., GA, Right

Cephalometric Radiographs: Using a consistent approach, lateral and postero-anterior (PA) cephalograms were obtained independently (Broadbent *et. al.*, 1975). Every participant was given instructions to breathe in, close in centric occlusion, and then slowly exhale. During the expiratory phase, radiographs were exposed. Acetate paper was used to manually trace each radiograph onto a light-viewing box. When two images were displayed by bilateral landmarks, the average of the two was calculated. Ricketts (1981) was followed in the analysis of the PA cephalograms. Facial width was defined as the distance between the centre of the root of the zygomatic arch on either side and maxillary width as the distance between the locations on the jugal process where the outline of the maxilla's tuberosity and the zygomatic buttress intersect.

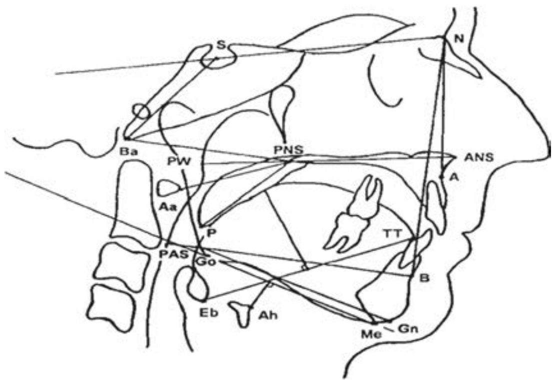

Fig. 5: Schematic Diagram of Lateral Cephalogram Illustrating the Linear and Angular Measurements Used in the Analysis

Landmarks

- **Point A:** The most posterior point on the curve of the maxilla between the anterior nasal spine.
- **Aa:** The most anterior point on the atlas vertebrae.
- **Ah:** The most anterior and superior point on the body of the hyoid bone.
- **Ar (Articular):** The point of intersection of the inferior cranial base surface and the averaged posterior surfaces of the mandibular condyles.
- **ANS (Anterior Nasal Spine):** The tip of the median, sharp bony process of the maxilla at the lower margin of the anterior nasal opening.
- **Point B:** The point most posterior to a line from infradentale to pogonion on the anterior surface of the symphyseal outline of the mandible.
- **Ba (Basion):** The most inferior, posterior point on the anterior margin of the foramen magnum in the median plane.
- **Co (Condylion):** The most posterior superior axial point on the curvature of the average of the right and left outline of the condylar head.

Statistical Analysis: Appropriate statistical methods were applied to research.

RESULTS AND DISCUSSIONS

In (table 1): The mean of the right Maxillary sinus volume of male 17.68 cm3 and the ±SD was ±8.43 cm3 and female 10.83 cm3 and the ±SD was ±4.19 cm3. For the Left volume, the mean was 17.54±7.39 cm3 of male and 12.14±3.69 female. In a bilateral comparison between the volume of the right and left sides in the same individual, no significant differences were found using the Wilcoxon signed rank test (P=0.016). The normality of the distribution of the volumes of the right and left Maxillary sinus for men and women was determined using the Shapiro-Wilk test., the variable follows a normal distribution for both men and women and t test was applied to compare the volumes of the left Maxillary sinus, with the average of the left volume being significantly greater in the men (17.54 cm3) than in the women (12.14 cm3) (P=0.008). Since the variable right volume did not have a normal distribution, the Mann-Whitney U test was used and no significant differences were noted in these variables (P=0.053). The pyramid shape with a quadrangular base of Right Maxillary sinus volume (cm3) 18.73±7.43 was the most common shape in (Table 2), followed by the pyramid shape with a triangular base at 14.04±5.42 and the wing shape at 8.14±1.43. The factors, including gender and maxillary sinus shape, did not significantly correlate (P=0.041). However, according to the Kruskal-Wallis test, there was no statistically significant correlation (P=0.041) between the participants' ages and any particular maxillary sinus form. Using the Kruskal-Wallis test, a comparison of the shape and right volume showed statistically significant differences (P=0.041). An ANOVA was utilised to evaluate the left volume and shape and statistically significant differences were found (P=0.039). The volumes of the wing form and the pyramid shape with a quadrangular base were then compared using Dunnett's test of multiple comparisons, which revealed significant differences (P=0.054). In (Table 3): The subjects had significantly narrower inter-tooth distances at all four levels and a shorter maxillary depth. The palatal index was significantly greater at the second inter-premolar and the first inter-molar regions in patients than in controls. In (table 4): Analysis of the PA cephalogram of maxilla showed a significant difference between patients and controls in the (max/mand) width ratio (0.68±0.01 versus 0.73±0.01., P<0.001) and in the (max /facial) width ratio (0.44±0.005 versus 0.47±0.005., P<0.01), both being reduced in the patient group. Analysis of the lateral cephalograms revealed that in the patient group, both the maxilla (ANS–PNS) and mandible (Go-Gn) were shorter when compared with controls. Patients had a greater mandibular plane to hyoid bone distance (MP-H), a longer soft palate (PNS-P) and a greater tongue length (TGLt) than controls. There was no significant difference between the two groups. In (table 5), the mean value of mesiodistal dimension of the right maxillary central incisor at the level of contact area was 8.63 mm and 8.83 mm for male and female, respectively, which was statistically not significant (p>0.05). The left maxillary central incisor was also statistically not significant with the mean value of 6.83 mm and 6.80mm for male and female, respectively. But the right and left mandibular central incisor for male and female were highly statistically significant (p<0.001). The mean value of right side was 6.44 mm and 5.06 mm and left side 5.44 mm and 5.06 mm for male and female respectively. The mean value of the right and left maxillary lateral incisor at the level of contact area was statistically not significant (p>0.05).

Table 1: Distribution of the Subjects Included According to the Observed Volume and Gender of the Subjects of Maxillary Sinus

	Right Maxillary sinus volume (cm3)		Left Maxillary sinus volume (cm3)		Total volume (cm3)	
	X¯±SD	Mann-Whitney U (P)	X¯±SD	t-test (P)	X¯±SD	t-test (P)
Male	17.68±8.43	0.053	17.54±7.39	0.008	19.14±7.76	0.016
Female	10.83±4.19		12.14±3.69		12.03±3.81	

Table 2: Distribution of the 24 Subjects Included According to the Shape and Observed Volume of Maxillary Sinus

	Right Maxillary sinus volume (cm3)		Left Maxillary sinus volume (cm3)		Total volume (cm3)	
	X¯ ±SD	Kruskal-Wallis (P)	X¯ ±SD	ANOVA (P)	X¯ ±SD	ANOVA (P)
Pyramid quadrangular base	18.73±7.43	0.041	17.53±6.74	0.039	17.49±6.87	0.054
Pyramid triangular base	14.04±5.42		13.19±3.83	13.68±4.59		
Wing	8.14±1.43		8.17±0.83	7.64±1.17		

Table 3: Maxillary Arch Measurements Among Subjects

Maxillary arch measurement	Mean±SD
Inter-canine distance	31.00±0.40
First inter-premolar distance	37.48±0.40
Second inter-premolar distance	40.60±0.50
Inter-molar distance	47.50±1.00
Maxillary depth	33.60±0.50
Palatal height at canine	8.05±0.50
Palatal height at first premolar	14.50±0.50
Palatal height at second premolar	18.00±0.50
Palatal height at first molar	20.00±0.40
Palatal index at canine	0.23±0.02
Palatal index at first premolar	0.43±0.02
Palatal index at second premolar	0.55±0.02
Palatal index at first molar	0.45±0.01

Table 4:Lateral Cephalometric Measurements in Patients and Controls

Cephalometric variable	Mean±SD
Linear measurements (mm)	
SN	77.97±0.69
ANS–PNS	55.85±0.99
Aa–PNS	32.84±0.60
Ba–PNS	43.05±0.75
PNS–Pw	23.44±0.80
Go–Gn	76.18±1.15
MP–H	18.45±1.20
PAS	10.45±0.76
PNS–P	41.64±0.90
TGLt	77.21±1.60

Table 5: Statistical Analysis of Mesiodistal Dimensions in the Central Incisor Series

Position	Gender	Mean	SD	Result
Right Maxillary Central Incisor	Male	8.63	0.51	
	Female	8.83	0.52	NS
Left Maxillary Central Incisor	Male	6.83	0.54	
	Female	8.71	0.54	NS
Right Mandibular Central Incisor	Male	6.44	0.19	
	Female	5.06	0.4	***
Left Mandibular Central Incisor	Male	5.44	0.19	
	Female	5.06	0.22	***

Table 6: Statistical Analysis of Mesiodistal Dimensions in the Lateral Incisor Series

Position	Gender	Mean	SD	Result
Right Maxillary Central Incisor	Male	6.53	1.45	
	Female	6.65	0.51	NS
Left Maxillary Central Incisor	Male	6.93	0.37	
	Female	6.73	0.46	NS
Right Mandibular Central Incisor	Male	6.03	0.22	
	Female	5.53	0.17	***
Left Mandibular Central Incisor	Male	6.03	0.33	
	Female	5.53	0.17	***

(Table 1), shows that males had an average right Maxillary sinus volume of 17.63 cm3 with a ±SD of ±8.43 cm3, whereas females had an average of 11.93 cm3 with a ±SD of ±4.19 cm3. The average left volume was 19.54±7.39 cm3 in males and 12.14±3.69 cm3 in females. The Wilcoxon signed-rank test (P=0.353) revealed no significant variation in volume between the right and left sides of the same subject. The morphological properties of the Maxillary sinus have been studied[14], but the morphology and volume of the Maxillary sinus have not been thoroughly examined. Jun[15] observed a mean volume of 24.043 cm3 in men and 15.859 cm3 in women, respectively. (Table 2), shows that the pyramid form with a quadrangular base of Right Maxillary sinus volume (cm3) 16.73±7.43 was the most common, followed by the pyramid shape with a triangular base at 14.04±5.42 and the wing shape 7.14±1.43. There was no significant relationship identified between characteristics such as gender and the morphology of the maxillary sinus (P=0.328). Using the Kruskal-Wallis test, however, there was no statistically significant link (P=0.069) between the participants' age and any specific shape of the Maxillary sinus. Further Kiemer[15] obtained the values using semi automatic volume for the average calculation between age group 20-30 years. (Table 3), shows that the individuals had considerably reduced maxillary depth and narrower inter-tooth spacing at all four levels. In patients, the palatal index was considerably higher at the second inter-premolar and first inter-molar regions than in controls. The individuals' palatal heights at the canine, first and second premolar and first molar regions showed no changes in the current investigation. However, the patient group had considerably higher palatal indices in the second inter-premolar and first inter-molar areas, which can be attributed to shorter inter-tooth distances. This data suggests that the height of the palate alone is not a valid predictor of maxillary constriction and that width must also be considered when determining constriction[16]. (Table 4), analysis of the PA cephalograms showed a significant difference between patients and controls in the (max/mand) width ratio (0.68±0.01 versus 0.73±0.01., P<0.001) and (max/facial) width ratio (0.44±0.005 versus 0.47±0.005. P<0.01). Both were reduced in the patient group. The lateral cephalograms revealed that the sick group had a shorter maxilla (ANS-PNS) and mandible (Go-Gn) than the controls. Patients had a larger mandibular plane to hyoid bone distance (MP-H), a longer soft palate (PNS-P) and a longer tongue length (TGLt) than controls. (Table 5), shows that the average mesiodistal dimension of the right maxillary central incisor at the level of contact area was 8.83 mm for males and 8.63 mm for females, which was not statistically significant (p>0.05). The left maxillary central incisor was also not statistically significant, with mean values of 8.96 mm for males and 8.80 mm for females. However, the right and left mandibular central incisors for male and female were significantly significant (p<0.001). The mean right side value was 5.43 mm and 5.04 mm, while the left side was 5.43 mm and 5.02 mm for males and females, respectively. The mean value of the right and left maxillary lateral incisors in terms of contact area was not statistically significant. (Table 6), shows the mean value of right side was 6.53 mm and 6.65 mm and left side 6.93 mm and 6.73 mm for male and female respectively. But result were highly statistically significant (p<0.001) for right and left mandibular lateral incisor with the mean value for right side was 6.03 mm and 5.53 mm and for left side 6.03 mm and 5.53 mm male and female respectively. The MD dimension for maxillary and mandibular canine result was statistically significant (p<0.01) for both the side.

CONCLUSION

In this hand, the measurement of the Maxillary sinus and the study of their anatomy are relevant for surgical approach in clinical dentistry. A classification was presented that allows an analysis of sinus morphology, although it is necessary to conduct studies with larger samples to obtain more conclusive results. Maxillary constriction may occur more commonly in patients with subjects, compared with non-snoring, non-apnoeic subjects. Maxillary constriction may play an important role in the development of subjects and, if so, this may have therapeutic implications

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