A CBCT ANALYSIS OF THE APPROXIMATION OF MAXILLARY POSTERIOR TEETH TO FLOOR OF MAXILLARY SINUS

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LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL FORM
CBCT	Cone beam computed tomography
CT	Computed tomography
MSF	Maxillary sinus floor
2D	Two dimensional
3D	Three dimensional
mm	Millimeter
cm	Centimeter
kV	Kilovolts
mA	Milliamperes
P value	Probability value
OPG	Orthopantomogram
PA	Periapical
SD	Standard deviation
MSD	Maxillary sinus distance
ENT	Ear, nose,Throat
PE	Partially edentulous
CE	Completely Edentulous
MT	Mucosal thickening
ANOVA	Analysis of variance
LCD	Liquid crystal display
FOV	Field of view
CPU	Central processing unit

Introduction

With the advancement in science & technology in the medical field it is necessary for a clinician to be abreast with basic knowledge of the area of interest. Now a days newer treatment modalities have become available due to better diagnostic or imaging techniques. Therefore it is no surprise that surgical procedures in the maxillofacial region have also increased in number .These procedures are both curative and diagnostic in nature and include surgeries like periapical surgeries, preprosthetic, sinus lift procedures or implant placement.

The success of any surgical procedure depends on its planning and execution so as to avoid any type of complication. Therefore, while conducting surgical procedures in order to prevent any complications, it is imperative that the clinician should be well acquainted with the anatomical structures adjacent to surgical site, including the morphology and anatomy of the involved structure. This is not only helpful during the surgical procedure itself but also for correct diagnosis and proper

treatment planning. Nowadays many surgical procedures are being carried out in maxillary posterior region because of better understanding of the region due to the availability of 3D imaging techniques like CBCT.

Maxillary sinus is the first paranasal sinus to developing and development is complete by approximately 20 years of age. It expands by the process of pneumatization. Maxillary sinus floor (MSF) is in close approximation to the maxillary posterior teeth and may extend between the roots of these teeth and also between individual roots of multirooted maxillary teeth [1].This relationship of maxillary sinus floor with sinus depends on the degree of pneumatization.

Clinicians are especially concerned for patients with a highly pneumatized maxillary sinus because most often the root apices of the molars of such patient are protruding into maxillary sinus . There is always a risk of those teeth penetrate the sinus and enter the inferior recess of a maxillary sinus.[2]

This close relationship can lead to accidental communication between oral cavity and maxillary sinus due to various reasons like periapical pathologies or surgical procedures in this region. The spread of a periapical or periodontal infection to the sinus or iatrogenic perforation of the sinus floor depends on the anatomical relationship between the roots and respective cortical plates which influence the spread of odontogenic infection originating in maxillary posterior teeth.

The maxillary sinus can exhibit anatomic variations, in the form of antral septa, mucosal thickening, complete opacification or partial opacification. As some of these conditions can modify dental implant planning and must require specialized treatment, its recognition is important in dental practice, and especially in implantology.

Radiographic techniques like intra oral periapical radiograph, maxillary occlusal projection, orthopantomogram, water's view are being routinely for diagnostic imaging. But these modalities being a two dimensional in nature are inadequate and impractical for morphometric assessment of osseous relationship .[2]Also the diagnostic quality is minimized due to superimposition of different anatomic structures over the maxillary sinus. These limitations of 2 dimensional radiography can be overcome by the use of Cone beam computed tomography (CBCT) .

CBCT is a recent and advanced radiographic imaging technique used to create 3-dimensional images of the maxillary sinus .[3] It overcomes the limitations of conventional radiography and gives benefits of good image quality, volumetric analysis, short scan times, and relatively less radiation dose than conventional medical CT.

CBCT is routinely advised for various reasons such as dental implant site assessment, periapical, bony and inflammatory pathologies, endodontic lesion, sinus augmentation, impacted and supernumerary teeth and orthodontics where in the area of the maxillary sinus can be within the imaging field. Therefore , there is need for clinician to have a thorough knowledge of anatomical relationship of the root tips of the maxillary posterior teeth with floor of maxillary sinus and its 3 dimensional radiographic interpretation before planning any procedure in the posterior maxilla.

Hence, this study was conducted to assess the relationship between roots of maxillary posterior teeth and floor of maxillary sinus using Cone beam computed tomography.

Aim &Objectives

Aim

To assess the anatomic relationship between roots of maxillary posterior teeth with maxillary sinus and the variations of maxillary sinus using CBCT.

Primary Objectives

- To assess the distance between the roots of maxillary posterior teeth and maxillary sinus floor.
- To evaluate vertical relationship between roots of maxillary posterior teeth and maxillary sinus floor .
- To evaluate the horizontal relationship between roots of maxillary posterior teeth and maxillary sinus floor.

- To measure distance between roots and respective cortical plate below bifurcation.
- To determine bone thickness at the furcation of posterior teeth.

Other Objective :-

To detect the variations in maxillary sinus.

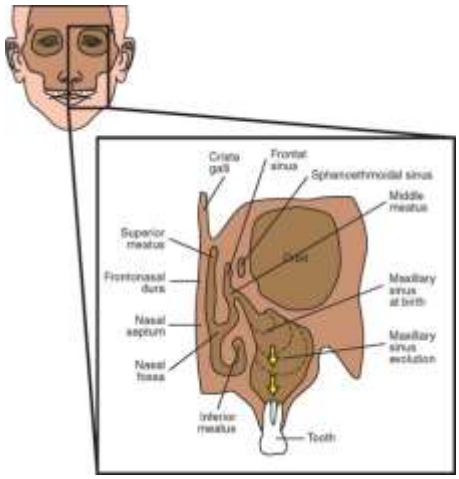
Review of Literature

Surgical procedures in the maxillary posterior region have increased in number such as periapical, preprosthetic sinus lift procedure and implants .

To achieve best results it is imperative that any surgical procedure should be devoid of any complications. Therefore, while conducting surgical procedures in order to prevent any complications, it is important to be well acquainted with relationship between maxillary sinus floor(MSF) and roots of maxillary posterior teeth.

The maxillary sinus is also known as Antrum Of Highmore. The maxillary sinus is the first to develop during human fetal life, roughly during the 10th week.[4] The maxillary sinus begins to form from an outpouching of the lateral wall of the ethmoid area of the nasal capsule within the infundibulum and immediately posterior to the developing uncinate process. This outgrowth enlarges slowly throughout fetal life due to the constriction by the perichondrium of the nasal capsule, limiting

extension into the maxillary process (maxilla). Thus, the maxillary sinus appears as a slit, caught between the developing ethmoid cells, the inferior turbinate, and the bone of the maxilla. Only as the nasal capsule is resorbed during its ossification does the maxillary sinus have an opportunity to enter the developing maxillary process. As the maxillary sinus expands into the maxilla, it is restricted by dental development. Further growth of the maxillary sinus into the maxilla follows the development of the maxilla and the descent of the teeth.[4]



Diagramatic representation showing development of maxillary sinus

The maxillary sinus varies in its extension. In about 50%of the population, the sinus expands into alveolar process, placing it in close relation to the roots of the premolars and molars. The roots of the maxillary premolars, molars and occasionally canine teeth may project into maxillary sinus .[5]

During surgery of maxillary posterior teeth, the sinus is at risk for exposure as a result of surgical procedures or by pathologic invasion .[6] It is essential to understand anatomic relationship between maxillary sinus floor and root of maxillary posterior teeth for planning of surgical procedures in the same region.

Tooth roots that protrude into maxillary sinus can have various implications such as:-

- *Implants*- A positive correlation between the length of the roots projection on the maxillary sinus in panoramic radiographs and the amount of pneumatization after extraction is described by Wehrbein and Diedrich . Sinus expansion after extractions can greatly decrease the bone height available for implant placement.
- *Extraction complications*- Oroantral fistulae or root displacement into the sinus cavity are a frequent complication after extractions of first and second molars.
- *Endo-antral syndrome* -Endo-antral syndrome, the spread of pulpal disease beyond the confines of the dental supporting tissues into the maxillary sinus causing sinusitis, may be present.[1]

The horizontal relationship between the root and alveolar cortex may also influence the buccolingual spread of infection.[7]

There are different classifications regarding relationship of roots of maxillary posterior teeth and floor of maxillary sinus given by different authors:-

1. Sharan et al(2006)[1]

0- The root is not in contact with the cortical borders of the sinus

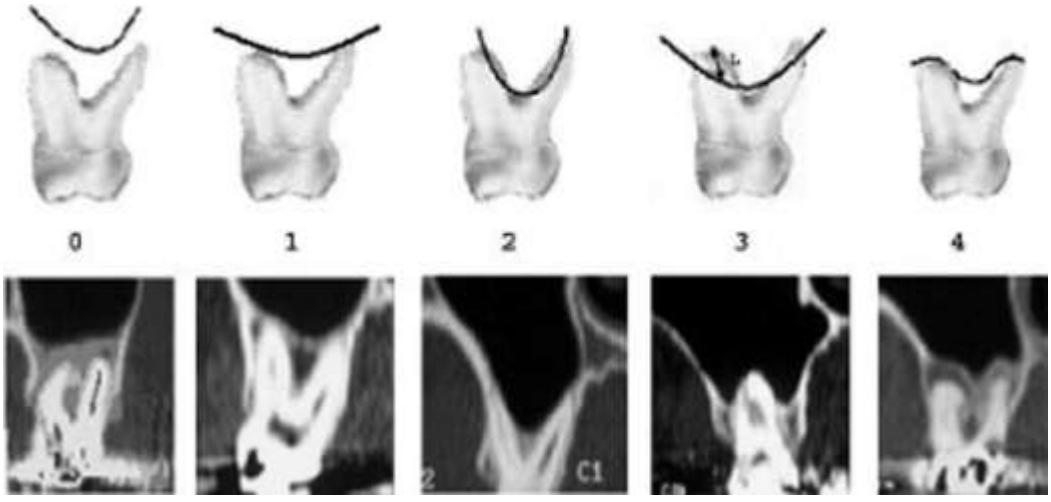
1- An inferiorly curving sinus floor, the root is in contact with the cortical borders of the sinus;

2- An inferiorly curving sinus floor, the root is projecting laterally on the sinus cavity but its apex is outside the sinus boundaries

3- An inferiorly curving sinus floor, the root apex is projecting on the sinus cavity,

4- A superiorly curving sinus floor enveloping part or all of the tooth root.

Schematic illustrations and panoramic images of the 5 classifications of the maxillary posterior teeth roots in relationship to the inferior wall of the sinus (L, measurement of the root-projection length on the sinus cavity).



Schematic illustrations and cross-sectional CT images of the 5 classifications of the maxillary posterior teeth roots in relationship to the inferior wall of the sinus (L, measurement of the root-protrusion length into the sinus).

2. Mattar et al (2010)[8]

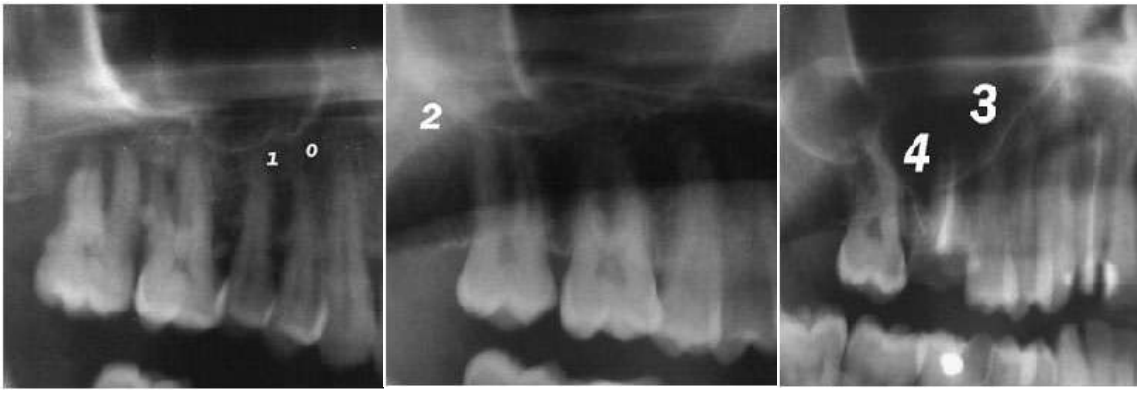
0= There is no contact between any root and the cortical borders of the sinus

1 = One or more root is in contact with the cortical borders of the sinus

2 = One or more root is projecting laterally on the sinus cavity but its apex is outside the sinus boundaries

3 = One or more root apex is projecting on the sinus cavity for a distance less than 2 mm

4 = One or more root apex is projecting on the sinus cavity for a distance more than 2 mm



Parts of panoramic radiographs showing relation scores to the maxillary sinus floor from 0 -4

3. Hassan B.A(2010)[9]

Class 1- Root tip is in the sinus root

Class 2- Tip is against the sinus wall

Class 3- Root tip is not in the sinus

4. Yoshimine et al(2012)[10]

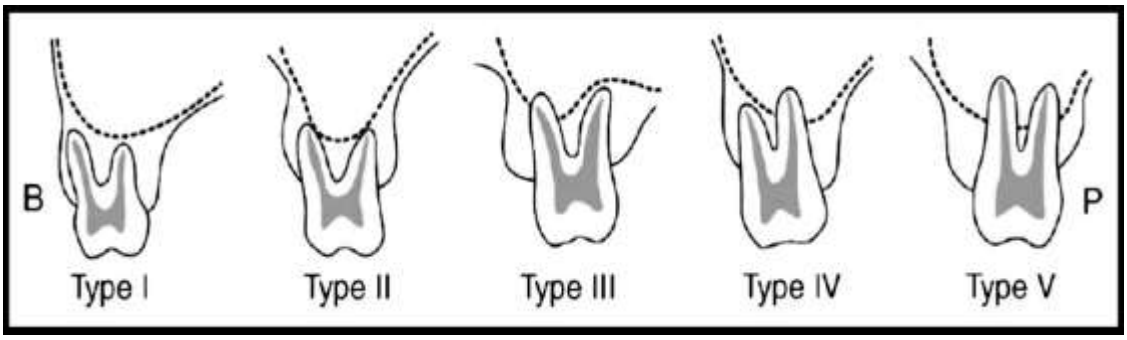
Type I: The inferior wall of the maxillary sinus was located above the level connecting the buccal and palatal root apices.

Type II: The inferior wall of the maxillary sinus was located below the level connecting the buccal and palatal root apices, without an apical protrusion over the inferior wall of the maxillary sinus.

Type III: An apical protrusion of the buccal root apex was observed over the inferior wall of the maxillary sinus.

Type IV: An apical protrusion of the palatal root apex was observed over the inferior wall of the maxillary sinus.

Type V: Apical protrusions of buccal and palatal root apices were observed over the inferior wall of the maxillary sinus.



5. Shubhasini et al(2015)[11]

Based on the distances between the roots of maxillary first molar and the sinus floor, measured in the coronal section and grouped according to classification given by Didilescu *et al*. Class 0: distance (d) = 0 mm; Class 1: 0 mm < d < 2 mm; Class 2: 2 mm ≤ d < 4 mm; Class 3: 4 mm ≤ d < 6 mm; Class 4: 6 mm ≤ d.

Class 0 Class 1 Class 2

Class 3 Class 4

CBCT images showing classification of roots based on distances between roots of maxillary first molar and the sinus floor

6. Kalkur C et al (2016)[12]

0 - The root is not in contact with the cortical borders of the sinus

1 - An inferiorly curving sinus floor, the root is in contact with the cortical borders of the sinus

2 - An inferiorly curving sinus floor, the root is projecting laterally on the sinus cavity but its apex is outside the sinus boundaries

3 - An inferiorly curving sinus floor, the root apex is projecting on the sinus cavity

4 - A superiorly curving sinus floor enveloping part or all of the tooth root

The relationship between the roots of maxillary posterior teeth and maxillary sinus floor can be assessed by conventional radiographic techniques such as intraoral periapical radiography , panoramic radiography and also with the computed tomography.

The drawbacks for two dimensional conventional radiography is that there are superimposition artifacts inherent to the scan methods leading to the over projection of maxillary tooth roots on sinus floor. Therefore panoramic radiography and periapical radiographs is unreliable in assessing the relationship between teeth roots and the maxillary sinus.[9]

Cone beam computed tomography (CBCT) is an absolutely recent imaging technology used to create 3-dimensional images of subjects.[3] The benefits of good image quality, volumetric analysis, short scan times, and relatively less radiation dose than conventional medical CT, therefore it has greater significance as an imaging modality within all disciplines of dentistry. [3]

Eberhardt JA , Torabinejad M, Christiansen EL, Linda CL, Calif (1992) [2] conducted study on computed tomographic display data from 12 autopsy specimens and 38 human subjects. They studied the mean distance between the apices of the maxillary posterior teeth and the floor of the maxillary sinus and the distance from these apices to the adjacent lateral bony surfaces. Results of the study showed that the apex of the mesiobuccal root of the maxillary second molar was closest to the sinus floor (mean 1.97 mm) but farthest from the buccal bony surface (mean 4.45 mm). The apex of the buccal root of the maxillary first premolar was closest to the adjacent lateral bony surface (mean 1.63 mm) but farthest from the floor of the sinus (mean 7.05 mm).

Ariji Y, Obayashi N . Goto M , Izumi M, Naitoh M, Kurita K ,Shimozato K, Ariji E et al (2006)[7] conducted the study on computed tomography images of 120 control subjects and 49 patients with infection originating in the maxillary first or

second molar. They investigated the horizontal relationship of the roots of maxillary molars with the cortical plates and the maxillary sinus and also studied the influence of these relationships on the spread of odontogenic infection. More than 60% of the first molar roots contacted both palatal and buccal cortical plates (Type A), while no such contact was seen in more than 60% of second molars. In case of both first and second molars the floor of maxillary sinus was most frequently observed at the level between the bifurcation and apices of roots. In patients with infection, 80% of patients with buccal cortical change showed the position in which the buccal roots were close to the buccal cortical plate. In this study Mucosal thickening of the maxillary sinus was found in 87.8%. The spread of odontogenic infection originating in the maxillary first and second molars , in buccopalatal direction was influenced by the horizontal root position in relation to the cortices.

Sharan A, Madjar D (2006)[1] conducted a retrospective study on paired panoramic radiographs and CT images of maxillae from 80 subjects . The topographic relationship between each root to the maxillary sinus floor was qualitatively studied on both OPG and CT images. Teeth classified and measured were maxillary second premolar, first and second molar .In classifications 0 and1 on CT and OPG,showed the same classification in 86% to 96% of the cases. In cases in which the cross-sectional CT images showed roots with classification 2, most of the panoramic radiographs (86%) showed classification 3. When the panoramic classification was 3, the CT images showed the same classification in only in 39% of the cases, and almost all the other cases showed a lower classification. When the panoramic classification was 4, the CT showed the same classification in only 47% of the cases and all the other cases presented a lower classification. Root projection on the sinus cavity was

found on the panoramic radiographs was 2.1 times more in comparison to the root protrusion length into the sinus measured by using CT images ($P < .001$). Authors concluded that the 86% of the roots projecting on the sinus cavity in panoramic radiographs, no vertical protrusion into the sinus was observed in CT images. Roots that did protrude into the sinus in the CT showed a protrusion length that was much shorter than the projection length appearance using panoramic radiography.

Mattar E, Hammad L, Faden A , Khalil H(2010)[8] analyzed 60 panoramic radiographs and studied the relationship of the maxillary sinus floor to the roots of posterior teeth in Saudi patients living in Riyadh, Saudi Arabia. A total of 266 teeth in the left side and 277 teeth in right side were examined in this study.

The authors found that most of the upper premolars have no close relation to the sinus floor as 77-98% of the first and second premolars scored 0 and 1 . Molar teeth showed closer relation to sinus floor as there was 37% of the first molar, 55 % of the second molars and 31 % of the third molar teeth scored 3 and 4. The results of the study showed that the first and second molar teeth are in a very close relation to the maxillary sinus in these subjects. The amount of protrusion of teeth roots into the sinus in panoramic radiographs should be taken into consideration by dentists while conducting extraction procedures in posterior maxilla.

Hassan BA(2010)[9] assessed the the reliability of periapical radiographs and orthopantomograms in detection of tooth root protrusion in the maxillary sinus by correlating the results with cone beam computed tomography. A total of 1400 CBCT patient's images were included . A dataset of matching OPG images of 101 patients with 628 maxillary premolars and molars and a second dataset of matching PA

radiographs of 93 patients with 359 maxillary premolars and molars were searched and included in this study. First the conventional PA radiographs and OPG and then the CBCT images were assessed. A single score was obtained for each tooth whether single or multirooted for each imaging technique. Out of 628 teeth included in OPG , sixty eight teeth (10.8%) were identified as class 1, 50 (8%) as class 2 and 510 (81.2%) as class 3. Within the 359 teeth included in the PA radiographs , sixty six teeth (18.4%) were identified as class 1, 19 (5.3%) class 2 and 266 (76.3%) class 3.Average correlation between OPG and CBCT images scores was 50%, 26% and 56.1% for class 1, class 2 and class 3, respectively. Average correlation between PA radiographs and CBCT images was 75.8%, 15.8% and 56.9% for class 1, class 2 and class 3, respectively. This study demonstrated that both periapical radiographs and orthopantomograms are not reliable as compared to CBCT in determination of exact relationship between the apex of tooth root and the maxillary sinus floor.

Kilic C, Kamburoglu K, Yuksel PS, Ozen T(2010)[5] assessed the relationship between the maxillary sinus floor and the maxillary posterior teeth root tips using dental cone-beam CT. A total of 87 right and 89 left maxillary sinus regions from 92 patients were examined using dental cone-beam CT. For both right and left sides ,they found the distance between sinus floor and root tip was longest for the first premolar root tip and shortest for the second molar buccodistal root tip. No statistically significant differences were found between the right and left side measurements or between female and male patients (P>.05). Therefore the authors concluded that, the knowledge of the anatomical relationship between the maxillary sinus floor and the maxillary posterior teeth root tips is important for the preoperative assessment while performing surgical procedures in maxillary posterior region.

Yoshimine S, Nishihara K, Nozoe E, Yoshimine M, Nakamura N (2012)[10] studied the anatomical characteristics of the maxillary premolars and molars and the maxillary sinus using cone beam computed tomography (CBCT) for dental implant treatment. Ten linear and one angular measurements was performed on 120 teeth in 30 patients on CBCT images . They also assessed positional relationship between inferior wall of maxillary sinus and maxillary premolars and molars according to Kwak's classification. The buccal alveolar bone was thinnest on the maxillary first premolars whereas thickest palatal alveolar bone was found on the maxillary second molars. Significantly greater internal angle was found at the maxillary premolars than that at the maxillary molars. A positive correlation was obtained between the internal angle and vertical distance between the apex of the roots and the maxillary sinus floor on the maxillary first premolar.

Ali SM , Hawramy FA, Mahmood KA(2012) [13] studied pairs of OPG and CT images of 27 patients to determine the relation of maxillary posterior teeth roots to the maxillary sinus floor .Maxillary second premolars, first and second molars were included. Using both the imaging techniques topographic relationship between roots and maxillary sinus floor was studied using the classification given by Kwak et al (2004). The projection lengths of the roots in the sinus cavity was also measured. Statistically significant (P>0.001) longer root projection in the sinus cavity was observed on OPG in comparison with the root protrusion measured by using CT images. In majority of the roots projecting on the sinus cavity in panoramic radiographs, no vertical protrusion into the sinus was observed on CT images. Roots protruding into the sinus in the CT showed shorter projection length in comparison with panoramic radiography. Authors have concluded that panoramic radiographs can

provide adequate assessment but if root protrusion detected in panoramic images ,CT is indicated to provide the additional information about the relation to the maxillary sinus floor and maxillary posterior teeth.

Jung Yh, Cho BH(2012)[14] investigated the relationship between the roots of the maxillary molars and the maxillary sinus using cone beam computed tomography(CBCT). A total of 332 maxillary molars in 83 patients were examined using CBCT images. In this study they have assessed the vertical relationship, horizontal relationship, distance between root apices and sinus floor and cortical plate thickness. A root protruding into the sinus occurred most frequently in mesiobuccal and distobuccal roots of maxillary molars. Root projecting laterally along the sinus cavity was most common in the palatal roots of the maxillary first molars. The mesiobuccal roots of the maxillary second molar were closest to the sinus. The mesiobuccal roots of the first molars were closest to the cortical plate. Authors concluded the buccal and palatal roots of maxillary molars showed different relationship with floor of maxillary sinus.

Didilescu A, Rusu M, Sandulescu M, Georgescu C, Ciuluvica R(2012)[15] studied 97 CBCT images and assessed the relationships between the maxillary first molar and the maxillary sinus floor . The distances between root tip and sinus floor as well as distance between furcations and the sinus floor, were evaluated . The palatal root of the maxillary first molar was found to be closest with the sinus floor and also proved to be the best predictor for the furcation-sinus floor distance. Therefore, while taking surgical decisions the clinician should be aware of the anatomical and morphological details of the palatal root of maxillary first molar.

Hussein ZA, Al-Nakib LH(2013)[16] studied 120 CT sagittal reconstructed images and investigated the relationship between the roots of the maxillary posterior teeth and the maxillary sinus floor . Vertical distance between the root tips of the maxillary first ,second premolars and first, second molar and sinus floor was measured and images were classified according to the relation between the root apices and the maxillary sinus floor into type1: Root apices below the sinus floor, type 2: Root apices in cosines floor and type 3: Root apices penetrate or inside the sinus floor . Means, standard deviations and minimum and maximum values were calculated for all right and left premolars and molars. T-tests were used to compare measurements between left and right sides and between female and male patients. The longest distance was found for the first premolar palatal root apex and shortest for the second molar mesiobuccal root apex for both right and left sides. No statistically significant differences were found between the right and left side measurements or between females and males patients. There was no significant difference in vertical relation of maxillary posterior teeth to floor of maxillary sinus between male and female and between right and left side. They found that the mesiobuccal root of the maxillary 2nd molar was closest whereas palatal root of 1st premolar was farthest to the sinus floor.

Ok E , Gungor E, Çolak M, Altunsoy M, Nur BG , Aglarci OS(2014)[17] studied the relationship between each root of maxillary premolars and molars and the maxillary sinus floor according to sex, sinus position, and age by decade in a by using CBCT scanning. Total 5,166 teeth(2,680 maxillary premolars and 2,486 maxillary molars) of 849 patients were studied. The vertical relationship between each root of the molar and premolar teeth to the sinus floor was classified. They found type 3 i.e

the roots extended below the sinus floor occurred most frequently in the first (92.4 %) and second (71.6 %) premolar teeth, type 1 (34.2 %) i.e the roots penetrated into the sinus floor occurred most frequently in the palatal roots of the first molar teeth, type 3 occurred most frequently in the mesiobuccal (39.9 %) and distobuccal (39.7 %) roots of the first molar teeth, and type 2 (36.7 %) i.e the roots contacted the sinus floor occurred most frequently in the mesiobuccal roots of the second molar teeth. There was no significant differences found between the left and right sides, but several differences were found between males and females. In this study the maxillary first premolars have no relationship with the maxillary sinus floor, but the maxillary second molars are closer to the sinus floor.

Arx TV, Fodich I, Bornstein MM(2014)[18] studied the anatomic relationship between maxillary premolars and maxillary sinus floor using cone-beam computed tomographic. CBCT images of 192 patients were included and the distances between the root apices of each root of the maxillary premolars and the adjacent maxillary sinus measured. They found the frequency of a premolar root protrusion into the maxillary sinus was very low in first premolars (0%–7.2%) but higher in second premolars (2.5%–13.6%). As per the results of the study states only few premolars (and if so second premolars) would present a risk of penetrating the border of the maxillary sinus during conventional or surgical endodontic treatment or in case of tooth extraction.

Georgiev T, Peev S, Arnautska H(2015) [19] conducted a retrospective study on 245 scans of maxilla to assess the relationship between the apices of maxillary posterior teeth and the floor of the maxillary sinus. The distance between root apices

of canines, first and second premolars ,first, second, third molars and the maxillary sinus floor was measured . Out of the 960 teeth examined,746 teeth were in dangerous proximity to the maxillary sinus, 156 of which penetrated the sinus cavity at different depths. In this study in patients from the Varna region the maxillary second molars appeared to be the most common teeth to project into the sinus and when extracting these teeth dental clinicians must be particularly cautious for possible complications related to this problem.

Shubhasini AR, PraveenBN, Bhanushree R, Shubha G, Keerthi G, Sangeetha(2015)[11] assessed the relationships between the roots of the maxillary first molar and the maxillary sinus floor. Total 29 cone-beam computed tomography scans of maxillary first molar and floor of the maxillary sinus were studied retrospectively . Individual root of the tooth categorized according to Classification given by Didilescu et al. Totally, 21 (72.41%) mesiobuccal roots, 18 (62.06%) distobuccal roots, and 14 (48.27%) palatal roots showed a Class 1 relationship. Out Of 8 cases 2 (37.5%) cases which belonged to Class 0 had protrusion of root into the sinus. This study showed , Class 0 relationship was the highest for palatal root. Most of the root apices had Class 1 relationship with the floor of the sinus. Therefore Maxillary molars need thorough three-dimensional radiographic assessment to understand its approximation with the maxillary sinus.

Akhavan H, Toursavadkouhi S, Talaeipour A, Rahimifard A, Sadighnia A (2016)[20] measured the distance between the maxillary sinus floor and the maxillary first and second molar root tips using 100 Cone-beam computed tomography scans. The closest distance between each root tips and floor of maxillary

sinus was recorded. The longest distance between maxillary sinus floor and maxillary posterior root tips belongs to mesiobuccal root of maxillary first molar (1.42 +- 0.72) and palatal root of maxillary second molar (1.42+- 0.83), the shortest distance belongs to distobuccal root of maxillary second molar (0.98+- 0.68) and the difference was significant (P<0.001). There is a close relationship between maxillary sinus floor and maxillary posterior root tips specially distobuccal root of maxillary second molar. To avoid complications like sinusitis or oroantral fistula formation more attention should be given while conducting tooth extraction or periapical surgeries in this region.

Estrela C, Guedes OA, Helena AG. Alencar,Estrela CA, Silva RG , Pécora JD (2016)[21] performed a retrospective analysis of the anatomical relationship between posterior teeth root apices and maxillary sinus floor (MSF) on 202 CBCT scans. The distance between the root apices and the MSF, as well as the MSF thickness of the cortical bone closest to root apices and furcation regions were measured. All the measurements were performed on maxillary first and second premolars, first and second molars. The shortest distances between MSF and the root apices were observed in the mesiobuccal root of the second molar (0.36±1.17 mm) and the palatal root of the first molar (0.45±1.10 mm) and the widest in buccal roots of the first premolars (5.47±4.43 mm). The cortical thickness ranged from 0.65±0.41 mm over the mesiobuccal root of the second molar to 1.28±0.42 mm over the buccal root of the first premolar. The most observed vertical and horizontal relationships were type II and 2H, respectively. The maxillary molar roots showed greater proximity to the MSF. The thickness of the MSF cortical bone closest to the apices and furcation regions was found to be similar only for premolars. Study revealed that

the maxillary molar showed greater proximity with the maxillary sinus when compared with premolars.

Kalkur C, Sattur AP, Guttal KS, Naikmasur VG, Burde K(2017)[12] compared the imaging characteristics of Orthopantomograph and Digital Volumetric Tomography to study Correlation between maxillary sinus floor topography and relative root position of posterior teeth. A total of 510 maxillary teeth from 85 patients were classified according to their topographic relationship to the maxillary sinus and measured according to their projection lengths on the sinus cavity using OPG and DVT modalities. In cases of classification 0, 85% and in classification 1, 55.3% cases shows similar classification in both OPG and DVT. 28.5% of cases in both imaging modalities show classification 2. Classification 2, 3,4 was present in 28.5%,15.9%,11.1% cases respectively. Panoramic radiograph showed 2.24 times longer root projection on the sinus cavity as compared to DVT which was statistically significant. They concluded that the teeth roots projecting in to the sinus in OPG, shows no vertical protrusion in to the sinus in DVT images. Hence DVT was better than OPG as measurements with DVT were more exact and closer to anatomical reality.

Ahn NL, Park HS (2017)[22] evaluated the distances from the maxillary posterior root apices to the inferior wall of the maxillary sinus using cone-beam computed tomography images . They have measured the distances along the true vertical axis from the apex of the root to the sinus floor in 118 patients (63 male, 55 female) aged 10 to 28 years. They found the frequency of root contact with the sinus floor increased from 70% at the second premolar to more than 80% at the buccal roots

of the first and second molars. Male and older age (20-28 years) groups had significantly smaller distances or more protrusion of the root into the sinus than female and younger age (10-20 years) groups. The distances were shorter, or there was more protrusion of the root into the sinus in the hyperdivergent, down-canted palatal plane, and large gonial angle groups. Results of this study showed that male, older age, hyperdivergent skeletal pattern, and large gonial angle groups had significantly closer distances between maxillary root tips and the sinus floor or more protrusion of the roots into the sinus. The intrusion of the maxillary molars for orthodontic purposes in those situations may be difficult and slow because of the pneumatized maxillary sinus.

Dehghani M**, Motallebi** E**, Navabazam** A**, Montazerlotfelahi** H**, Ezoddini F, Ghanea S(2017)**[23] analyzed 440 maxillary first and second premolars, and first and second molars of 55 patients to study the relation between maxillary sinus floor and posterior maxillary teeth roots using panoramic and cone beam computed tomography. The agreement between CBCT and panoramic radiographs in determining root form was measured with kappa, which was found as 0.549 (P=0.0001). This implies that CBCT and panoramic radiographs showed an agreement in determining the position of maxillary sinus floor and posterior teeth roots. The difference between calculated mean (SD) distances of the two methods was 0.74(2.92) mm (P=0.0001). This indicates that the measurements by panoramic radiographs differ from CBCT. This study supports the use of CBCT to establish the exact correlation between maxillary sinus floor and posterior teeth roots, especially in classification 3 (projected in panoramic radiographs) for reducing damages and infection transmission.

Kosumarl W, Patanaporn V, Jotikasthira D, Janhom A (2017)[24] determined distances from the maxillary root apices of posterior teeth to the floor of the maxillary sinus, and the distances from the mandibular root apices of the posterior teeth to the mandibular canal, in Thai subjects with skeletal open bite and skeletal normal bite. Pretreatment cone-beam computed tomography (CBCT) images were obtained from 30 Thai orthodontic patients (15 patients with skeletal normal bite and 15 with skeletal open bite) whose ages ranged from 14 to 28 years. The MSDs and from the root apices of the maxillary second premolar, first molar, and second molar to the maxillary sinus floor were measured perpendicularly to the occlusal plane. The greatest mean MSDs were from the root apex of the second premolars in both groups, whereas the least mean MSDs were from the mesiobuccal root apex of the second molars. They found there were no differences in the mean MSDs between the skeletal normal bite group and the skeletal open bite group.

Haghanifar S, Moudi E, Bijani A, Arbabzadegan A, Nozari F(2018)[25] aimed to demonstrate the relationship between the roots of maxillary molars and maxillary sinus floor and measuring the divergence angle of the roots by CBCT. 160 patients and on 419 teeth were included in this cross-sectional study . The vertical relationship between each root and maxillary sinus was categorized into four classes in cross-sectional images. Class 0 (the root is located far away from the border of the maxillary sinus), Class 1 (the root is in contact with the maxillary sinus floor) the Class 2 (the root is projecting laterally on the maxillary sinus) and Class 3 (the root is projecting into the maxillary sinus) and divergence angle of roots was measured based on cross-sectional images. The class 2 (39.1%) accounted the most common class in the maxillary molar teeth. The Class 0 has showed significantly more in men (31.7%)

than women (18.7%). The most angular divergence among three roots of molars has been found in the first molar and the divergence angle between the buccal and palatal roots was greater than that between the buccal roots. The maxillary first molar has the highest divergence and its relation with the maxillary sinus floor is class 2.

Al-Sultany HK, l-Sheakli II (2018)[26] did measurements of posterior root apices and maxillary sinus floor according to the side and gender using cone beam computerized tomography in 60 patients . Distances were measured along the true vertical axis from the apex of the root to the sinus floor, and the thickness and density of maxillary sinus floor . The results of the study showed that the frequency of root contact with the sinus floor increased from 42.5% at the second premolar to more than 91% at the mesiobuccal roots of the second molars. The more protruded root into the sinus floor was the mesiobuccal root apices of the second molars. The distances of both mesiobuccal and palatal roots of second molars and density of second premolar and first molar in left side were significantly higher than the right side, while the thickness of mesiobuccal roots of the second molar was higher in right side than in left side. The distance and density had no significant difference in both males and females, while the thickness of distobuccal and palatal roots of the second molar is higher in females than in males. They concluded that the intrusion of the maxillary molars in small distances between root tips and sinus floor could be difficult and slow due to the pneumatization of the maxillary sinus.

Katti G, Shahbaz S, Katti C, Rahman MS(2018)[27] studied the relationships between the roots and furcation of the maxillary first molar to the floor of the maxillary sinus. This retrospective study was carried out on 50 CBCT scans of

maxillary first molars of 36 patients were taken and the vertical relationship of the roots and furcation with the floor of the sinus were analyzed and classified. Totally 14 (28%) mesio buccal roots, 8 (16%) disto buccal roots and 5 (10%) palatal roots which were perforating into the sinus and total of 18 scans had furcations whose distance from the sinus floor was less than 5mm with Mean ± SD as 3.64 ± 1.14 and rest had more than 5mm with Mean ± SD as 6.19 ± 2.63 . This study concluded that any pathology assessment or treatment plan in the first molar region must be dealt with proper three dimensional images to understand the approximation of the sinus and plan out procedure best suited for the patient.

Variations of maxillary sinus

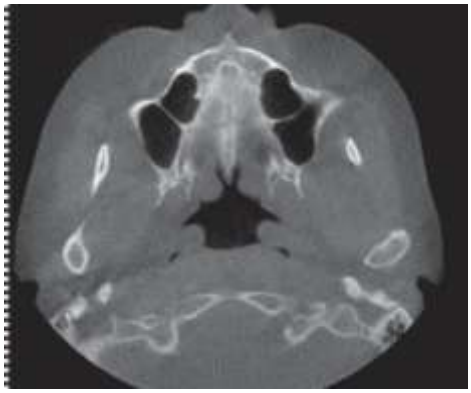
The maxillary sinus is largest of all the paranasal sinuses. The maxillary sinus has a horizontal pyramidal shape consisting of a base, an apex, and 4 sides. The base(medial wall) forms the vertical lateral wall of the nasal cavity, and the apex is at the junction of the maxillary and zygomatic bones. The remaining 3sides of the pyramid form the superior , anterior, and posterior walls of the sinus. The superior wall makes up the roof of the sinus, which is also the orbital floor. The anterior wall forms the facial portion of the maxillary bone. The posterior and lateral walls merge to form the posterolateral walls of the sinus, and separates the sinus from the infra temporal fossa and forms the maxillary tuberosity and pterygoid fossa.[4]

Maxillary sinus shows presence of anatomical variations in asymptomatic patients. These variations can be detected on routine radiography performed for either for diagnostic or treatment planning purposes.

Bony septa, polyps, sinusitis or mucosal thickening can pose difficulties while performing surgeries in the maxillary posterior region such as sinus lift procedure, implant placement and periapical surgeries . The Schneiderian membrane i.e the lining of the maxillary sinus can be perforated, therefore certain modifications of the surgical approach will be needed to prevent the perforation. Bony septa in the maxillary sinus was first described by Underwood in 1910.[28]

Atrophy-related resorption of the alveolar process leads to vertical loss of bone volume and progressive sinus pneumatization leads to an excavation of the alveolar process from the cranial aspect which varies from one individual to another. Because atrophy- related resorption may occur differently in different areas of the alveolar process, bony septa can be considered residues between two such zones of resorption [29] For biomechanical reasons, a bony septum remains in the region between two such zones of resorption which allows transfer of masticatory pressure. The septae are composed of cortical bone and may be either complete or partial.

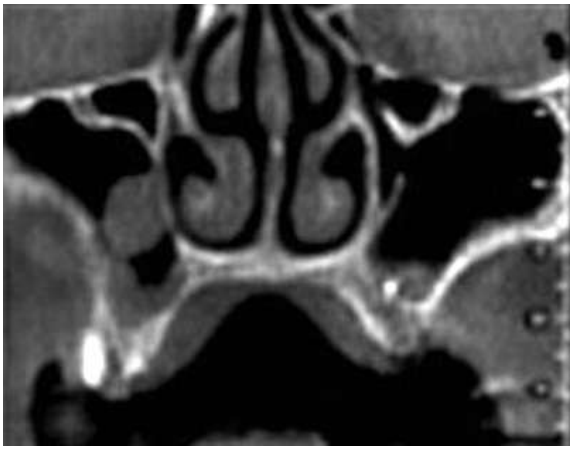
Various authors have given several hypotheses regarding the etiology of antral septa. According to Neivert the septa were derived from the fingerlike projections produced by the embryologic out-pouching of the ethmoid infundibulum, where the contiguous walls did not resorb. Krennmair et al. classified the septa into primary and secondary septa. Septa arising from the development of the maxilla, are termed as primary septa whereas septa arise from the irregular pneumatization of the sinus floor following tooth loss are termed as secondary septa.[30]



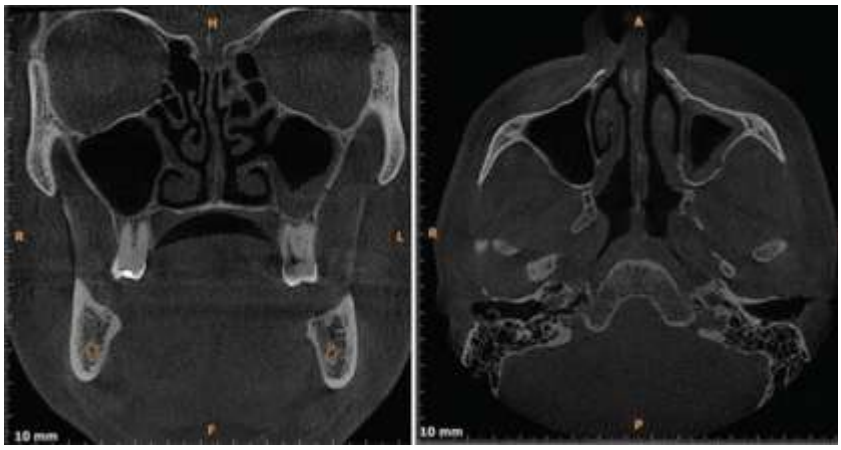
Septa in both maxillary sinuses, axial view

Mucosal thickening is an inflammatory reaction with hyperplasia of the mucous lining of the maxillary sinus. Normally maxillary sinus is lined with the respiratory mucosa which comprises of ciliated columnar epithelium and goblet cells. The goblet cells secrete a thin layer of mucus which contains immune cells such as activated WBCs and this mucus layer is similar to a conveyor belt system motored by the cilia of the epithelium which beat in a synchronised direction towards the sinus ostium (opening) and there on to the rear of nose and down the throat into the esophagus(upper1/3rd).

The pathogenesis for mucosal thickening is that, in the presence of bacterial infection , the infected mucosa swells up in response to the bacteria which alter the goblet cells to change the composition of the mucus and to generate a shield of thick mucus for themselves which acts as a shield against antibiotics. If there are signs of mucosal thickening in the maxillary sinus, they are relevant for modifying surgical procedures in maxillary posterior region such as sinus elevation.[31]



CBCT scans with incidental findings of mucosal thickening



CBCT scans with incidental findings of mucosal thickening

The incidence of variations in asymptomatic subjects varied between 10.9% and 69.1% in some reported studies.[32]

According to recent literature the incidence of maxillary sinus septa, mucosal thickening ,polyps is 66.7%(Mudgade 2018), 52.3% (Malik 2018),16%(Eman 2017) respectively.[33,34,35]

As these normal variations can modify surgeries in maxillary posterior region. All surgical interventions in the posterior maxillary region require detailed knowledge of maxillary sinus anatomy and possible anatomical variations and must

require specialized treatment. Therefore detailed knowledge of the patient's morphological conditions its recognition is important in dental practice, allows exact planning of invasive surgery and helps to avoid complications. Therefore, an exact and definitive radiological assessment is necessary.

Failure to detect incidental abnormalities is associated with the limited ability and experience of oral radiologists when interpreting radiographic images. Therefore the systematic visual scrutiny of the whole image, including the dentoalveolar region and all adjacent structures of the maxilla-mandibular complex is necessary .

Krennmair G , Ulm C, Lugmayr H (1997)[29] studied incidence, morphology and clinical implication of antral septa in 165 patients clinically and radiographically using CT scan. They found septa in 18(27.7%) clinical diagnosed patients whereas 32(16)% patients diagnosed by CT . 21(13.2%) septa were non atrophic and 11(26.8%)septa were atropic maxillary segments ($p<0.01$).CT examination showed one complete septum (0.5%),21 incomplete septa on sinus floor and 10 incomplete septa on anterior antral wall. In atrophic maxillary sinuses, the incidence (27.7% vs 26.8%), morphology (all septa located on sinus floor) and height (8.1_+2.5 vs 6.8_+ 1.6 mm) did not differ between the clinical and the CT examinations. To reduce the rate of complications detailed knowledge about location, morphology and height of antral septa is of clinical relevance at the time of maxillary sinus surgery, i.e. sinus floor elevation.

Krennmair G, Ulm C, Lugmayr G, Solar P(1999)[36] evaluated the incidence, location, and height of antral septa in edentulous and dentate maxilla. They have divided 194 maxillary posterior regions subdivided into four groups (group 1- 61

clinically and radiographically (panoramic radiography)examined atrophic ridges; group 2 -41 anatomically examined atrophic ridges; group 3- 42 radiographically [CT] examined atrophic ridges; and group 4 - 50 CT examined dentate maxillary ridges), . They found that the incidence of antral septa was significantly greater ($P < .01$) in atrophic edentulous regions (groups 1,2, and 3) than in dentate regions (group 4). In case of atrophic maxillae about 70% of antral septa were located in the anterior (premolar) region. Antral septa are commonly found in edentulous atrophic maxillae as compared to dentate maxillae. The septae are shorter in edentulous atrophic maxillae than those found in dentate maxillae. When present, maxillary sinus septae are more common anteriorly than posteriorly. Panoramic radiography has less sensitivity and specificity than CT scanning for the detection of sinus septa.

Rudralingam M, Jones K, Woolford TJ(2002)[37] observed total 372 CT scans , out of which 352 from ENT department and 20 from maxillofacial department. 340 scans showed mucosal thickening , unilateral opacity of maxillary sinus was found in 20 patients out of which 3 had maxillary sinusitis ,one had mucous retention cyst and one had mucormycosis. Two had benign conditions i.e inverted papilloma and ameloblastic fibroma and four patients with malignant disease i.e two cases of adenoid cystic carcinoma ,one squamous cell carcinoma and one lymphoma. They concluded that Computed Tomography (CT) is the method of choice for imaging conditions that affect paranasal sinuses.

Kim MJ, Jung UW, Kim CS, Kim KD, Choi SH, Kim CK et al (2006)[30] investigated the CT scans of sample population of 100patients whose treatment was being planned for implant-supported restorations. In their study the prevalence of

one or more septa per sinus was found to be 26.5% (53/200), 31.76% (27/85), and 22.61% (26/115) in the average study population and the atrophic/edentulous and the non-atrophic/dentate maxillary segments, respectively. They analyzed the anatomic location of the septa within the sinus and it was revealed that 15 (25.4%) were located in the anterior region, 30 (50.8%) in the middle region, and 14 (23.7%) in the posterior region. The measured heights of the septa varied among the different areas .The mean heights of the septa were1.63–2.44, 3.55–2.58, and5.46–3.09 mm in the lateral, middle, and medial areas, respectively. Authors inferred that there is a wide anatomical variation in the prevalence, size, location, and morphology of maxillary sinus septa, irrespective of the degree of atrophy. Therefore, during sinus augmentation procedures, a thorough and extensive understanding of the anatomic structures is essential to prevent the complications.

Koymen R, Gocmen-mas n, Karacayli U, Ortakoglu K, Ozen T, Yazici AC (2009)[38] evaluated the the incidence, anatomic features of antral septa as locations, courses, shape or types and heights of septa using dental CT images. This study included a total of 205 cases. 177 patients were partially edentulous (PE) whereas 28 patients had no teeth. The assessment of 410 sinus segments (205 left and 205 right segments) was performed . The prevalence of sinus segments with septa was found to be 145/ 410. Septa were detected in 91 of the 177 PE cases. There were a total of 26 septa in 18 of the 28 completely edentulous (CE) cases. A total of 165 septa were detected in these segments. The prevalence of septa was 46.4% (26/56) in the CE, and 39.2% (139/354) in the PE segments. Thirty septa were found in the anterior, 110 in the middle and 25 in the posterior region. All detected septa were located mediolateral direction. Their relative position: lateral, middle or medial were

also noted. The height measurements of the septa varied amongst the different positions. All parts of the maxillary sinus showed the presence of septa of various heights and courses. Therefore timely and adequate assessment of the inner aspect of the maxillary sinus is essential to avoid complications during sinus augmentation procedures.

Pazera P, Bornstein MM, Pazera A, Sendi P, Katsaros C (2011)[49] studied the frequency of incidental maxillary sinus findings on 139 using cone-beam computed tomography (CBCT) images made for orthodontic purpose. Two experienced observers reviewed the CBCT scans and recorded all incidental maxillary sinus findings. Out of 139, 65 CBCT scans (46.8%) showed incidental findings in maxillary sinus . Three types of incidental findings were diagnosed i.e flat mucosal thickening (23.7%), polypoid mucosal thickening (19.4%), and signs of acute sinusitis (3.6%). The mean thickness of the mucosal lining in the maxillary sinus was 1.58 mm (95% CI: 1.17–1.98 mm). The authors concluded that a high percentage of the CBCTs made for orthodontic diagnostic purposes exhibit incidental maxillary sinus findings not associated with the primary indication.

Ritter L, Lutz J, Neugebauer J, Scheer M, Dreiseidler T, Zinser MJ et al(2011)[31] conducted a study to assess the prevalence of pathologic findings in the maxillary sinus by using 1029 CBCT scans. CBCT scans were retrospectively inspected for pathologic findings in the maxillary sinus by 3 observers. Findings were differentiated by mucosal thickening, partial opacification with liquid accumulation, total opacification, and polypoidal mucosal thickening. Position and diameter of the maxillary sinus ostium were also assessed. In this study they have Correlated the

pathologic findings with age and gender of the patient. A total prevalence for pathologies in the maxillary sinus of 56.3% was found in this study. The most frequent pathology was mucosal thickening. Patients >60 years of age showed significantly more pathologies in the maxillary sinus (P = .02), and male patients showed significantly more pathologies than female patients (P =.01). Pathologies in the maxillary sinus are frequently found in CBCT imaging and have to be treated or followed-up accordingly.

Lana JP, Carneiro PM, De Souza PA, Manzi FR, Horta MC(2011)[40] , In this study 500 CBCT scans were independently evaluated by two oral and maxillofacial radiologists who assessed the presence of anatomic variations and lesions of the maxillary sinus. The anatomic variations detected were pneumatization (83.2%), antral septa (44.4%), hypoplasia (4.8%), and exostosis (2.6%). The identified lesions were mucosal thickening (_3 mm in 54.8% and >3 mm in 62.6%), polypoid lesions (21.4%), discontinuity of the sinus floor (17.4%), airfluid level (4.4%), bone thickening of the maxillary sinus wall (3.8%), antroliths (3.2%),discontinuity of the sinus lateral wall (2.6%), sinus opacification (1.8%), and foreign body (1.6%). As some of these conditions require modification for dental implant planning and must require specialized treatment, its recognition is noteworthy in dental practice, and especially in implantology. The amount and significance of the anatomic variations and lesions detected in this study reinforces the importance of computed tomography in preoperative planning for dental implant .

Park YB, Jeon HS , Shim JS, Lee W ,Moon HS(2011)[41] investigated the prevalence, location, height, morphology, and orientation of maxillary sinus septa by

use of 200 CT images . CT and DentaScan reformatted data from 400 sinuses were analyzed. They found 111 septa in 400 maxillary sinuses (27.7%). This corresponded to 37% of the patients. Among total 111 septa, 25 sinus septa (22.5%) were located in the anterior, 51 (45.9%) in the middle, and 35 (31.5%) in the posterior regions. The directional orientation analyses showed that 106 septa were buccopalatal, 4 were sagittal, and 1 was transverse type. In this study mean septal heights were 7.78 and 7.89 mm in the right and left sinuses, respectively. They concluded that analysis of three-dimensional CT images provide useful information that will be useful to avoid unnecessary complications during surgical procedures related to maxillary sinus.

Gracco A, Parenti SI ,Ioele C, Bonetti GA, Stellini E(2012)[42] performed a study to determine the prevalence of incidental maxillary sinus findings in 513 CBCT scans of orthodontic patients . The frequencies of pseudocysts and mucosal thickening of the maxillary sinus were recorded. Logistic regression analysis was used to determine the influence of age and gender on these abnormalities. They found Pseudocysts in 52 patients (10.1%) and 59 sinuses (5.75%). Mucosal thickening was observed in 206 patients (40.1%) and 258 sinuses (25.1%). Gender and age were significantly associated with pseudocysts ($p = 0.027$) and mucosal thickening ($p < 0.001$), respectively. In their study half of the orthodontic patients had incidental maxillary sinus findings. Men were more likely to show pseudocysts, and older patients (aged 41 - 60 years) were more likely to show mucosal thickening.

Rege IC, Sousa TO , Leles CR , Mendonça EF(2012)[43] evaluated 1113 CBCT scans to investigate maxillary sinus abnormalities in asymptomatic patients .CBCT scans were examined by two examiners and identification of abnormalities,

the presence of periapical lesions and proximity to the lower sinus wall were recorded. Abnormalities were diagnosed in 68.2% of cases . Most prevalent abnormality was mucosal thickening (66%), followed by retention cysts (10.1%) and opacification (7.8%). Therefore it is important for the dentomaxillofacial radiologist to undertake an interpretation of the whole volume of CBCT images to identify the sinus abnormality in asymptomatic patients.

Lim GT, Spanger M (2012)[44] assessed the incidental findings in the maxillary sinus on CT. A total of 262 CT scans were reviewed (524 maxillary sinuses). All maxillary sinus incidental findings were recorded and categorised into mucosal thickening, polypoid mucosal thickening, partial and total opacification. The age and gender of the patients and the side of mucosal pathology was also recorded. .Seventy-two patients had pathological changes (27.5%), 44(16.8%) had mucosal thickening, 20(8.0%) had polypoid thickening,6 (2.3%)had partial and another 7(2.7%) had complete opacification. Study showed that there is a high rate of undiagnosed maxillary sinus pathology incidentally found on CT scans. Clinicians reviewing head and neck CT scans such as dentists, general medical practitioners, maxillofacial and ENT surgeons should be aware of such maxillary sinus disease and patients should be followed up appropriately.

Orhan K , Seker BK, Aksoy S, Bayindir H , Berberoğlu A , Seker E(2012)[45] did a study to determine the prevalence, height, location and morphology of maxillary sinus septa in dentate, partially dentate and edentulous adults as well as in mixed dentition children using CBCT for maxillary sinus . Total ***Five*** hundred and fifty-four sides in the CBCT scans of 272 patients (30 children and 242 adults) were

retrospectively analyzed. The prevalence, location and morphology were assessed in axial, sagittal, cross-sectional and panoramic 3-dimensional images. The height of septa was measured with the angle between the direction of the septum and median palatine suture. The differences among age, localization and measurements were statistically analyzed. They found that the prevalence of maxillary sinus segments with septa was 58%. There were a total of 13 (3.2%) septa of completely edentulous (CE), 198 (53.9%) septa of edentate and 14 (3.8%) septa of the mixed dentition maxillary segments. The location of septa observed in all study groups demonstrated a greater prevalence (69.1%) in the middle region than in the anterior and posterior regions. No statistically significant differences were observed with regard to gender or age, for septum height ($p > 0.05$). However, maxillary sinus septa are higher in partially edentulous patients than edentate and CE ones ($p < 0.05$). They inferred that the extensive evaluation of maxillary sinus with an appropriate radiographic technique is essential to prevent possible complications during sinus surgery.

Dobele I, Kise L, Apse P, Kragis G, Bigestans A(2013)[46] aimed to assess the presence of anatomic variations and pathology of the maxillary sinus using cone beam computed tomography (CBCT) of the maxilla.This retrospective study was carried out on a sample of 34 CBCT scans of dental patients (68 sinuses). CBCT was used to assess maxillary sinus mucosa and out flow and prevalence of septa. The mucosal thickening was measured and the sinus outflow was classified as open or obstructed. Mucosal thickening was found in 48.5%, septa in 20.6% and total opacity in 2.9% of the sinuses. Maxillary sinus outflow was blocked in 26.5% of the scans. Strong association between radiological signs of maxillary sinus ostium blockage and

thickened mucosa was observed. For risk assessment prior to surgery routine CBCT scans, including maxillary sinus ostium are recommended.

Raghav M, Karjodkar FR, Sontakke S, Sansare S(2014)[32] conducted a retrospective study to record the prevalence of incidental maxillary sinus pathologies in patients presenting with dental problems using the 201 cone-beam computed tomography (CBCT) . Pathologic findings were categorized as mucosal thickening (MT), opacification (OPA), polypoidal-mucosal thickening (PT), others (antrolith and discontinuity of the sinus floor) . They correlated the presence of pathologic findings with age and gender .The prevalence for total incidental findings was 59.7%. The present study showed MT (35.1%) as most prevalent finding followed by OPG in (16.6%), PT in 7.2% and others in 0.7%. There was no statistically significant difference between gender and between the age group. Oral radiologists should be aware of these incidental findings and comprehensively evaluate the entire captured CBCT volume, as the incidental maxillary sinus abnormalities are highly prevalent in the asymptomatic dental patients.

Altzinger JM , Damerau G, KW Grätz , B Stadlinger(2015)[47] conducted a study to evaluate the validity and the inter- and intra-examiner reliability of panoramic-radiograph-driven findings of different maxillary sinus anatomic variations and pathologies. Maxillary sinus variations and pathologies was initially detected by CBCT, by two blinded consultants individually using a questionnaire that defined ten different clinically relevant findings. Using the identic questionnaire, these consultants performed the evaluation of the panoramic radiographs later. The results were analyzed for inter-imaging differences in the evaluation of the maxillary sinus

between 2D and 3D imaging methods. Additionally, two resident groups (first year and last year of training) performed two diagnostic runs of the panoramic radiographs and results were analyzed for inter- and intra-observer reliability. This study showed that panoramic radiograph diagnosis of "no finding" found similar on CBCT (p=0.803).The difference between the imaging methods was significant solely for maxillary bone cyst penetrating into the sinus(p=0.032). No significant difference were found between 2D and 3 D imaging methods in the detection of a complete opacity(p=0.714), a foreign body (p=0.571),oroantral communication (p=0.998),a basal septum (p=0.0.911),a polypoid mucosal thickening (p=0.123),a fluid level (p=0.253),and a status post sinus lift (p=0.998). In CBCT basal septa was seen in 54% cases, followed by basal opacities(43%),foreign body(15%).They concluded that the variations and pathologies of the maxillary sinus was evaluated properly by using CBCT.

Kannaperuman J, Natarajarathinam G, Rao AV, Muthusamy N(2015)[48] used OPG to evaluate the prevalence of maxillary sinus septa in the edentulous and dentate maxilla. This retrospective study was based on the analysis of 921 pairs of maxillary sinuses . Sinus septum was present in 217 (23.6%) of the 921 pair of maxillary sinuses. Totally, 704 (76.4%) patients did not have maxillary sinus septum. Also, out of 527 male patients, 125 patients had the septum and out of 394 female patients, 92 patients had sinus septum. This study gives an idea about the prevalence of sinus septum that would help a surgeon prevent a few possible complications during sinus lifting.

Gandhi RK, WabaleRN, Siddiqui AU, Farooqui MS(2015)[49] aimed to determine the incidence, location, and orientation of maxillary sinus septa in formalin embalmed cadavers. This study was conducted on 210 cadaveric heads. The sinus cavity was explored for the presence of maxillary sinus septa, their anatomical plane, location and dimensions. They found the mean linear distance between maxillary sinus floor and its anatomical ostium was 26.76±5.21 mm and 26.91±4.96 mm on right and left side, respectively. A total of 59 maxillary sinus septa (28.1%) were observed in 210 maxillary specimens. Septae were most common, 33 septa (55.9%), in the middle region (between first and second molar tooth) of the sinus cavity. Significantly more maxillary sinus septa were observed in edentulous maxillae in comparison to the dentate upper jaw. Therefore the morphological details of maxillary sinus septa, particularly their location and anatomical planes, will guide dentists in performance of safe implant surgeries.

Alkurt MT , Peker I , Değerli S , Cebeci AR , sadik e(2016)[50] Conducted a retrospective study to compare the performance of cone-beam computed tomography (CBCT) and panoramic radiography in detecting the presence and location of maxillary sinus septa. This study included panoramic radiographs and CBCT images of 104 maxillary sinuses of 52 individuals (26 females, 50% and 26 males, 50%) which were examined by four dentomaxillofacial radiologists. The posterior maxillary segments in proximity of maxillary sinus were classified as edentulous and dentate maxillary segments. The location of maxillary sinus septa was classified as primary septa and secondary septa according to the presence of maxillary tooth at the affected site. The maxillary sinus septa were divided into three categories (anterior, middle and posterior) according to its relation with posterior maxillary

teeth. They found septa in 23.1% and 29.8% of the maxillary sinuses on panoramic radiography and CBCT images, respectively. The majority of maxillary sinus septa were observed in dentate posterior maxillary segments on both panoramic (45.8%) radiography and CBCT (64.5%) images. Statistically significant differences ($p<0.001$) were found between panoramic radiography and CBCT images for presence, location and neighborhood with the posterior maxillary teeth of maxillary sinus septa. Results showed low reliability of panoramic radiography images in the detection of maxillary sinus septa. CBCT images can provide valuable information to the clinicians about the presence and location of maxillary sinus septa.

Bornstein M M, Seiffert C, Ferrin LM, Fodich I, Jacobs R, Buser D et al (2016) [51] conducted a study to evaluate the frequency, morphology and locations of maxillary sinus septa using CBCT. They evaluated 294 maxillary sinuses in 212 patients(126 females,86 males).In their study sinus septa were present in 141 patients(66.5%) and in 166 of 294 sinus(56.5%).The most common orientation of sinus septa was coronal(61.8%),7.6% were axially and 3.6%sagitally.Most septa were located in the region of first and second molar(60.7%)and in the floor of maxillary sinus(58.6%).Sinus were pathologic in 57.7% cases in females and 72.3% in males. They concluded that maxillary septas should be taken into consideration to prevent complication during sinus floor elevation procedures .

Raghunathan A, Gopal S, Sumathy C(2016)[52] investigated maxillary sinus abnormalities and anatomical variations in patients, by using Cone Beam Computed Tomography on 100 subjects. The study revealed that right sinus had an increased mesio lateral width, the left sinus had an increased superoinferior and anteroposterior

length and the volume of the right sinus was comparatively more than left sinus. The most common finding was the mucosal thickening (37.5%), followed by antral septa (24.6%), opacification (12.9%), and sinus hypoplasia (9.6%), polyps (4%), inflammatory cysts (2.9%), fracture (0.7%) and aplasia (0.7%) were all statistically significant. The sexual dimorphism of the maxillary sinus also proved to be statistically significant. This study highlighted that the maxillary sinus exhibits a number of abnormalities as well as anatomical variations which might in turn predispose to a chronic sinus infection. In addition to this, it also proves that the incidence of maxillary sinus pathologies which are detectable in CBCT images are not only taken for evaluation of sinus infections but also for other dental purposes, thereby insisting their importance in diagnostic radiology.

Shahidi S , Zamiri B , Danaei SM , Salehi S , Hamedani S(2016)[53] detected anatomic variations of the maxillary sinus in cone-beam computed tomography (CBCT) and located the posterior superior alveolar artery (PSAA) in a sample population in south of Iran. This cross-sectional prevalence study was performed on 198 CBCT scans The anatomic variations which were evaluated in the axial images included the presence of alveolar pneumatization, anterior pneumatization, exostosis, and hypoplasia. Moreover, the location and height of sinus septa and the location of PSAA were assessed. In this study a total of 396 examined sinuses, maxillary sinus alveolar pneumatization was the most common anatomic variation detected. Anterior pneumatization was detected in 96 sinuses (24.2%). Antral septa were found in 180 sinuses (45.4%) and were mostly located in the anterior region. Meanwhile, PSAA was mostly detected intraosseous in 242 sinuses (65.7%).In this study authors concluded that anatomic variations of the maxillary sinus were common findings in

CBCT of the maxilla. Preoperative assessment of the location of PSAA and the maxillary sinus morphology using CBCT seems to be very helpful to adjust the surgical treatment plan to yield more successful treatments.

Sigaroudi AK, Kajan ZD, Rastgar S, Asli HN (2017)[54] conducted a study to analyze different patterns of maxillary sinus septa in cone-beam computed tomography (CBCT) images. They included 222 patients (93 females 61.2% and 59 males 38.8%) with a age ranging from 20 to 81 years. The prevalence of sinus septa in the females and males were 29% and 35.2% respectively. A total of 42.1% of 152 patients had internal septa only in one maxillary septum, and 57.9% had internal septa in both maxillary sinuses. Single perpendicular septum and single long partial perpendicular septa was seen in 28.3% (75) of cases and 25.3%(67) of cases respectively. They concluded that there was a significant difference between the location of sinus septa and the frequency of membrane perforation risk.

Elwakeel EE, Ingle E,. Elkamali YA, Alfadel H, Alshehri N, Madini KA(2017) [35] used CBCT to detect maxillary sinus abnormalities in asymptomatic patients. 193 patients were included in the study forming 386 CBCT images for detection of maxillary sinus abnormalities. The correlation of abnormalities with age, gender, the sinus wall affected and proximity of the lesions to the floor of maxillary sinus were recorded and analyzed . Incidental abnormalities of maxillary sinus were 73%. The mucosal thickening was the most common abnormality (41.4%) followed by polyps (16%), increased dimensions of the sinus (10.2%), decreased dimensions of the sinus (8.3%),bubbles inside sinus (8.3%), partial opacification (8%), complete opacification (5%).There was significant difference between the genders. There was a

moderate significant relation between classification of periapical lesions and sinus abnormalities (P-value=0.045). For early detection and treatment of maxillary sinus abnormalities among a symptomatic patients , the oral radiologists should evaluate the CBCT images with full examination of maxillary sinus .

Yildirim TT ,Güncü GN, Colak M, Nares S, Tözüm TF(2017)[55] performed a study to determine the prevalence, height, location, orientation, and type of maxillary sinus septa in atrophic, non-atrophic, and partially atrophic maxillary segments using cone beam computerized tomography (CBCT). This retrospective cross-sectional study was conducted on CBCT images of 1000 maxillary sinus with 500 subjects . The differences among gender, left and right side of maxillary sinus, type of crest and feature of septa were statistically analyzed. A total of 297 septa was recorded in 1000 maxillary sinuses (29.7%) with a mean height was 4.62±2.50 mm. Forty-four (8.7%) septa were located in the anterior area, 123 (24.5%) in the middle area, and 131 (26.4%) in the posterior area. Seventy maxillary sinus septa (26.1%) were observed with a mediolateral type orientation. The only significant association identified was between type of crest and type of septa. The study showed that the maxillary sinus septa exhibited variable characteristics according to orientation and type of crest therefore CBCT analysis is very important and should be performed before maxillary sinus surgery to prevent possible complications.

Mudgade DK, Motghare PC, Kunjir GU, Darwade AD, Raut AS(2018)[33] determined different anatomical variations in maxillary sinus by using 150 CBCT scans . The distribution of age, sex, reasons for CBCT, and dimensions of sinus calculated using descriptive statistics .Authors found that the prevalence of obstructed

ostium was 23.3% and septa was 66.7%. Average height, width, and antero‑posterior (A‑P) dimensions for right MS were 34.13 mm, 26.09 mm,37.39mm and that of left MS were 33.24 mm, 26.11 mm, 37.72 mm respectively. Average distance between lower border of ostium to sinus floor in right MS is 32.17 mm and that of left is 32.69 mm. Average diameter of ostium in right MS is 1.88 mm and that of left is1.67 mm. Study highlights the importance of accurate assessment of MS and its variations in order to properly differentiate the pathologic lesions from anatomic variations avoiding unnecessary surgical explorations.

Malik SS, Nasim A, Mohan RS, Kamarthi N, Goel S, Gupta S(2018) [34] analyzed the prevalence of pathological changes in maxillary sinus in asymptomatic cases using CBCT for diagnostic purposes. This retrospective study evaluated 231 patients for incidental maxillary sinus pathologies. Evaluation of pathological findings was done using factors of age and gender. The present study showed 86 cases with maxillary sinus pathology and 145 cases with no pathological findings. Patients with maxillary sinus pathology were mostly diagnosed with mucosal thickening on both sides. In right maxillary sinus, 45 cases (52.3%) showed mucosal thickening, and on the left side 36 cases (41.9%) were diagnosed with mucosal thickening. Among 86 cases reported, 20 right maxillary sinus (23.3%) and 25 left maxillary sinus (29.1%) showed no signs of pathology. The incidental maxillary sinus pathologies are highly prevalent in asymptomatic patients. Therefore, oral radiologists should be aware of these incidental findings which will help in early diagnosis and treatment of disease.

Materials and Method

After getting clearance from the ethics committee of the institution this retrospective observational study was carried out to study approximation of Maxillary Posterior Teeth to Floor of Maxillary Sinus using cone-beam computed tomography.

3D CBCT images of 150 patients showing bilateral maxillary sinus and posterior teeth were analyzed. The images were acquired from a CBCT centre.

Materials used:

1) 150 CBCT images showing bilateral maxillary sinus and posterior teeth.

2) 14-inch LCD monitor using HP intel (R) core (TM) i3-3227U CPU @ 1.90 GHz processor, 64-bit operating system having product ID : 00261-30000 AA825

3) CS 9300 Select CBCT machine with voxel size 0.3mm and an exposure time of 8.00 seconds at 5.0mA, 90 kV with an axial slice thickness of 0.3mm. Reconstruction of the data was performed with CS 3D Imaging software to create three-dimensional projection of images with maximum intensity for making linear measurements.

Inclusion criteria

- CBCT images of patients with complete root development of maxillary first and second premolars, first and second molar.
- CBCT scans showing completely visible maxillary first and second premolars and molars.
- CBCT scan showing bilateral maxillary sinus.

Exclusion criteria

- Maxillary posterior teeth with periapical pathology.
- History of trauma in maxillofacial region.
- Any pathologies involving the sinus such as malignancy and tumour.
- If any one of the maxillary posterior teeth is missing.
- Developmental anamolies in maxillofacial region.

Methodology

All CBCT images were evaluated in the axial and panoramic reconstruction for assessment of roots of maxillary molars, maxillary sinus and cortical plates. Linear measurements were done using built in measurement tools.

All the images were evaluated for the following:-

1. Vertical distance between root tips of individual root of maxillary premolar and molar and MSF –

   The measurement of vertical distance between root tips and MSF was performed in cross sectional images . A tangent was drawn parallel to inferior cortical wall at deepest point of floor of maxillary sinus using linear measurement tool in CBCT software .Second line parallel to the tangent and touching the root apex was drawn .The linear distance between this two lines were measured for each root.

Measurement of vertical distance between the root tips and MSF

2. Vertical distance measured for each root was classified as per classification given by Didilescu et al.

Class 0: Distance (d) = 0 mm;

Class 1: 0 mm < d < 2 mm

Class 2: 2 mm ≤ d < 4 mm

Class 3: 4 mm ≤ d < 6 mm

Class 4: 6 mm ≤ d.

3. Vertical relationship between roots of maxillary posterior teeth and floor of (MSF) assessed by criteria described by Kwak et al.

Type I: The MSF was located above the level connecting the buccal and palatal root apices.

Type II: The MSF was located below the level connecting the buccal and palatal root apices without an apical protrusion over the MSF.

Type III: An apical protrusion of the buccal root apex was observed over the MSF

Type IV: An apical protrusion of the palatal root apex was observed over the MSF.

Type V: Apical protrusions of the buccal and palatal root apices were observed over the MSF

Type I Type II Type III Type IV Type V

Vertical relationship between roots of maxillary posterior teeth and floor of (MSF)

4. Horizontal relationship between roots of maxillary posterior teeth and floor of maxillary sinus was studied using criteria proposed by Kwak et al.

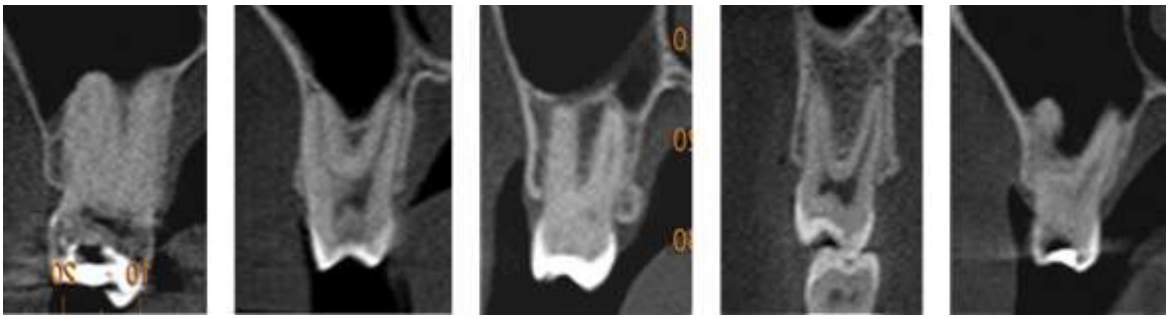
Type 1H: The alveolar recess of the MSF was located more towards the buccal side than towards the buccal root.

Type 2H: The alveolar recess of the MSF was located between the buccal and palatal roots.

Type 3H: The alveolar recess of the MSF was located more towards the palatal side than towards the palatal root.

Type 4H: The alveolar recess of the MSF passes over the roots without establishing relationship with them.

Type 5H: The alveolar recess of the MSF is located towards the buccal side and towards the palatal side, and may or may not also extend between the roots.



Type 1H Type 2H Type 3H Type 4H Type 5H

Horizontal relationship between roots of maxillary posterior teeth and floor of maxillary sinus

5. Distance between roots to the appropriate cortical plate . Horizontal distance between root surface of buccal roots and buccal cortical plate was obtained .Similarly the distance between palatal roots palatal cortical plate was obtained.

Measurement of buccal and palatal cortical plate thickness

6. Thickness of bone between floor and furcation area measured in mm. Thickness of bone between sinus floor and furcation area of first and second molars was measured as a linear distance between line which was drawn tangent to deepest point of floor of maxillary sinus and

Measurement of thickness of bone between furcation and MSF

7. The morphologic variations such as septa in sinus, mucosa thickening , Opacification of sinus etc.

Variations in right and left maxillary sinus were studied using Panoramic reconstruction images and axial section of all CBCT scans.

Statistical methods

Collected data were entered into Micro software Excel spreadsheet. Windows 10 Microsoft Word and Excel 7.0 were used to generate tables and charts . Continuous variables were presented as Mean ± SD . Categorical variables were expressed in frequency and percentages. Mean distance values were compared for single, buccal and palatal root by performing oneway non-parametric ANOVA test(Kwallis ANOVA test) for non-normalized data. Mean distance was compared between male and Female, site wise by performing independent t-test. For small numbers, Fisher exact test was used wherever applicable. Mean distance between buccal and palatal root , gender wise were compared by performing paired t-test. P<0.05 was considered as statistical significance. Statistical software STATA version 14.0 was used for data analysis.

1. Sample Mean for a set of observation is given by:

$$y = \frac{1}{n}\sum_{i=1}^{n} yi$$

2. Standard Deviation for a set of observation is given by:

$$s = \sqrt{\frac{1}{(n-1)}\sum_{i=1}^{n}(yi - \bar{y})^2}$$

where yi = observation on each object.

n = number of objects.

3. Student's t-test for independent samples

The test is used for comparing the statistical significance of difference in the means of two samples. It compares the sample difference between two means in relation to the variation in the data (expressed as the standard deviation of the difference between the means).

It is given by the formula:

$$t = \frac{(\overline{x}_1 - \overline{x}_2) - (\mu_1 - \mu_2)}{S_{(\overline{x}_1 - \overline{x}_2)}}$$

COLOUR PLATE 1

Figure 1: CBCT machine

COLOUR PLATE 2

Figure 2: Maxillary Right First Premolar with measurement of vertical distance between buccal and palatal root and MSF(Class 2) , thickness of buccal and palatal cortical plate

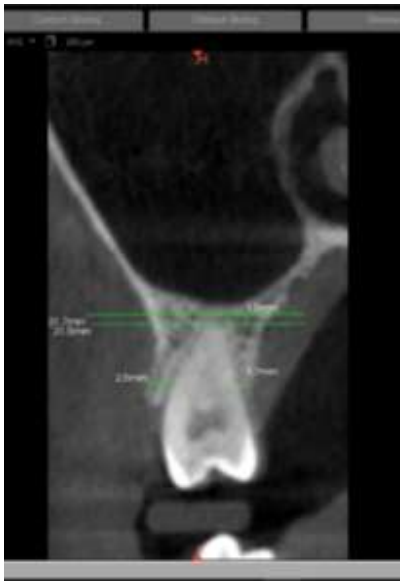


Figure 3: Maxillary Right second Premolar with measurement of vertical distance between single root and MSF(Class 1) , thickness of buccal and palatal cortical plate

COLOUR PLATE 3

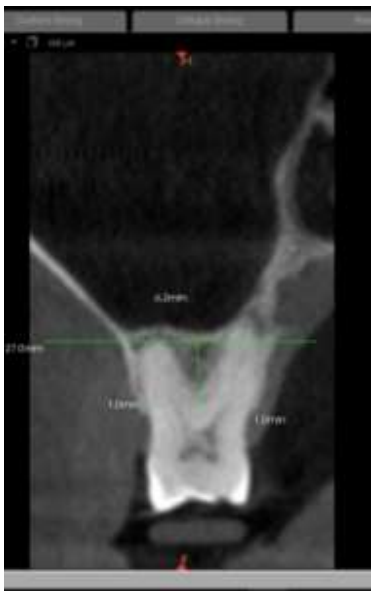


Figure 4: Maxillary right first molar with measurement of vertical distance between MB and DB root and MSF(Class 0) , thickness of buccal and palatal cortical plate, distance between MSF and furcation area

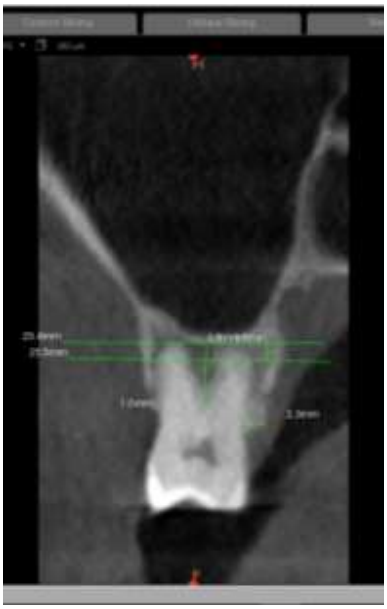


Figure 5:Maxillary Right Second Molar with measurement of vertical distance of MB (class 0) and DB(class 1) root , thickness of buccal and palatal cortical plate, distance between MSF and furcation area

COLOUR PLATE 4

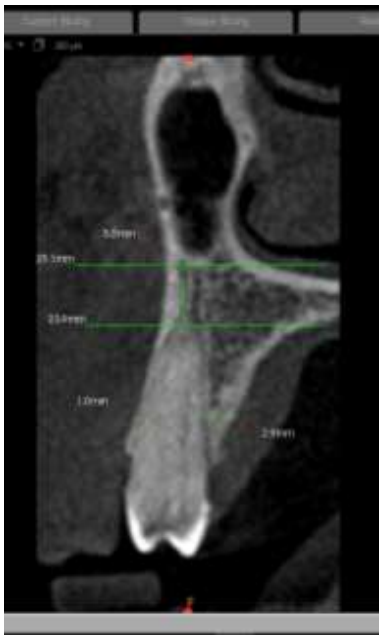


Figure 6:Maxillary left first premolar , with measurement of vertical distance between single root and MSF(Class 2) , thickness of buccal and palatal cortical plate

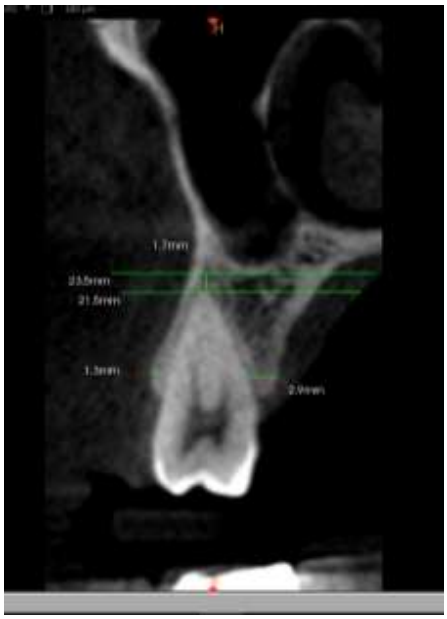


Figure 7: Maxillary left second premolar, with measurement of vertical distance between single root and MSF(Class 1) , thickness of buccal and palatal cortical plate

COLOUR PLATE 5

Figure 8: Maxillary left first molar with measurement of vertical distance between MB and DB root and MSF(Class 0) , thickness of buccal and palatal cortical plate, distance between MSF and furcation area

Figure 9: Maxillary left second molar with measurement of vertical distance between MB and DB root and MSF(Class 0) , thickness of buccal and palatal cortical plate, distance between MSF and furcation area

COLOUR PLATE 6

Figure 10 Maxillary first molar showing Type II vertical relation. type IIH Horizontal relation

Figure 11 Maxillary first molar showing Type I vertical relation. type IIIH Horizontal relation

COLOUR PLATE 7

Figure 12 Maxillary first molar showing Type I vertical relation. type IVH Horizontal relation

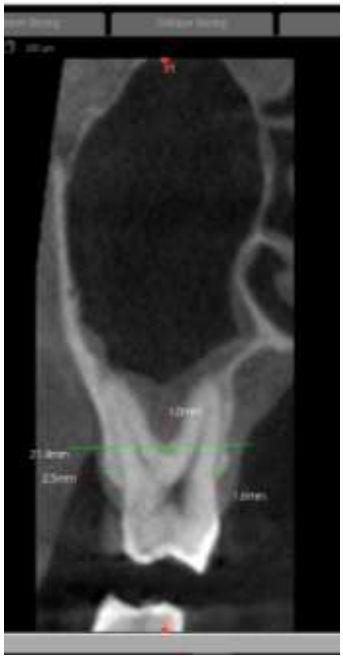


Figure 13 Maxillary first molar showing Type V vertical relation. type VH Horizontal relation

COLOUR PLATE 8

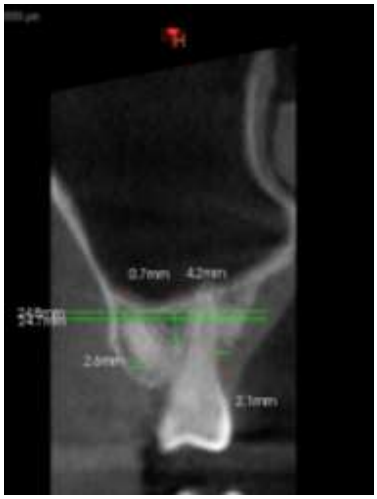


Figure 14 Maxillary first molar showing Type IV vertical relation. type IIIH Horizontal relation

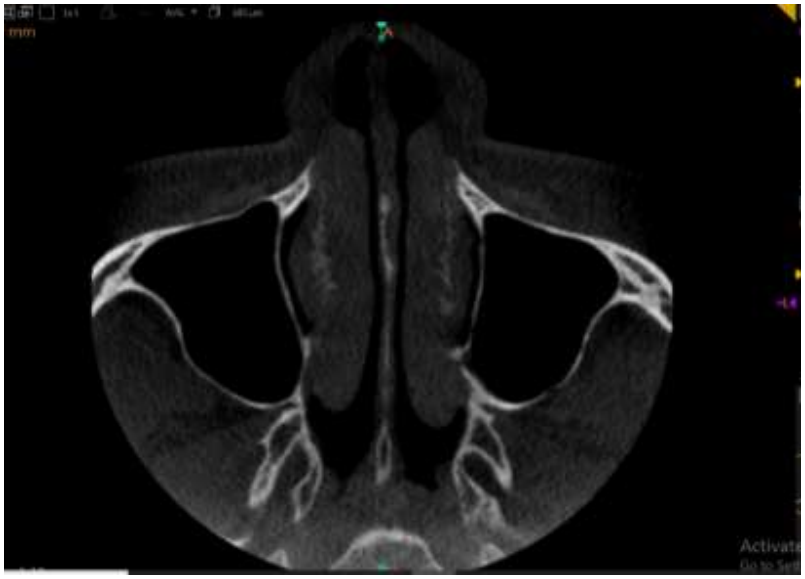


Figure 15 Maxillary sinus showing no variation

COLOUR PLATE 9

Figure 16 Maxillary sinus showing septa on right side (Unilateral)

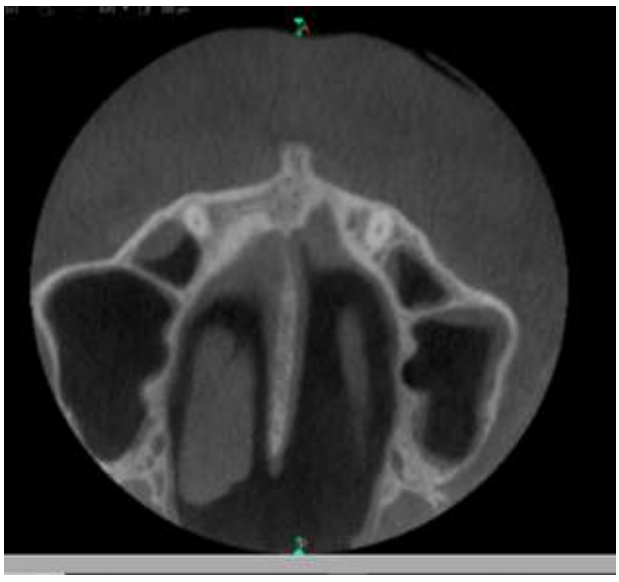


Figure 17 Maxillary sinus showing septa on right and left side(Bilateral)

COLOUR PLATE 10

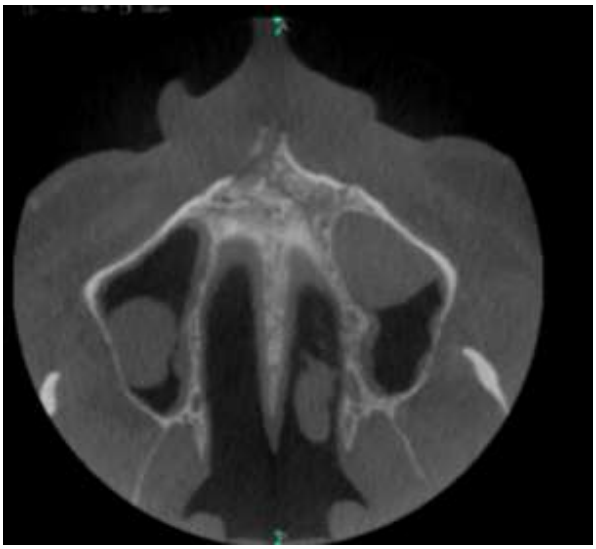


Figure 18 Maxillary sinus showing polypoidal mucosal thickning on right and left side(Bilateral)

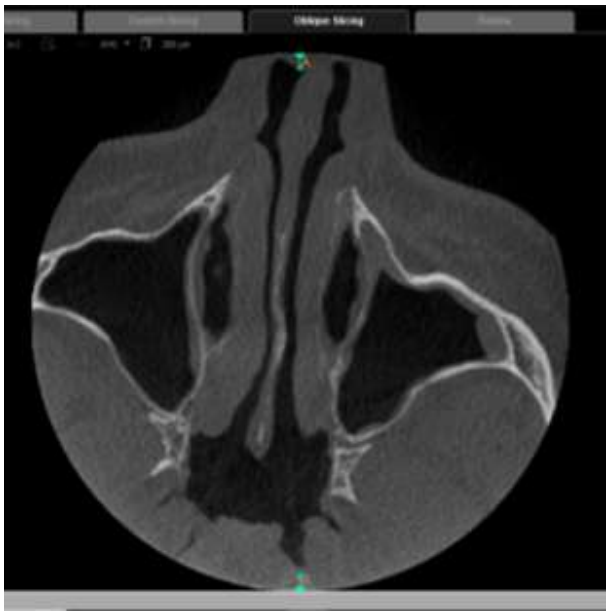


Figure 19 Maxillary sinus showing flat mucosal thickning on left side (Unilateral)

COLOUR PLATE 11

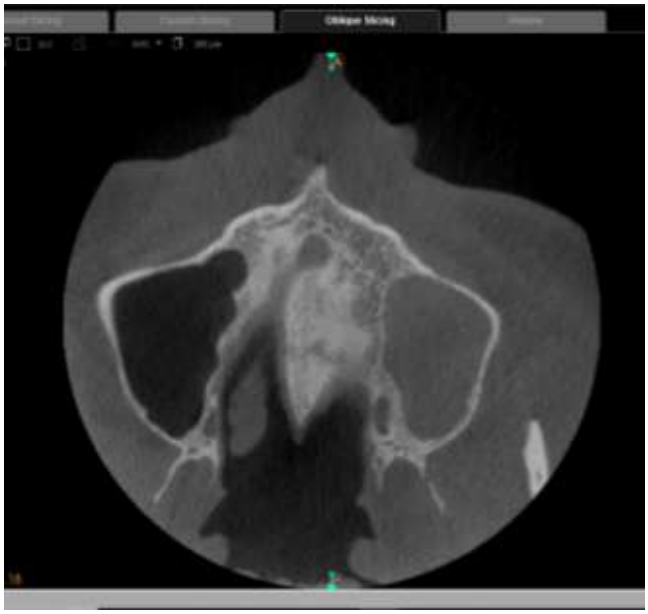


Figure 20 Maxillary sinus showing opacification on left side (Unilateral)

Figure 21 Maxillary sinus showing opacification on right side and septa on left side

Results

Table No.1 Age distribution .

Table 1 provides the age distribution of individuals included in study . The mean age of the subjects was 29.63 ± 6.65 years. There were 96 (64%), 40 (26.67%) , 14 (9.33%) patients in the age range of 20-30 , 31-40 , 41-50 years respectively.

Table 2: Gender distribution .

Table 2 represents total number of males and females included in the study. There were 97(64.67%) males and 53(33.33%) females.

Table No.3a Average mean distance and Standard deviation values of Premolar in mm between maxillary pre molar apices and MSF in Males and Females

Table 3a represents average mean distance and Standard deviation values of Premolar in mm between maxillary pre molar apices and MSF in Males and Females. The average mean distance between root apices and maxillary sinus floor in

premolars with single root in males was found to be 1.94 ± 2.32 mm and in females it was found to be 1.33 ± 2.11 mm . The difference of means was statistically not significant as indicated by p-value of 0.1179. Similarly the mean value of average distance between buccal root in males was 1.94 ± 2.39 mm and in females 1.29 ± 2.20 mm . The difference of means was also statistically not significant as indicated by p-value of 0.1081 . The mean value of average distance between palatal root and MSF in males was 1.60 ± 2.37 mm and in females 2.78 ± 2.30 mm . The difference of means was highly significant as revealed by p-value 0.0037 . The difference between average mean distances between of individual root apex and maxillary sinus floor was found to be not significant in males with p-value 0.5163 and highly significant in females depicted by p-value of 0.0001.

Table No.3b Average mean distance and Standard deviation values of Premolar in mm between maxillary pre molar apices and MSF in right and left side

Table 3b represents average mean distance and Standard deviation values of Premolar in mm between maxillary pre molar apices and MSF in right and left side. The average mean distance between root apices and maxillary sinus floor in premolars with single root in males on right side was found to be 2.92 2.76 mm and in females it was found to be 1.58± 2.65 mm . The difference of means was statistically highly significant as indicated by p-value of 0.0001 . Similarly the mean value of average distance on left side in males was 1.60 ± 2.37 and in females 2.78 ±2.30 with p-value of 0.0001 which is highly significant. The average mean distance between buccal root apices and maxillary sinus floor in premolars in males on right side was found to be 2.11± 2.74 mm and in females it was found to be 1.62 ± 0.34 mm . The difference of means was statistically not significant as indicated by

p-value of 0.1828 . Similarly the mean value of average distance on left side in males was 1.94± 2.32 and in females 1.33± 2.11 with p-value of 0.0640 which is statistically not significant.

Table No. 3c The mean distance and Standard deviation values in mm between maxillary pre molar apices and MSF (Tooth-14)

Table 3c shows the mean distance and Standard deviation values in mm between root apices of right maxillary first premolar and MSF. The mean distance between root apices and maxillary sinus floor in premolars with single root in males was found to be 5.67 ± 4.39 mm and in females it was found to be 6.67 ± 4.05 mm . The difference of means was statistically not significant as indicated by p-value of 0.3561. On similar lines, the mean value of distance between buccal root in males was 6.36 ± 5.47 and in females 7.1 ± 5.15 mm . The difference of means was also statistically not significant as indicated by p-value of 0.5102. The mean value of distance between palatal root and MSF in males was 6.60 ± 5.63 mm and in females 7.72 ± 5.51. The difference of means was statistically not significant as revealed by p-value 0.4229.On comparison of mean distances between individual roots apex and maxillary sinus floor it was found to be not significant with p-value 0.8187 in males and 0.8420 in females.

Table No.3d The mean distance and Standard deviation values in mm between maxillary pre molar apices and MSF . (Tooth-15)

Table 3d shows the mean distance and Standard deviation values in mm between root apices of maxillary right second premolar and MSF. The mean distance between root apices and maxillary sinus floor in premolars with single root in males was found to be 1.55 ± 2.72mm and in females it was found to be 2.21 ± 2.39 mm .

The difference of means was statistically not significant as indicated by p-value of 0.1678. Similarly the mean value of distance between buccal root in males was 0.49 ± 0.73 and in females 0.67 ± 1.15 mm . The difference of means was also statistically not significant as indicated by p-value of 0.7187. The mean value of distance between palatal root and MSF in males was 0.57 ± 0.92mm and in females 0.93 ± 1.61. The difference of means was statistically not significant as revealed by p-value 0.5669. The difference between mean distances between of individual root apex and maxillary sinus floor was found to be not significant with p-value 0.8420in males and 0.2891in females.

Table No.3e: The mean distance and Standard deviation values in mm between maxillary pre molar apices and MSF (tooth 24)

Table 3e shows the mean distance and Standard deviation values in mm between root apices of maxillary left first premolar and MSF. The mean distance between root apices and maxillary sinus floor in premolars with single root in males was found to be 4.46 ± 4.39 mm and in females it was found to be 5.45 ± 3.52 mm . The difference of means was statistically not significant as indicated by p-value of 0.2457. Similarly the mean value of distance between buccal root in males was 6.68 ± 4.92 and in females 7.25 ± 5.24 mm . The difference of means was also statistically not significant as indicated by p-value of 0.7285. The mean value of distance between palatal root and MSF in males was 6.68 ± 4.92 mm and in females7.73 ± 4.82 mm. The difference of means was statistically not significant as revealed by p-value 0.6840 . The difference between mean distances between of individual root apex and maxillary sinus floor was found to be significant in males with p-value 0.0188 and not significant in females depicted by p-value of 0.3082.

Table No.3f The mean distance and Standard deviation values in mm between maxillary pre molar apices and MSF (Tooth-25)

Table 3f depicts the mean distance and Standard deviation values in mm between root apices of maxillary left second premolar and MSF. The mean distance between root apices and maxillary sinus floor in premolars with single root in males was found to be 0.96 ± 1.95 mm and in females it was found to be 1.20 ± 1.76 mm . The difference of means was statistically not significant as indicated by p-value of 0.4818 . Similarly the mean value of distance between buccal root in males was 1.78 ± 2.05 and in females 3.37 ± 3.85 mm . The difference of means was also statistically not significant as indicated by p-value of 0.1542 . The mean value of distance between palatal root and MSF in males was 1.12 ± 1.50 mm and in females2.96 ± 4.11 mm . The difference of means was statistically not significant as revealed by p-value 0.0926 . The difference between mean distances between of individual root apex and maxillary sinus floor was found to be significant in males with p-value 0.0292 and not significant in females depicted by p-value of 0.1106.

Table No.3g : The mean distance and Standard deviation values in mm between maxillary first and second pre molar apices and MSF

Table 3g depicts the mean distance and Standard deviation values in mm between root apices of maxillary first and second premolar and MSF. The mean distance between root apices and maxillary sinus floor in first premolars with single root was found to be 4.06 ± 4.08 mm and in second premolar it was found to be 2.54 ± 2.64 mm . The difference of means was statistically highly significant as indicated by p-value of 0.001 . Similarly the mean value of distance between buccal root of first premolar was 6.82 ± 2.69mm and in second premolar 1.57 ± 1.94 mm .

The difference of means was also statistically highly significant as indicated by p-value of 0.001 . The mean value of distance between palatal root and MSF in first premolar was 7.71 ± 5.22mm and in second premolar 1.14± 2.03 mm . The difference of means was statistically highly significant as revealed by p-value 0.001 .

Table No.3h: Average mean distance and Standard deviation values in mm of Molars between maxillary pre molar apices and MSF in Males and Females

Table 3h represents average mean distance and Standard deviation values of molar in mm between maxillary molar apices and MSF in Males and Females. The average mean distance between root apices and maxillary sinus floor in molars in mesiobuccal roots in males was found to be 0.21 ± 0.48 mm and in females it was found to be 1.33 ± 2.11 mm. The difference of means was statistically not significant as indicated by p-value of 0.1179 . Similarly the mean value of average distance between distobuccal root in males was 1.94 ± 2.39 and in females 1.29 ± 2.20 mm . The difference of means was also statistically not significant as indicated by p-value of 0.1081 . The mean value of average distance between palatal root and MSF in males was 1.60 ± 2.37 mm and in females 2.78 ± 2.30 . The difference of means was highly significant as revealed by p-value 0.0037 . The difference between average mean distances between of individual root apex and maxillary sinus floor was found to be not significant in males with p-value 0.5163 and highly significant in females depicted by p-value of 0.0001.

Table No.3i : Average mean distance and Standard deviation values in mm of Molars between maxillary pre molar apices and MSF in right and left side.

Table 3i depicts average mean distance and Standard deviation values of molar in mm between maxillary molar apices and MSF in right and left side. The

average mean distance between root apices and maxillary sinus floor in molars in MB root in males on right side was found to be 0.18 ± 0.42 mm and in females it was found to be 0.40±0.72 mm . The difference of means was statistically significant as indicated by p-value of 0.0230 . Similarly the mean value of average distance on left side in males was 0.24 ± 0.74 and in females 0.45± 0.81with p-value of 0.0087 which is highly significant. The average mean distance between distobuccal root apices and maxillary sinus floor in molars in males on right side was found to be 0.31 ± 0.66 mm and in females it was found to be 0.43 ± 0.67 mm. The difference of means was statistically not significant as indicated by p-value of 0.1218 . Similarly the mean value of average distance on left side in males was 0.35 ± 0.78 and in females 0.46 ± 0.77 with p-value of 0.0730 which is statistically not significant. In case of distances between palatal root and MSF in right side in males 0.25 ± 0.56 mm and in females 0.38 ± 0.71 mm which was not significant denoted by P value of 0.2760 similarly on left side it was found to be 0.29 ± 0.71 mm in males and 0.40 ± 0.73mm in females which was also not significant indicated by P value 0.1178.

Table No. 3j : The mean distance and Standard deviation values in mm between maxillary molar apices and MSF (Tooth-16)

Table 3j shows the mean distance and Standard deviation values in mm between root apices of right maxillary first molar and MSF. The mean distance between root apices and maxillary sinus floor mesiobuccal roots in molars in males was found to be 0.26 ± 0.64 mm and in females it was found to be 0.60 ± 1.12 mm . The difference of means was statistically significant as indicated by p-value of 0.0365. The mean value of distance between distobuccal root in males was 0.30±

0.75 mm and in females 0.41 ± 0.76 mm . The difference of means was also statistically not significant as indicated by p-value of 0.1649 . The mean value of distance between palatal root and MSF in males was 0.12 ± 0.49 mm and in females 0.35 ± 0.87. The difference of means was statistically not significant as revealed by p-value 0.1052.On comparison of mean distances between apices of MB,DB and palatal roots and maxillary sinus floor it was found to be not significant with p-value 0.0627 in males and 0.1900 in females.

Table No.3k :The mean distance and Standard deviation values in mm between maxillary molar apices and MSF . (Tooth-17)

Table 3k shows the mean distance and Standard deviation values in mm between root apices of right maxillary second molar and MSF. The mean distance between root apices and maxillary sinus floor mesiobuccal roots in males was found to be 0.10 ±0.37 mm and in females it was found to be 0.20 ± 0.61 mm . The difference of means was statistically not significant as indicated by p-value of 0.3151. The mean value of distance between distobuccal root in males was 0.32 ± 0.67 mm and in females 0.46 ± 0.84 mm . The difference of means was also statistically not significant as indicated by p-value of 0.2752 . The mean value of distance between palatal root and MSF in males was 0.37 ±0.89 mm and in females 0.43 ± 1.01 . The difference of means was statistically not significant as revealed by p-value 0.6891 .On comparison of mean distances between apices of MB,DB and palatal roots and maxillary sinus floor it was found to be significant with p-value 0.0163 in males and not significant in females with p-value 0.1135.

Table No.3l : The mean distance and Standard deviation values in mm between maxillary molar apices and MSF . (Tooth 26)

Table 3l shows the mean distance and Standard deviation values in mm between root apices of left maxillary first molar and MSF. The mean distance between root apices and maxillary sinus floor mesiobuccal roots in males was found to be 0.20 ± 0.61 mm and in females it was found to be 0.43 ± 0.75 mm . The difference of means was statistically significant as indicated by p-value of 0.0413 . The mean value of distance between distobuccal root in males was 0.44 ± 1.06 mm and in females 0.53 ± 0.97 mm . The difference of means was also statistically not significant as indicated by p-value of 0.1571 . The mean value of distance between palatal root and MSF in males was 0.31 ± 1.07 mm and in females 0.42 ± 1.04. The difference of means was statistically not significant as revealed by p-value 0.1704 .On comparison of mean distances between apices of MB,DB and palatal roots and maxillary sinus floor it was found to be significant with p-value 0.1255 in males and not significant in females with p-value 0.4169.

Table No.3m : The mean distance and Standard deviation values in mm between maxillary molar apices and MSF in Males.(Tooth 27)

Table 3m shows the mean distance and Standard deviation values in mm between root apices of left maxillary second molar and MSF. The mean distance between root apices and maxillary sinus floor mesiobuccal roots in males was found to be 0.29 ± 0.95 mm and in females it was found to be 0.47 ± 1.10 mm . The difference of means was statistically not significant as indicated by p-value of 0.1123 . The mean value of distance between distobuccal root in males was 0.27 ± 0.77 mm and in females 0.39 ± 0.80 mm . The difference of means was also

statistically not significant as indicated by p-value of 0.1406 . The mean value of distance between palatal root and MSF in males was 0.28 ± 0.76 mm and in females 0.37 ± 0.84 . The difference of means was statistically not significant as revealed by p-value 0.3823 .On comparison of mean distances between apices of MB,DB and palatal roots and maxillary sinus floor it was found to be not significant with p-value 0.8916 in males and not significant in females with p-value 0.9718.

Table No.3n: The mean distance and Standard deviation values in mm between maxillary first and second molar apices and MSF

Table 3n depicts the mean distance and Standard deviation values in mm between root apices of maxillary first and second molar and MSF. The mean distance between mesiobuccal root and maxillary sinus floor in first molars was found to be 0.38 ± 0.78 mm and in second molar it was found to be 0.26 ± 0.75mm . The difference of means was statistically not significant as indicated by p-value of 0.17 . Similarly the mean value of distance between distobuccal root of first molar was 0.42 ± 0.88mm and in second molar 0.36 ± 0.77mm . The difference of means was also statistically not significant as indicated by p-value of 0.6 . The mean value of distance between palatal root and MSF in first molar was 2.8 ± 0.86mm and in second premolar 0.36± 0.78mm . The difference of means was statistically highly significant as revealed by p-value 0.001 .

Table No. 4 : Distribution of Classes between maxillary root apices of maxillary premolars and molars

Table 4 shows distribution of classes between maxillary root apices of maxillary premolars and molars based on the distances between individual root apices and MSF in males and females. In first premolars of right and left side number

of roots in class o were 43 in males and 13 in females ,in class 1 no. of roots 58 in males and in 13 in females, in class 2 no of roots 23 in males, 19 in females ,in class 3 no. of roots 47 in males and 27 in females , no. of roots in class 4- 72 in males and 59 in females.In second premolars of right and left side number of roots in class o were 14 in males and 8 in females , no. of roots in class 1 were, 47 in males and 34 in females, no. of roots in class 2 were , 22 in males 13 in females , in class 3 it was found that 14 in males and 14 in females and in class 4 , 122 in males and 71 in females. In first molars of right and left side number of roots in class o were 501 in males and 236 in females , in class 1 -36 in males and 41 in females, no. of roots in class 2- 30 in males ,33 in females , in class 3- 11 in males and 8 in females ,in class 4- 0 in males and 0 in females.In second molars of right and left side number of roots in class o were 486 in males and 246 in females , in class 1 -69 in males and 51 in females, in class 2- 22 in males 18 in females , in class 3 no. of roots 7 in males and 3 in females. No roots were in class 4 in both in males and females.

Table No.5a : Average Distance between Root surface and appropriate cortical plates between Male and Female in premolars

Table 5a shows the average mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of premolars between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 1.73 ± 0.80 mm in males while in females it was 1.54 ± 0.68 mm .The difference of mean was not significant depicted by P value of 0.1522 .similarly for palatal cortical plate it was found to be 1.95 ± 0.53 in males and 1.95 ±0.53 mm in females . The difference between distances between root surface and buccal and palatal cortical plates in males was not significant with p-value of0.7112 .

The difference between average distances between root surfaces and buccal cortical plate and palatal cortical plate in males was found to be highly significant with p value <0.0001 and females was significant with P value of 0.0327.

Table No.5 : Average Distance between Root surface and appropriate cortical plates between right and left side in premolars

Table 5b represents the average mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of premolars between right and left side . Mean distance between root surface and buccal cortical plate was found to be 1.65 ±0.73 mm on right side while in left side it was 1.67 ± 0.91 mm .The difference of mean was not significant depicted by P value of 0.5857 .similarly for palatal cortical plate it was found to be 1.87 ± 0.60 in right side and 2.00 ± 0.59 mm in left side . The differences between distances between root surface and buccal and palatal cortical plates in right and left side was significant with p-value of 0.0167 . The difference between average distances between root surfaces and buccal cortical plate and palatal cortical plate in males was found to be highly significant with p value <0.0001 and females was significant with P value of 0.0327.

Table No.5c : Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-14)

Table 5c represents the mean distance and Standard deviation values of distances between Root surface and appropriate cortical plates of right first premolar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 1.39 ± 0.58mm in males while in females it was 1.26 ±0.57 mm .The difference of mean was not significant depicted by P value of 0.0909

similarly for palatal cortical plate it was found to be 1.74±0.72 mm in males and 1.77±0.71 mm in females . The difference was not significant with p value of 0.7776.The difference between distances between root surface and buccal and palatal cortical plates in males was found to be highly significant with p-value of 0.0002 similarly in females depicted with p value of <0.0001.

Table No.5d : Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-15)

Table 5d represents the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of right second premolar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 2.00±0.97 mm in males while in females it was 1.86±1.15 mm .The difference of mean was not significant depicted by P value of 0.4289 similarly for palatal cortical plate it was found to be 1.92±0.63 in males and 2.11±1.00 mm in females . The difference between distances between root surface and buccal and palatal cortical plates in males was not significant with p-value of 0.1803 . The distances between root surfaces and buccal cortical plate and and palatal cortical plate in males and females was not significant with P value of 0.5030 and 0.1036 respectively.

Table No.5e : Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-24)

Table 5c represents the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of left first premolar between Male and Females. . Mean distance between root surface and buccal cortical plate was found to be 1.48 ±0.89 mm in males while in females it was 1.31± 0.2726

mm .The difference of mean was not significant depicted by P value of 0.2726 similarly for palatal cortical plate it was found to be 2.08 ±0.73 in males and 1.97±0.66 mm in females . The difference between distances between root surface and buccal and palatal cortical plates in males was not significant with p-value of 0.3796 . The distances between root surfaces and buccal cortical plate and and palatal cortical plate in males and females was highly significant with P value of <0.0001 and <0.0001 respectively

Table No.5f : Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-25)

Table 5d represents the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of left second premolar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 2.04 ±1.25 mm in males while in females it was 1.72 ± 0.79 mm .The difference of mean was not significant depicted by P value of 0.0954 similarly for palatal cortical plate it was found to be 1.96 ± 0.70 in males and 1.97 ±0.67 mm in females . The difference between distances between root surface and buccal and palatal cortical plates in males was not significant with p-value of 0.8741 . The distances between root surfaces and buccal cortical plate and palatal cortical plate in males and females was not significant with P value of 0.3596 and 0.0644 respectively.

Table No.5g: Average Distance between Root surface and appropriate cortical plates between Male and Female in molars

Table 5g represents the average mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates between

males and females. Average mean distance between root surface and buccal cortical plate was found to be 2.48 ± 1.25 mm in males while in females it was 2.23 ± 0.85 mm .The difference of mean was not significant depicted by P value of 0.1965 similarly for palatal cortical plate it was found to be 2.05 ± 0.57 mm in males and 2.36 ± 3.48 mm in females represented by P-value of 0.1265 . The difference between average distances between root surface and buccal and palatal cortical plates in males was highly significant with p-value of 0.0004 . The average distances between root surfaces and buccal cortical plate and palatal cortical plate in females was not significant with P value of 0.7957 .

Table No. 5h : Average Distance between Root surface and appropriate cortical plates between right and left side in molars

Table 5h depicts the average mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates between right and and left side . Average mean distance between root surface and buccal cortical plate was found to be 2.48 ± 1.08 mm on right side while on left side it was 2.37 ± 1.07 mm .The difference of mean was significant depicted by P value of 0.0499 similarly for palatal cortical plate it was found to be 2.36 ± 4.15 mm on right side and 1.97 ± 0.71 mm on left side represented by P-value of 0.0257 . The difference between average distances between root surface and buccal and palatal cortical plates on right side was not significant while highly significant difference was found between buccal and cortical plate on left side with p value of <0.0001.

Table No. 5i Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-16)

Table 5i represents the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of right first molar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 2.37 ±1.18 mm in males while in females it was 2.16 ± 1.28 mm .The difference of mean was not significant depicted by P value of 0.326 similarly for palatal cortical plate it was found to be 2.00 ± 0.74 in males and 1.81 ±0.66 mm in females represented by P-value of 0.2237 . The difference between distances between root surface and buccal and palatal cortical plates in males was highly significant with p-value of 0.0024 . The distances between root surfaces and buccal cortical plate and and palatal cortical plate in females was not significant with P value of 0.4222.

Table No.5j : Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-17)

Table 5j represents the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of right second molar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 2.72 ±1.39 mm in males while in females it was 2.53 ± 0.93 mm .The difference of mean was not significant depicted by P value of 0.3672 similarly for palatal cortical plate it was found to be 2.16 ± 0.76 in males and 1.99 ±0.1619 mm in females represented by P-value of 0.2237 . The difference between distances between root surface and buccal and palatal cortical plates in males was highly significant with p-value of 0.0001 . The distances between root surfaces and

buccal cortical plate and and palatal cortical plate in females was highly significant with P value of 0.0004.

Table No.5: Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-26)

Table 5k represents the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of left first molar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 2.42 ±1.50 mm in males while in females it was 2.12 ± 0.94 mm .The difference of mean was not significant depicted by P value of 0.1863 similarly for palatal cortical plate it was found to be 1.93 ± 0.77 mm in males and 1.73 ±0.73 mm in females represented by P-value of 0.1270 . The difference between distances between root surface and buccal and palatal cortical plates in males was highly significant with p-value of 0.0045 . The distances between root surfaces and buccal cortical plate and and palatal cortical plate in females was highly significant with P value of 0.0028.

Table No.5l : Distance between Root surface and appropriate cortical plates between Male and Female. .(Tooth-27)

Table 5l shows the mean distances and Standard deviation values of distances between Root surface and appropriate cortical plates of left second molar between Male and Females. Mean distance between root surface and buccal cortical plate was found to be 2.50 ±1.15 mm in males while in females it was 2.26 ± 0.89 mm .The difference of mean was not significant depicted by P value of 0.1825 similarly for palatal cortical plate it was found to be 2.11 ± 0.89 mm in males and 1.99 ±0.88 mm in females represented by P-value of 0.4219 . The difference between

distances between root surface and buccal and palatal cortical plates in males was highly significant with p-value of 0.0026 . The distances between root surfaces and buccal cortical plate and and palatal cortical plate in females was not significant with P value of 0.0715 .

Table No. 6a : Average Thickness of bone between Floor of maxillary sinus and furcation in male and females

Table 6a represents the average mean and Standard deviation values of thickness of bone between Floor of maxillary sinus and furcation between of molars in Male and Female. Average mean thickness of bone between floor of maxillary sinus and furcation and was found to be 5.18 ± 1.75 mm in males while in females it was 5.47 ± 2.16 mm .The difference of mean was not significant depicted by P value of 0.3901 .

Table No. 6b : Average Thickness of bone between Floor of maxillary sinus and furcation of right and left side

Table 6b represents the average mean and Standard deviation values of thickness of bone between Floor of maxillary sinus and furcation between of molars in right and left side . Average mean thickness of bone between floor of maxillary sinus and furcation and was found to be 5.00 ± 2.08 mm on right side and in left side it was 5.28 ± 1.90 mm .The difference of mean was significant depicted by P value of 0.0300.

Table No.6c : Thickness of bone between Floor of maxillary sinus and furcation between Male and Female.(Tooth-16)

Table 6c represents the mean and Standard deviation values of thickness of bone between Floor of maxillary sinus of right maxillary first molar and furcation

between Male and Female. Mean thickness of bone between floor of maxillary sinus and furcation and was found to be 4.11 ±2.21 mm in males while in females it was 5.00 ± 2.61 mm .The difference of mean was significant depicted by P value of 0.0286 .

Table No. 6d : Thickness of bone between Floor of maxillary sinus and furcation between Male and Female.(Tooth-17)

Table 6d represents the mean and Standard deviation values of thickness of bone between Floor of maxillary sinus and furcation of right maxillary second molar between Male and Female. Mean thickness of bone between floor of maxillary sinus and furcation and was found to be 5.29 ±2.37 mm in males while in females it was 6.09 ± 2.43 mm .The difference of mean was not significant depicted by P value of 0.0507 .

Table No. 6e : Thickness of bone between Floor of maxillary sinus and furcation between Male and Female. (Tooth-26)

Table 6e represents the mean and Standard deviation values of thickness of bone between Floor of maxillary sinus and furcation between of left maxillary first molar in Male and Female. Mean thickness of bone between floor of maxillary sinus and furcation and was found to be 4.63 ± 2.01 mm in males while in females it was 4.99 ± 2.53 mm .The difference of mean was not significant depicted by P value of 0.3410 .

Table No.6f : Thickness of bone between Floor of maxillary sinus and furcation between Male and Female.(Tooth-27)

Table 6f represents the mean and Standard deviation values of thickness of bone between Floor of maxillary sinus and furcation between of left maxillary second

molar in Male and Female. Mean thickness of bone between floor of maxillary sinus and furcation and was found to be 5.74 ± 1.96 mm in males while in females it was 1.96 ± 2.19 mm .The difference of mean was not significant depicted by P value of 0.5666.

Table No.7 : The vertical relationship between maxillary molar roots and maxillary sinus floor in Males and females

Table 7 represents the distribution of types vertical relationship between maxillary molar roots and maxillary sinus floor in Males and females . Number of first molars in type I was found 43 in males and 41 in females ,while number of molars in type II was found to be 112 in males and 48 in females. Number of first molars in type III was found 24 in males and 11 in females ,while number of molars in type IV was found to be 8 in males and 4 in females. For type V in males and females no. of molars was found to be 5 and 3 respectively. For second molar ,no. of teeth in type I were 51 in males and 48 in females while in type II it was found 98 in males and 72 in females. No of second molars in type III were 39 in males and in 13 females while in type IV no. of teeth were 1 in male and in 1 in female. For type V no. of teeth were 5 in males and 3 in females.

Table No.8: The horizontal relationship between maxillary molar roots and maxillary sinus floor in Males and females

Table 8 represents the distribution of types horizontal relationship between maxillary molar roots and maxillary sinus floor in Males and females . Number of first molars in type IH was found 20 in males and 10 in females ,while number of molars in type IIH was found to be 108 in males and 45 in females. Number of first molars in type IIIH was found 7 in males and 3 in females ,while number of

molars in type IVH was found to be 52 in males and 46 in females. For type VH no of molars were 7 in males and 2 in females. Number of first molars in type IH was found 35 in males and 15 in females ,while number of molars in type IIH was found to be 52 in males and 35 in females. Number of first molars in type IIIH was found 36 in males and 29 in females ,while number of molars in type IVH was found to be 27 in males and 25 in females. For type VH no of molars were 2 in males and 2 in females.

Table No. 9a Variation in Maxillary sinus between Right and Left.

Table 9a shows the variation in Maxillary sinus between right and left side. The prevalence of septa was found in 33 (22%) on right side and 59(39.33 %) on left side with highly significant difference denoted by p value of 0.001. Similarly the mucosal thickening was found in 75 (Flat – 69 (46%) ,polyp -6(4%)) on right side and 94(Flat – 82 (54%) ,polyp -12(8%)) on left side , with significant difference denoted by p value of 0.027 .Opacification was found 2(1.33%) on right side and 7(4.66%) on left side with no significant difference with p value of 0.173 .39 (26%) on right side and 27 (18%) on left side showed no variation.

Table No. 9b : Variation in Maxillary sinus between Male and Females in right side

Table 9b shows the variation in Maxillary sinus between Male and Females in right side. The prevalence of septa was found in 23(23.7%) males and in 12 (18.8 %) females with no significant difference with p value of 0.494. In contrast the prevalence of mucosal thickening was found in 68 males(Flat – 65 (67.01%) ,polyp - 3 (3.09%)) and in 7 females (Flat – 4 (7.54%) ,polyp-3(5.6%)) with highly

significant difference denoted by p value of <0.001.Opacification was found only in 2(2.06%) males while it was absent in females. In males and females no variations was seen in 19(19.58%) and 20(37.73%) maxillary sinuses respectively.

Table No. 9c : Variation in Maxillary sinus between Male and Females in left side

Table 9c shows the variation in Maxillary sinus between Male and Females on left side. The prevalence of septa was found in 42(43.30 %) males and in 17(32.08 %) females with no significant difference with p value of 0.179 . Similarly the prevalence of mucosal thickening was found in 64 males(Flat – 53(54.64%) ,polyp -11(11.34%)) and in 30 females (Flat – 29(54.72%) ,polyp-1(1.89%) with no significant difference denoted by p value of 0.095 .Opacification was found only in 6(6.19%) males and in in 1(1.89%) females with no significant difference between genders with p value of 0.422 . In males and females no variations was seen in 13(13.40%) and 14(26.42%) maxillary sinuses respectively.

Discussion

Maxillary sinus is the largest of all the paranasal air sinuses and grows very rapidly as the permanent teeth erupt until 20 years of age. After this age the size of the maxillary sinus usually remains static. The inferior wall of maxillary sinus is curved rather than flat and is formed by lower third of the medial wall and the buccoalveolar wall .The roots of maxillary first and second premolars and molars have a close relationship with the MSF. Therefore clinicians conducting any type of surgical procedures in the posterior maxilla must be aware of the degree to which teeth roots may protrude into the sinus.

Maxillary sinus is air filled cavity that appears radiolucent in the radiograph but may show presence of numerous variations even in asymptomatic patients such as bony septa, mucosal thickening and opacification. These variations of the maxillary sinus may be responsible for complications of the sinus while performing

surgeries in the maxillary posterior region such as sinus lift procedure, implant placement and periapical surgeries.

Many imaging techniques such as the conventional radiographic views like lateral cephalograms, panaromic radiography, Water's view were used for the assessment of maxillary sinus. But due to the disadvantages like superimposition of images and limited total visualization of the sinus, one should not rely upon them as a guide for diagnosis and treatment. With the advent of newer imaging modalities like CBCT it is possible to obtain 3D assessment of relationship of MSF and roots of maxillary posterior teeth and also to identify variations of maxillary sinus.

The present study documents the anatomical relationship between the root tips of the maxillary posterior teeth and maxillary sinus floor. Both right and left side was evaluated separately. The prevalence of variations in maxillary sinus on right and left side was also studied.

The CBCT images of 150 patients who had undergone CBCT imaging for any purpose were included in the study according to the inclusion criteria. The sample consisted of 97 males and 53 females .Distances for all maxillary premolars and molars were evaluated.

The average distance between MSF and root apex of single rooted premolars including first and second premolars was found to be 1.94 ± 2.32 mm in males and 1.33 ± 2.11 mm in females .In case of premolars with two roots it was 1.94 ± 2.39 mm in males and 1.29 ± 2.20 mm in females for buccal roots whereas for palatal roots it was found to be 1.60 ± 2.37 mm and 2.78 ± 2.30 mm in males and females respectively. (Table 3a) (Graph1a)

On comparing the average distances in males and females there were no significant difference between the genders , except for the palatal roots which was found to be highly significant . (Table 3a) (Graph1a)

Similar results were found in the studies conducted by **Cenk Cilic [5], Husain et al[16]** with no differences between female and male patients .

In the study by , **Thomas von Arx et al[18]** premolar roots were on an average situated closer to the maxillary sinus in males than in females irrespective of the assessed root and the CBCT plane but without reaching statistical significance, whereas, in the present study it was found that premolar roots were closer in females in case of single rooted premolars and buccal roots in bifurcated premolars .This could be due to difference in gender ratio and methodology in both studies. The previous study has evaluated the distances between roots and MSF in sagittal, coronal and axial sections.

Sultany et al[26] , Ok et al[17] inferred that all premolars in male subjects were more protruded into the sinus than female in contrast to the results of our study where mean values of distances from female subjects suggest that premolar are more protruded into the sinus except for single rooted premolars on left side which shows more protrusion in case of males. Study population and larger sample size could be the reason for this difference.

No significant gender difference was obtained for buccal root, but single rooted premolar showed highly significant difference on both right and left and for palatal significant difference was seen only on the left side .(Table 3b)(Graph 1b)

Husain et al[16] conducted a study on 120 Iraqi subject , who had undergone spiral Computed Tomography scan and found no difference in distances on right and left side. Although on comparing the distances it is seen that the average distances are more in the present study . These differences might be due to differences in resolution of CT and CBCT , as the present study was conducted using CBCT scans.

On evaluating distances between root apices and MSF for first and second premolars individually no significant difference was obtained for gender on either side and for all root types . On comparing the distance between buccal , palatal or single roots for both premolars no significant difference was found on right side ,whereas on left side it was significant only for males. (Table 3c,3d,3e,3f)

Hassan et al[9], Kilic C et al[5] found the average distance of the root apex from the sinus floor was the longest in the first premolar on right and left side , similar results were obtained in the present study. On the contrary **Ahn et al[22]** found it was longest for second premolars this difference might be due to difference in study population ,sample size and gender distribution in both the studies.

On comparing the mean distances between the root apices and MSF of first and second premolars it was found to be highly significant for all root types.(Table3g)

In our study on comparing the two premolars the shortest distance was observed for palatal root of second premolar (1.14±2.03 mm) and ,whereas **Carlos Estrela et al[21]** found the same in case of single rooted premolar (1.71±2.81 mm) .(Table 3g) (Graph 1c)

The average distances between MSF and root apex of all molars including first and second was measured in males and females . The average distance for mesiobuccal root was found to be 0.21 ± 0.48 mm in males and 0.43 ± 0.64 mm in females .In case of distobuccal roots it was 0.33 ± 0.61 mm in males and 0.44± 0.58 mm in females . For palatal roots it was found to be 0.27 ± 0.57 mm and 0.39 ± 0.59 mm in males and females respectively. There were no significant differences between the genders , in the average distances between roots except for the mesiobuccal root where significant difference found .(Table 3h) (Graph 1d)

Sultany et al[26] inferred from all mean values of the distances of root apex and MSF that in male subjects molar roots were more protruded into the sinus than in female, similar to the results of our study . (Table 3h) (Graph 1d)

In the present study comparison of the the average mean distances between the roots of all molars and MSF on right and left side for individual roots was done. On both sides no significant gender differences was obtained except for mesiobuccal root . (Table 3i)(Graph 1e) Results were in accordance with the study conducted by **Husain et al[16]** except for mesiobuccal root.

On comparing the right and left sides, no significant gender difference was found for the distances between roots of both molars and MSF except for the mesiobuccal root of first molar. (Table 3j,3k, 3l,3m)

In our study the distances between MSF and root apex for each root i.e for mesiobuccal , distobuccal and palatal in case of right first and second molar , was smaller compared to distances measured in the study conducted by **Husain et al[16]** ,whereas on the left side the distances were less only for the first molar.

In study conducted by **shubhasini et al**[11] ,the mean distance of maxillary sinus floor to the mesiobuccal root was 1.6410 mm; to that of distobuccal root was 1.5469 mm, and to that of the palatal root was 1.1855 mm . Whereas in the present study it was found to be for mesiobuccal roots 0.26 ± 0.64mm in males and 0.60 ± 1.12 in females , for distobuccal roots 0.30± 0.75 in males and 0.41 ± 0.76 in females and for palatal roots it was found to be 0.12 ± 0.49 in males and 0.35 ± 0.87 in females. Aithough there were differences in the distances , which could be due to difference in sample size , but in both studies the shortest distance was found to be in case of palatal root and longest for the mesiobuccal root. (Table 3j)

In the present study the distance between root tips and MSF was found to be shortest with mesiobuccal roots of second molar on right side, and palatal roots of second molar on left side .Several studies[2,14,15,17,9,21,22] have also found the same. .In contrast the studies conducted by **Cenk Cilic**[5] et al , **Akhavan et al** [20] showed the shortest distance was found to be with distobuccal root of second molar tip for both right and left sides. (Table 3k,3m)

In the study conducted by **Sultany et al**[26] the palatal root of the first molar on right side show the deepest protrusion into the sinus floor , in present study it was found to be with mesiobuccal root of right maxillary first molar. The mesiobuccal roots of the second molars on left side show the deepest protrusion into the sinus on the left side whereas in present study it was found to be with palatal root. This discrepancy may be due to different geographical population used and large sample size in present study.

Dehghani et al[23], Ariji et al [7], Mattar et al[8], Sharan et al[1] ,Hassan et al[9] observed protrusion of roots into sinus was found to be higher in molars compared to premolars i.e the mean distances between roots of maxillary premolars and MSF was greater as compared to mean distance between roots of molars and MSF ,results were in accordance with the present study.(Table 3a,3b,3h,3i)

On comparing the mean distances between the root apices and MSF of first and second molars ,the difference was found to be highly significant only for palatal root.(Table3n)(Graph 1f)

Although from the present study we can conclude that root tips of molars are in close proximity to MSF as compared to roots of premolars. After reviewing the literature a general consensus cannot be arrived at for generalizing the proximity of individual roots to MSF. The topographic relationships between the roots and sinus may show variations in case of premolars and molars and in males and females. Therefore it becomes very important that each case should be thoroughly evaluated preoperatively by using CBCT to avoid complications during surgical procedures in this region.

Relationship between roots of maxillary posterior teeth and MSF was analyzed according to classification given by Didilescu et al.

Class 0: Distance (d) = 0 mm; Class 1: 0 mm to 2 mm , Class 2: 2 mm to 4 mm, Class 3: 4 mm to 6 mm, Class 4: more than 6 mm

In our study we classified , the total 2031 roots including premolars and molars in different classes in males and in females.

We found that in case of premolars in males (194) and females(130) most common classification was found to be class 4 i.e the distance was greater than 6mm . .(Table 4)

Whereas, in molars most frequently found classification was class 0 i.e the distance was 0 mm, both in males (986) and females(482) .(Table 4)

Didilescu et al[15] also maximum molars in class 0 , which is in accordance with the present study. On the contrary **Shubhasini et al** [11]found class 1 as the most common classification . The difference could be due to a smaller sample size used in the study by **Shubhasini et al**[11] .

The thickness of buccal and palatal cortical plate for maxillary premolars and molars on both sides was also evaluated in the present study . Highly significant difference was found between buccal and palatal cortical plate thickness on both right and left sides and significant difference was found between males and females. On comparing the two sides significant difference was seen only for the palatal cortical plate thickness .(Table 5a,5b) (Graph 2a,2b)

The thickness of palatal cortical plate was more as compared to buccal cortical plate in both the genders and on both sides. .(Table 5a,5b) (Graph 2a,2b)

On evaluating the premolars individually first premolars on both sides showed similar findings as all premolars combined together whereas there was no significant difference between the cortical plates in case of second premolars.(Table 5c,5e)(Table 5d,5f)

Yoshimine et al[10] found that the horizontal thickness of the buccal alveolar bone was thinnest on the maxillary first premolars. Similar results were found in the present study.

Average mean distance between root surface of molars and cortical plates was measured and highly significant difference was found in buccal and palatal cortical plate thickness in males whereas in females there were no significant difference.(Table 5g)(Graph 2c)

Average mean distance between root surface of molar and cortical plate on right and left side was compared and it was found that there was significant difference between buccal and palatal cortical plate thickness . Whereas on comparing right and left side , highly significant difference was seen between buccal and palatal cortical plate thickness on left side. .(Table 5h)(Graph 2d)

In case of first molar on right and left side , highly significant difference was found in thickness of both cortical plates in both males and females except for first molar on left side. Buccal cortical plate was found to be thicker than palatal cortical plate in both sides.(Table 5i,5k)

In case of second molar also on right and left side , highly significant difference was found in thickness of both cortical plates in both males and females except for first molar on right side. Similar to first molars, second molars also showed thicker buccal cortical plate as compared to palatal. .(Table 5j,5l)

In the studies by **Ariji et al[7] and Jung et al[14]** the distances from the buccal cortical surface is smaller in the buccal roots of the first molar than those in the

second molar whereas in the present study it was found to be larger for buccal roots of first and second molars. These differences might be due to the difference in the sample size and they have used different classification and imaging modality(CT) to determine the cortical bone thickness.

The results of the present study showed that the thickness of both buccal and palatal cortical plates is more in molars as compared to premolars and also that there is difference in buccal and palatal cortical plate thickness with respect to gender and side. The anatomical relationship between the root and the cortical plates may influence the spread of odontogenic infection originating in the maxillary premolars and molars. Therefore it is important in predicting the spread of infection as well as in treatment planning.

In the present study the thickness of bone between floor of maxillary sinus and furcation of the roots was measured for maxillary first and second molars on right and left side.

Average mean thickness of bone between floor of maxillary sinus and furcation and was found to be 5.18 ± 1.75 mm in males while in females it was 5.47 ± 2.16 mm .No significant difference was found between the two genders.(Table 6a)(Graph 3a)

On comparing right and left side average mean thickness of bone between floor of maxillary sinus and furcation and was found to be 5.00 ± 2.08 mm on right side and in left side it was 5.28 ± 1.90 mm .The difference of mean was found to be significant. (Table 6b)

On comparing the thickness of bone between floor of maxillary sinus and furcation for first and second molars on right and left side ,it was found to be more in case of second molars.

In case of first molar on right side significant difference was found in between males and females for thickness of bone between MSF and furcation.(Table 6c)

Bone thickness in furcation and MSF was found to be more in case of females than in males in both the molars on right and left side.

The shortest distance was for right first molar (4.11±2.21 mm) and longest was for right second molar (6.09 ±2.43mm) .**Katti et al**[27] showed maximum distance was 7.61 ± 2.11 mm and minimum it was 3.64 ± 1.14 mm. Differences might be due to difference in sample size and study population.

As per Didilescu *et al*., a distance of more than 5 mm between furcation and the sinus floor is needed for an immediate implant placement to be done without any chances of perforation into the sinus. In the present study the average thickness of bone between the furcation of roots and maxillary sinus was found to be more than 5 mm in males and in females on right and left side. Results are in accordance with the study by **Dididlescu et al**[15] . Therefore it is important to assess thickness of the bone in furcation area before planning for immediate implant placement in the same region.

In the present study the positional relation between inferior wall of maxillary sinus and maxillary molars was evaluated using Kwak's classification.

Vertical relationship between maxillary molar roots and maxillary sinus floor in Males and females was assessed . It was described as -Type I: The MSF was located above the level connecting the buccal and palatal root apices.

Type II: The MSF was located below the level connecting the buccal and palatal root apices without an apical protrusion over the MSF.

Type III: An apical protrusion of the buccal root apex was observed over the MSF Type IV: An apical protrusion of the palatal root apex was observed over the MSF.

Type V: Apical protrusions of the buccal and palatal root apices were observed over the MSF

In the present study, total 600 molars were evaluated and classified under different types of vertical relationship between molar roots and MSF .

For both first and second molars , type II was most common type of vertical relationship and type IV was least common in males and females (Table 7)

In the study conducted by **Yoshimine et al**[10] they also found that Type II was most commonly seen at the maxillary first molars . Type II was found to be most frequent vertical relationship in the study conducted by **Carlos E et al** [21] for first and second molars, in accordance with the present study. On the contrary **kilic et al**[5] found type I as the most common vertical relationship**.** In the study **Jung et al**[14] type V was the most common vertical relationship.

The difference between these studies may be attributed not only to methodological differences, but also to the characteristics of ethnicity, since the analyzed populations were diverse.

Horizontal relationship between maxillary molar roots and maxillary sinus floor in Males and females was assessed. It was described as –

Type 1H: The alveolar recess of the MSF was located more towards the buccal side than towards the buccal root.

Type 2H: The alveolar recess of the MSF was located between the buccal and palatal roots.

Type 3H: The alveolar recess of the MSF was located more towards the palatal side than towards the palatal root.

Type 4H: The alveolar recess of the MSF passes over the roots without establishing relationship with them.

Type 5H: The alveolar recess of the MSF is located towards the buccal side and towards the palatal side, and may or may not also extend between the roots.

For both first and second molars most common horizontal relationship found was type IIH that is the alveolar recess was most often located between the buccal and palatal roots. Type V that is both buccal and palatal roots are completely protruded into the sinus, was least common in both males and females.(Table 8)

Type IIH was found to be most frequent horizontal relationship in the study conducted by **Carlos E et al[21] and Jung et al[14]** for first and second molars, in accordance with the findings in the present study.

In the present study most common vertical and horizontal relationship between maxillary molars and MSF was Type II and Type IIH respectively. According to the **Carlos E et al**[21] ,the presence of vertical Type II and horizontal Type IIH relationships may contribute to a rapid dissemination of odontogenic infectious processes to the MS. Therefore assessment of these relationship is important.

Anatomical variations in the form of septa, mucosal thickening, opacification of maxillary sinus were identified and their incidence evaluated on right and left maxillary sinus and in males and females. In the present study out of 150 scans, 90(60%) scans showed pathological changes in at least one sinus or both.(Table 9a)The prevalence in the previous studies [49,31,42,43,32,35] was found to be ranging from 27.5% to 76.1% .

Variations observed were either unilateral or bilateral therefore,out of 300 maxillary sinuses examined variations were identified in 239(79.6%) sinuses.

Antral septa are defined as pointed bone structures, and, maxillary sinus exostosis as a rounded bone structure, both originating from any maxillary sinus wall.[40]

In the present study, out of 300 maxillary sinuses, 92 (30.6%) sinuses showed septas, which is in accordance with study conducted by **Kim et al**[30] **and Raghunathan et al**[52] i.e 29.5% and 29.5% respectively in 200 maxillary sinuses **.** Whereas in the studies conducted by **Bornstein et al**[51] **, Orhan et al** [45]**, Lana et al**[40] **,Shahidi et al**[53] septas were found in the range of 55% to 69%.

Mucosal thickening is an inflammatory reaction with hyperplasia of the mucous lining of the maxillary sinus. The pathogenesis for mucosal thickening is that, in the presence of bacterial infection , the infected mucosa swells up in response to the bacteria which alter the goblet cells to change the composition of the mucus and to generate a shield of thick mucus. Flat mucosal thickening is considered when it is of more than 1 mm thickness whereas it was considered as polyp when its appearance resemble with teardrop.

In the present study, out of 300 maxillary sinuses , 50.3 % sinuses showed presence of mucosal thickening .Studies by **Lana et al[40], Raghav et al[32]**, **Malik et al [34]** , **Elwakeel [35],Dobele et al[46],Pazera et al[49]** its prevalence ranges between was 17.5% to 54.8%.

Sinonasal inflammatory disease with sinus ostial obstruction i.e chronic sinusitis is the common cause for sinus opacification.

In the present study, out of 300 maxillary sinuses, 5.99 % sinuses showed presence of opacification. Different studies[52,32,46,43,40] showed its prevalence in the range of 1.8% to 16.6%.

Total 110(46.02%) pathologies were identified on the right side while 160

(66.94%) on the left side. The most common variation found was flat type of mucosal thickening (69) followed by septa (33) but as compared to right side ,left side showed more variations and this difference was statistically significant.(Table 9a)

These results were in contrast with the studies conducted by **Ritter et al[31] , Raghav et al[32]** where they found no difference of occurrence between the right and the left side.

On right and left side, there were no significant difference found in prevalence of variations in maxillary sinus between males and females except mucosal thickening on right side which showed highly significant difference. (Table 9b, 9c)(Graph 4a,4b)

Number of septa in maxillary sinus were which is almost equal for both the genders on both right and left side ,similar results was obtained by **Orhan et al[45], Bornstein et al[51] , Kannaperuman et al[48], Yildirim et al[55]** where near about equal number of septas were seen in males and females. Whereas male predilection was seen in the study conducted by **Ilavenil et al[28]** (54.5% males, 45.4% females) and female predilection were seen in the study conducted by **Sigaroudi et al[54]** (61.2% females, 38.8% males). This variation may be due to the variations in study population.

No significant difference in the occurrence of mucosal thickening between males and females was observed by **Malik et al[34] ,Raghav et al[32]** . On the contrary in the present study significant difference was seen in the occurrence in males and females only on right side . In the present study the prevalence of mucosal thickning , was found to be 46% on right side and 54 % on left side . On the contrary the study by **Raghunathan et al[52], Rege et al[43], Elwakeel et al [35]** the prevalence of MT was found to be less on left side than on right side.

In the present study, out of 300 maxillary sinuses , 12 % sinuses showed presence of polypoidal mucosal thickening. In the studies conducted by **Elwakeel et el[35] ,Raghunathan et al[52], Raghav et al [32] , Pazera et al [49]** its prevalence ranges between, 4% to 21.4%.

In the present study ,on right side the prevalence of polypoidal mucosal thickning was 4% and on left side it was 8% ,whereas **Rege et al[43]** found the prevalence to be 3.8% and on left side it was 1.8%. In the study by **Elwakeel et al[35]** ,its prevalence was found to be more i.e 13% on right and 19% on left. These differences in the prevalence might be due to difference in study population.

In the present study the prevalence of opacification on right side(1.33%) was less compared to left side(4.66%).In the study by **Elwakeel et al[35] ,Raghunathan et al[52] ,Raghav et al[32] ,Rege et al[43]** showed high prevalence on right side than on left side .

On considering its gender wise distribution , on right and left side there no gender differences in the prevalence of opacification (Table 9b, 9c)(Graph 4b,4c) . On similar lines **Raghav et al[32]** did not find gender differences in the prevalence of opacification. On the contrary **Raghunathan et al[52], Elwakeel et al[35]** found significant gender differences due to difference in male and female ratio.

The pathologies like bony septa, polyps, mucosal thickening can pose difficulties while performing surgeries in the maxillary posterior region. Present study showed the high percentage of of variations in maxillary sinus therefore complete scrutiny of the CBCT scan is necessary identify such variations.

Conclusion

This retrospective observational study was carried out on 150 CBCT scans showing bilateral maxillary sinus and posterior teeth . In this study the relationship between the maxillary sinus floor and maxillary posterior teeth was evaluated in terms of vertical distance between the roots and MSF, cortical plate thickness, thickness of bone in the furcation area, vertical and horizontal relationship between molars and MSF .Variations in maxillary sinus was also evaluated.

The conclusion which can be drawn from our study is that:

1. In premolars ,palatal root in females and buccal root in males are situated farthest from the maxillary sinus floor whereas ,palatal root in males and buccal root in females was found to be closest.

2. In molars, distobuccal root was found to be farthest in males and females whereas ,mesiobuccal root and palatal root was closest to MSF in males and females respectively.

3. Relationship between roots of maxillary posterior teeth and MSF was analyzed according to classification given by Didilescu et al. In the present study , in case of premolars in males (194) and females(130) most common classification was found to be class 4 i.e the distance was greater than 6mm ,Whereas, in molars most frequently found classification was class 0 i.e the distance was 0 mm, both in males (986) and females(482)

4. In premolars, in males and females palatal cortical plate was found to be thicker than buccal cortical plate. Similarly palatal cortical plate thickness was found to be more than buccal cortical plate on both right and left side.

5. For molars , buccal cortical plate was thicker in males whereas in females no significant difference was found between the two cortical plates. On right and left side the thickness of buccal cortical plate was found to more as compared to palatal cortical plate.

6. The thickness of bone between the furcation of roots and MSF was found to be more in females as compared to males. It was found to be more on left side as compared to right side.

7. The most common positional relationship between molars and MSF was found to be type II vertical relationship and Type IIH horizontal relationship for first and second molars.

8. Out of 150 scans, 90(60%) scans showed variations in at least one sinus or both maxillary sinus .Most commonly found variation was mucosal thickening ,followed by septa and opacification on right and left side.

9. Out of 300 maxillary sinuses examined variations were identified in 239(79.6%) sinuses.

10. Number of variations were found to be more in left maxillary sinus than in right ,with significant difference in the prevalence of septa and mucosal thickening.

11. Males showed more variations than in females on right and left side, with highly significant difference in the prevalence of mucosal thickening.

Limitations

1. A larger sample size would provide a more precise data regarding relationship of maxillary posterior teeth and maxillary sinus.

2. The measurements of the dimensions were taken by hand tool in the CBCT software which might have lead to manual errors, thus reducing the accuracy.

3. The study was conducted by single observer due to which observer based bias could not be eliminated. This gave rise to a need to conduct the study with more than one observer to overcome this bias.

Future studies

1. Future research should be carried out in different geographical regions and on larger sample of subjects.

2. A prospective observational study should be done on patients undergoing surgical procedures in maxillary posterior region , which will provide more information regarding the 3D assessment of relationship of maxillary posterior teeth and MSF .

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Tables and Graphs

Table 1. Distribution of patients

Age in years	No. of patients	Percentage(%)
20 – 30	96	64.0
31 – 40	40	26.67
41 – 50	14	9.33
Total	150	100
Mean Age ± SD (Range)	29.63 ± 6.65 (20-49)	

Table 2. Gender distribution .

Gender	No. of patients.	Percentage(%)
Male	97	64.67
Female	53	33.33
Total	150	100

Table 3.a. Average mean distance and Standard deviation values of Premolar in mm between maxillary pre molar apices and MSF in Males and Females

Tooth	N	Single	Buccal	Palatal	Kw-value	p-value
Male	97	1.94 ± 2.32	1.94 ± 2.39	1.60 ± 2.37	1.322	0.5163,NS
Female	53	1.33 ± 2.11	1.29 ± 2.20	2.78 ± 2.30	24.103	0.0001,HS
p-value		0.1179,NS	0.1081,NS	0.0037,HS		

NS- not significant, HS-highly significant , at 5% level of significance.

Table 3.b. Average mean distance and Standard deviation values of Premolar in mm between maxillary pre molar apices and MSF in right and left side .

N		Single	Buccal	Palatal
Right	Male(97)	2.92± 2.76	2.11± 2.74	2.20 ± 2.86
	Female(53)	1.58± 2.65	1.62 ± 0.34	1.62± 2.64
p-value		0.0001,HS	0.1828,NS	0.0502,NS
Left	Male(97)	1.60 ± 2.37	1.94± 2.32	1.94± 2.39
	Female(53)	2.78 ±2.30	1.33± 2.11	1.29± 2.20
p-value		0.0001,HS	0.0640,NS	0.0261,S

NS- not significant, HS-highly significant, S-significant. at 5% level of significance.

Table 3.c. The mean distance and Standard deviation values in mm between maxillary right first premolar apices and MSF (Tooth-14)

Tooth	N	Single	Buccal	Palatal	Kw-value	p-value
Male	97	5.67 ± 4.39	6.36 ± 5.47	6.60 ± 5.63	0.400	0.8187,NS
Female	53	6.67 ± 4.05	7.1 ± 5.15	7.72 ± 5.51	0.344	0.8420,NS
p-value		0.3561,NS	0.5102,NS	0.4229,NS		

NS- not significant, at 5% level of significance.

Table 3.d. The mean distance and Standard deviation values in mm between maxillary right second premolar apices and MSF . (Tooth-15)

Tooth	N	Single	Buccal	Palatal	Kw-value	p-value
Male	97	1.55 ± 2.72	0.49 ± 0.73	0.57 ± 0.92	0.344	0.8420,NS
Female	53	2.21 ± 2.39	0.67 ± 1.15	0.93 ± 1.61	2.482	0.2891,NS
p-value		0.1678,NS	0.7187,NS	0.5669,NS		

NS- not significant, at 5% level of significance.

Table 3.e. The mean distance and Standard deviation values in mm between maxillary left first premolar apices and MSF (tooth 24)

Tooth	N	Single	Buccal	Palatal	Kw-value	p-value
Male	97	4.46 ± 4.39	6.68 ± 4.92	6.68 ± 4.92	7.948	0.0188,S
Female	53	5.45 ± 3.52	7.25 ± 5.24	7.73 ± 4.82	2.354	0.3082,NS
p-value		0.2457,NS	0.7285,NS	0.6840,NS		

NS- not significant, S-significant at 5% level of significance

Table 3.f. The mean distance and Standard deviation values in mm between maxillary left second premolar apices and MSF (tooth 25)

Tooth	N	Single	Buccal	Palatal	Kw-value	p-value
Male	97	0.96 ± 1.95	1.78 ± 2.05	1.12 ± 1.50	5.407	0.0292,S
Female	53	1.20 ± 1.76	3.37 ± 3.85	2.96 ± 4.11	4.403	0.1106,NS
p-value		0.4818,NS	0.1542,NS	0.0926,NS		

NS- not significant, S-significant at 5% level of significance

Table 3.g. The mean distance and Standard deviation values in mm between maxillary first and second premolar apices and MSF

Tooth	Single	Buccal	Palatal
First premolar	4.06± 4.08	6.82 ± 2.69	7.71± 5.22
Second premolar	2.54±2.64	1.57±1.94	1.14±2.03
P-value	<0.001HS	<0.001HS	<0.001HS

HS-highly significant.

Table 3.h. Average mean distance and Standard deviation values in mm of Molars between maxillary pre molar apices and MSF in Males and Females

Tooth	N	MB	DB	Palatal	Kw-value	p-value
Male	97	0.21 ± 0.48	0.33 ± 0.61	0.27 ± 0.57	1.703	0.4267,NS
Female	53	0.43 ± 0.64	0.44 ± 0.58	0.39 0.59	0.496	0.7804,NS
p-value		0.0217,S	0.0875,NS	0.0719,NS		

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, s-significant at 5% level of significance

Table 3.i. Average mean distance and Standard deviation values in mm of Molars between maxillary pre molar apices and MSF in right and left side.

Tooth		MB	DB	Palatal
Right	Male(97)	0.18± 0.42	0.31± 0.66	0.25 ± 0.56
	Female(53)	0.40 ± 0.72	0.43 ± 0.67	0.38± 0.71
p-value		0.0230,S	0.1218,NS	0.2760,NS
Left	Male(97)	0.24 ± 0.74	0.35 ± 0.78	0.29± 0.71
	Female(53)	0.45± 0.81	0.46± 0.77	0.40± 0.73
p-value		0.0087,HS	0.0730,NS	0.1178,NS

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, S-significant, HS-highly significant, at 5% level of significance

Table 3.j. The mean distance and Standard deviation values in mm between maxillary right first molar apices and MSF . (Tooth-16)

Tooth	N	MB	DB	Palatal	Kw-value	p-value
Male	97	0.26 ± 0.64	0.30± 0.75	0.12 ± 0.49	5.539	0.0627,NS
Female	53	0.60 ± 1.12	0.41 ± 0.76	0.35 ± 0.87	3.321	0.1900,NS
p-value		0.0365,S	0.1649,NS	0.1052,NS		

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, S-significant, at 5% level of significance

Table 3.k. The mean distance and Standard deviation values in mm between maxillary right second molar apices and MSF . (Tooth-17)

Tooth	N	MB	DB	Palatal	Kw-value	p-value
Male	97	0.26 ± 0.64	0.30± 0.75	0.12 ± 0.49	5.539	0.0627,NS
Female	53	0.60 ± 1.12	0.41 ± 0.76	0.35 ± 0.87	3.321	0.1900,NS
p-value		0.0365,S	0.1649,NS	0.1052,NS		

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, s-significant at 5% level of significance

Table 3.l. The mean distance and Standard deviation values in mm between maxillary left first molar apices and MSF . (Tooth-26)

Tooth	N	MB	DB	Palatal	Kw-value	p-value
Male	97	0.29 ± 0.95	0.27 ± 0.77	0.31 ± 1.07	0.229	0.8916,NS
Female	53	0.47 ± 1.10	0.39 ± 0.80	0.42 ± 1.04	0.0570	0.9718,NS
p-value		0.1123,NS	0.1406,NS	0.1704,NS		

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, at 5% level of significance

Table 3.m. The mean distance and Standard deviation values in mm between maxillary left second molar apices and MSF . (Tooth-27)

Tooth	N	MB	DB	Palatal	Kw-value	p-value
Male	97	0.29 ± 0.95	0.27 ± 0.77	0.28 ± 0.76	0.229	0.8916,NS
Female	53	0.47 ± 1.10	0.39 ± 0.80	0.37 ± 0.84	0.0570	0.9718,NS
p-value		0.1123,NS	0.1406,NS	0.3823,NS		

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, at 5% level of significance

Table 3.n.The mean distance and Standard deviation values in mm between maxillary first and second molar apices and MSF

Tooth	MB	DB	Palatal
First molar	0.38±0.78	0.42 ± 0.88	2.8± 0.86
Second molar	0.26±0.75	0.36 ±0.77	0.36±0.87
P-value	0.17 NS	0.6 NS	<0.001HS

MB-Mesiobuccal, DB-Distobuccal, NS- not significant, HS-Highly significant at 5% level of significance

Table No.4 Distribution of Classes between maxillary root apices of maxillary premolars and molars

	First premolars					Second premolars					First molars					Second molars				
Classes	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4	0	1	2	3	4
Males(97)	43	58	23	47	72	14	47	22	14	122	501	36	30	11	0	486	69	22	7	0
Females(53)	13	13	19	27	59	8	34	13	14	71	236	41	33	8	0	246	51	18	3	0

Class 0: distance (d) = 0 mm; Class 1: 0 - 2 mm; Class 2: 2- 4 mm; Class 3: 4 - 6 mm; Class 4: 6 mm ≤ d.

Table 5.a. Average Distance between Root surface and appropriate cortical plates between Male and Female in premolars

Tooth	Gender	Buccal		Palatal		p-value
		Mean	SD	Mean	SD	
Pre molar	Male(97)	1.73	0.80	1.95	0.53	<0.0001,HS
	Female(53)	1.54	0.68	1.95	0.53	0.0327,S
	p-value	0.1522,NS		0.7112,NS		

NS- not significant, HS-highly significant , S-significant at 5% level of significance

Table 5.b. Average Distance between Root surface and appropriate cortical plates between right and left side in premolars

Tooth	Site	Buccal		Palatal		p-value
		Mean	SD	Mean	SD	
Pre molar	Right	1.65	0.73	1.87	0.60	0.0011,HS
	Left	1.67	0.91	2.00	0.59	0.0002,HS
p-value	p-value	0.5857,NS		0.0167,S		

NS- not significant, HS-highly significant , s-significant , at 5% level of significance

Table 5.c. Distance between Root surface and appropriate cortical plates of maxillary right first premolar between Male and Female.(Tooth-14)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
14	Male(97)	1.39	0.58	1.74	0.72	3.9412	0.0002,HS
	Female(53)	1.26	0.57	1.77	0.71	4.7288	<0.0001,HS
p-value		0.0909,NS		0.7776,NS			

NS- not significant, HS-highly significant , at 5% level of significance.

Table 5.d. Distance between Root surface and appropriate cortical plates of maxillary right second premolar between Male and Female.(Tooth-15)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
15	Male(97)	2.00	0.97	1.92	0.63	0.6723	0.5030,NS
	Female(53)	1.86	1.15	2.11	1.00	1.6569	0.1036,NS
p-value		0.4289,NS		0.1803,NS			

NS- not significant, HS-highly significant , at 5% level of significance.

Table 5.e. Distance between Root surface and appropriate cortical plates of maxillary left first premolar between Male and Female.(Tooth-24)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
24	Male(97)	1.48	0.89	2.08	0.73	5.6675	<0.0001,HS
	Female(53)	1.31	0.80	1.97	0.66	4.7395	<0.0001,HS
p-value		0.2726,NS		0.3796,NS			

NS- not significant, HS-highly significant , at 5% level of significance.

Table 5.f. Distance between Root surface and appropriate cortical plates of maxillary left second premolar between Male and Female.(Tooth-25)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
25	Male(97)	2.04	1.25	1.96	0.70	0.9206	0.3596,NS
	Female(53)	1.72	0.79	1.97	0.67	1.8895	0.0644,NS
p-value		0.0954,NS		0.8741,NS			

NS- not significant, at 5% level of significance.

Table 5.g. Average Distance between Root surface and appropriate cortical plates between Male and Female in molars

Tooth	Gender	Buccal		Palatal		p-value
		Mean	SD	Mean	SD	
Molar	Male(97)	2.48	1.25	2.05	0.57	0.0004,HS
	Female(53)	2.23	0.85	2.36	3.48	0.7957,NS
	p-value	0.1965,NS		0.1265,NS		

NS- not significant, HS-highly significant ,at 5% level of significance.

Table 5.h. Average Distance between Root surface and appropriate cortical plates between right and left side in molars

Tooth	Gender	Buccal		Palatal		p-value
		Mean	SD	Mean	SD	
Molar	Right	2.48	1.08	2.36	4.15	0.7334,NS
	Left	2.37	1.07	1.97	0.71	<0.0001,HS
	p-value	0.0499,S		0.0257,S		

NS- not significant, HS-highly significant, S-significant, at 5% level of significance.

Table 5.i. Distance between Root surface and appropriate cortical plates of right maxillary first molar between Male and Female. .(Tooth-16)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
16	Male(97)	2.37	1.18	2.00	0.74	3.1125	0.0024,HS
	Female(53)	2.16	1.28	1.81	0.66	0.8090	0.4222,NS
p-value		0.326,NS		0.2237,NS			

NS- not significant, HS-highly significant, at 5% level of significance.

Table 5.j. Distance between Root surface and appropriate cortical plates of right maxillary second molar between Male and Female. .(Tooth-17)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
17	Male(97)	2.72	1.39	2.16	0.76	4.1007	0.0001,HS
	Female(53)	2.53	0.93	1.99	0.66	3.7965	0.0004,HS
p-value		0.3672,NS		0.1619,NS			

NS- not significant, HS-highly significant, at 5% level of significance

Table 5.k. Distance between Root surface and appropriate cortical plates of left maxillary first molar between Male and Female. .(Tooth-26)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
26	Male(97)	2.42	1.50	1.93	0.77	2.9114	0.0045,HS
	Female(53)	2.12	0.94	1.73	0.73	3.1354	0.0028,HS
p-value		0.1863,NS		0.1270,NS			

NS- Not significant, HS-highly significant, at 5% level of significance

Table 5.l. Distance between Root surface and appropriate cortical plates of left maxillary second molar between Male and Female. .(Tooth-27)

Tooth	Gender	Buccal		Palatal		t-value	p-value
		Mean	SD	Mean	SD		
27	Male(97)	2.50	1.15	2.11	0.89	3.0948	0.0026,HS
	Female(53)	2.26	0.89	1.99	0.88	1.8399	0.0715,NS
p-value		0.1825,NS		0.4219,NS			

NS- not significant, HS-highly significant, at 5% level of significance

Table 6.a. Average Thickness of bone between Floor of maxillary sinus and furcation in male and females in molars

Tooth	Male(97)		Female(53)		p-value
Molars	Mean	SD	Mean	SD	
	5.18	1.75	5.47	2.16	0.3901,NS

NS- not significant, at 5% level of significance

Table 6.b. Average Thickness of bone between Floor of maxillary sinus and furcation of right and left side in molars

Tooth	Right		Left		p-value
Molars	Mean	SD	Mean	SD	
	5.00	2.08	5.28	1.90	0.0300,S

S- significant, at 5% level of significance

Table 6.c. Thickness of bone between floor of maxillary sinus and furcation between Male and Female for maxillary right first molar.(Tooth-16)

Tooth	Male(97)		Female(53)		p-value
	Mean	SD	Mean	SD	
16	4.11	2.21	5.00	2.61	0.0286,S

S- significant, at 5% level of significance

Table 6.d. Thickness of bone between floor of maxillary sinus and furcation between Male and Female for maxillary right second molar.(Tooth-17)

Tooth	Male(97)		Female(53)		p-value
	Mean	SD	Mean	SD	
17	5.29	2.37	6.09	2.43	0.0507,NS

NS- not significant,at 5% level of significance.

Table 6.e. Thickness of bone between floor of maxillary sinus and furcation between Male and Female for maxillary left first molar.(Tooth-26)

Tooth	Male(97)		Female(53)		p-value
	Mean	SD	Mean	SD	
26	4.63	2.01	4.99	2.53	0.3410,NS

NS- not significant, at 5% level of significance.

Table 6.f. Thickness of bone between floor of maxillary sinus and furcation between Male and Female for maxillary left second molar.(Tooth-27)

Tooth	Male(97)		Female(53)		p-value
	Mean	SD	Mean	SD	
27	5.74	1.96	5.94	2.19	0.5666,NS

NS- not significant, at 5% level of significance.

Table 7 The vertical relationship between maxillary molar roots and maxillary sinus floor in Males and females

	First molars					Second molars				
Classes	Type-I	Type-II	Type-III	Type-IV	Type-V	Type-I	Type-II	Type-III	Type-IV	Type-V
Males	43	112	24	8	7	51	98	39	1	5
Females	41	48	11	4	2	48	72	13	1	3

Type I: The MSF was located above the level connecting the buccal and palatal root apices, Type II: The MSF was located below the level connecting the buccal and palatal root apices without an apical protrusion over the MSF, Type III: An apical protrusion of the buccal root apex was observed over the MSF, Type IV: An apical protrusion of the palatal root apex was observed over the MSF, Type V: Apical protrusions of the buccal and palatal root apices were observed over the MSF

Table 8 The horizontal relationship between maxillary molar roots and maxillary sinus floor in Males and females

	First molars					Second molars				
Classes	Type-1H	Type-2H	Type-3H	Type-4H	Type-5H	Type-1H	Type-2H	Type-3H	Type-4H	Type-5H
Males	20	108	7	52	7	35	52	36	27	2
Females	10	45	3	46	2	15	35	29	25	2

Type 1H: The alveolar recess of the MSF was located more towards the buccal side than towards the buccal root, Type 2H: The alveolar recess of the MSF was located between the buccal and palatal roots, Type 3H: The alveolar recess of the MSF was located more towards the palatal side than towards the palatal root, Type 4H: The alveolar recess of the MSF passes over the roots without establishing relationship with them, Type 5H: The alveolar recess of the MSF is located towards the buccal side and towards the palatal side, and may or may not also extend between the roots.

Table 9a Variation in Maxillary sinus between Right and Left.

Tooth	N	Septa	Mucosal Thickening		Opacification	No variation
		Septa	Flat	Polyp		
Right	150	33(22)	69(46)	6(4)	2(1.33)	39(26)
Left	150	59(39)	82(54)	12(8)	7(4.66)	27(18)
p-value		0.001,HS	0.027,S		0.173,NS	0.094,NS

NS- not significant, HS-highly significant, S-significant, at 5% level of significance.

Table 9b Variation in Maxillary sinus between Male and Females in right side

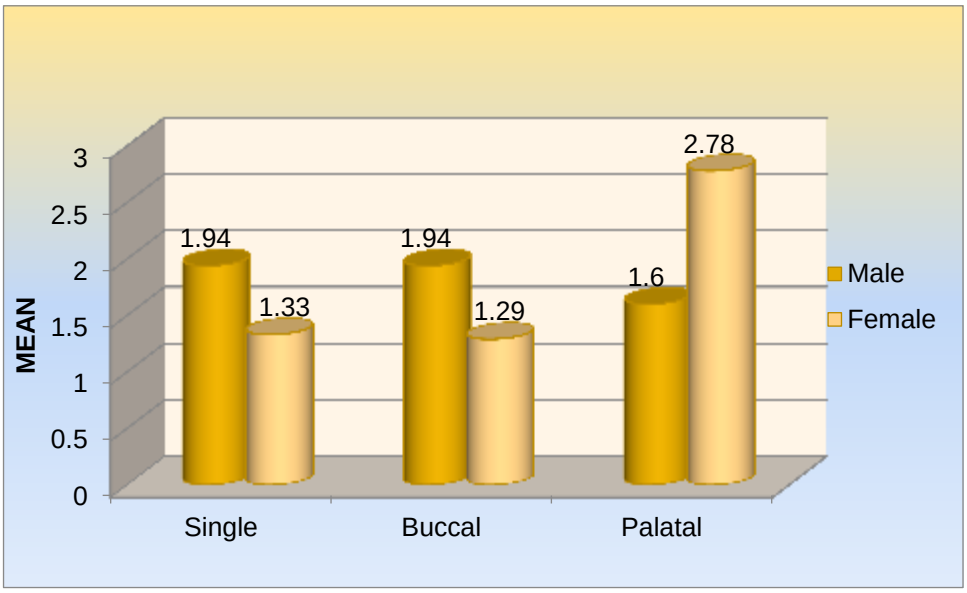
Tooth	N	Septa	Mucosal Thickening		Opacification	No variation
		Septa	Flat	Polyp		
Male	97	23(23.71%)	65(67.01%)	3(3.09%)	2(2.06%)	19(19.58%)
Female	53	10(18.86%)	4(7.54%)	3(5.6%)	0	20(37.73%)
p-value		0.494,NS	<0.001,HS		0.417,NS	0.015,S

NS- not significant, HS-highly significant, S-significant, at 5% level of significance.

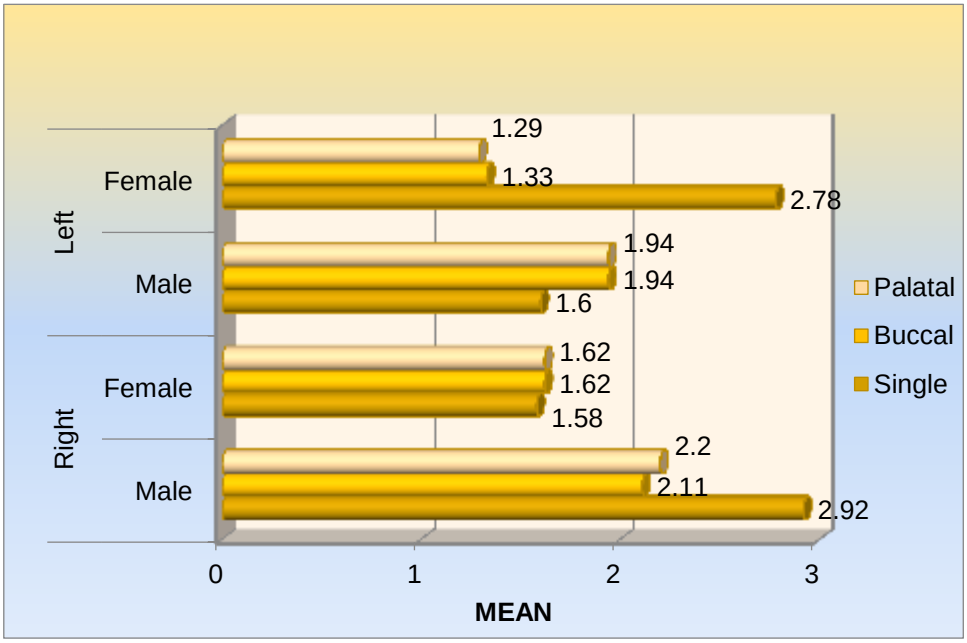
Table 9c Variation in Maxillary sinus between Male and Females in left side

Tooth	N	Septa	Mucosal Thickening		Opacification	No variation
		Septa	Flat	Polyp		
Male	97	42(43.30)	53(54.64)	11(11.34)	6(6.19)	13(13.40)
Female	53	17(32.08)	29(54.72)	1(1.89)	1(1.89)	14(26.42)
p-value		0.179,NS	0.095,NS		0.422,NS	0.047,S

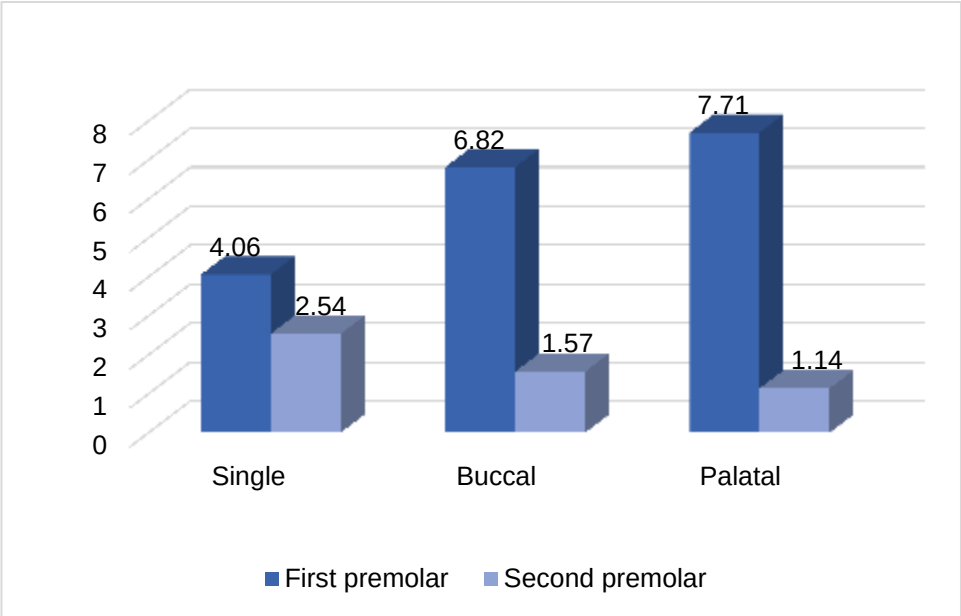
NS- not significant, HS-highly significant, S-significant, at 5% level of significance.



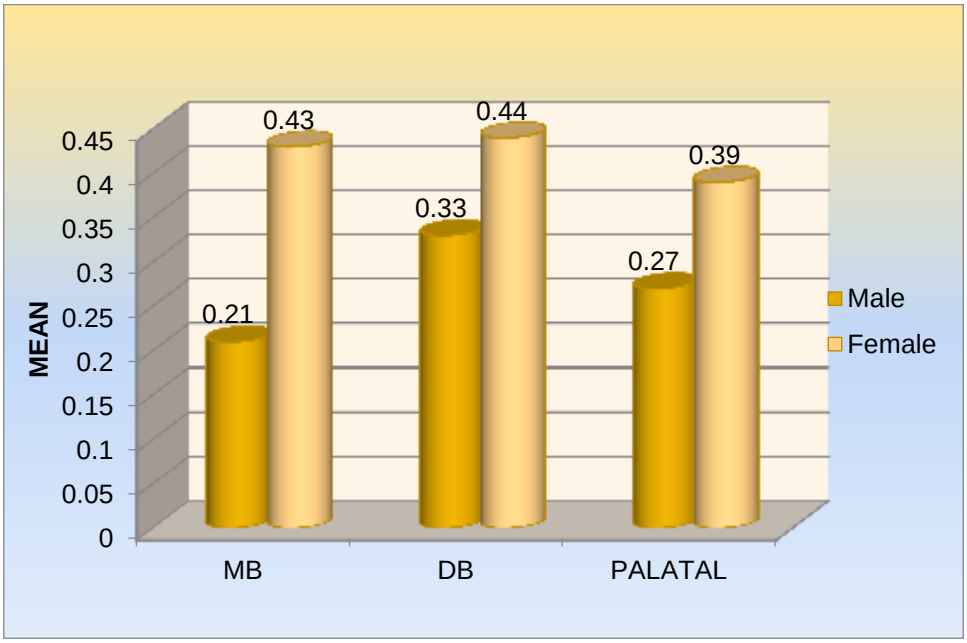
1.a. Average mean distance of Premolar in mm between maxillary pre molar apices and MSF in Males and Females



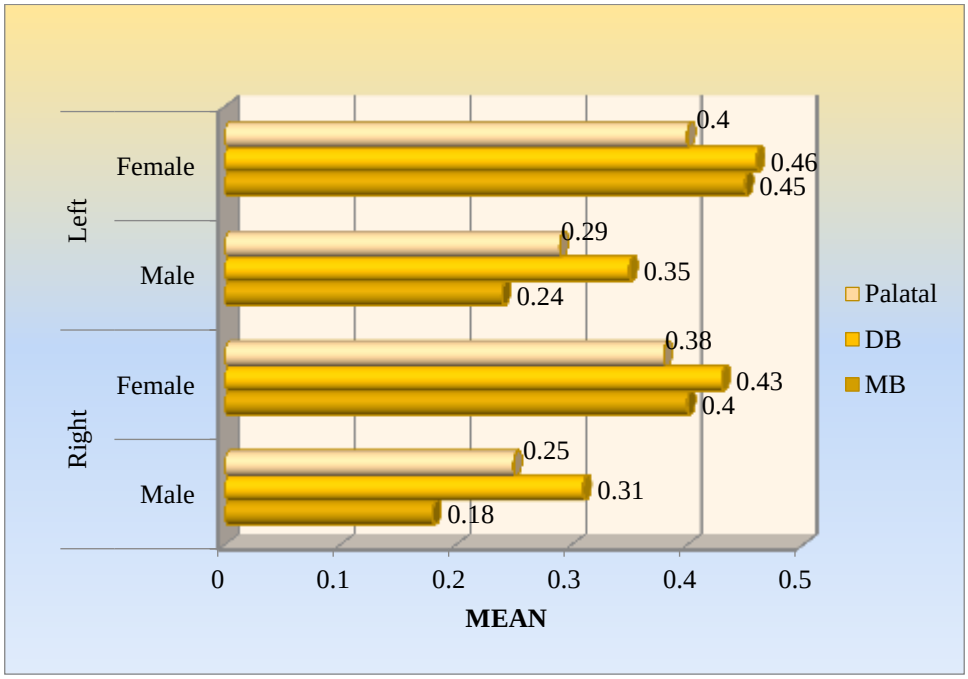
1.b. Average mean distance of Premolar in mm between maxillary pre molar apices and MSF in right and left side



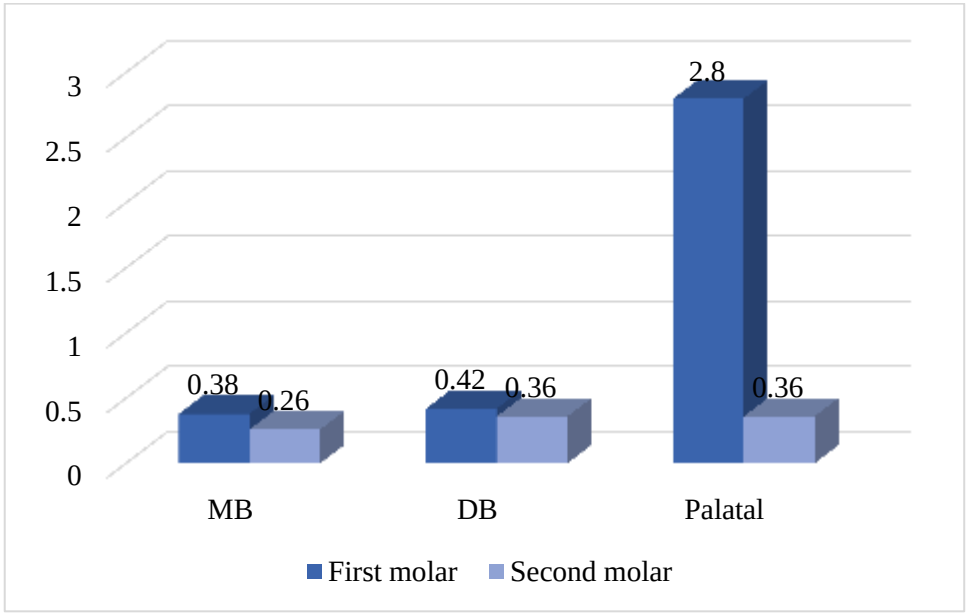
1 . c. The mean distance and Standard deviation values in mm between maxillary first and second premolar apices and MSF



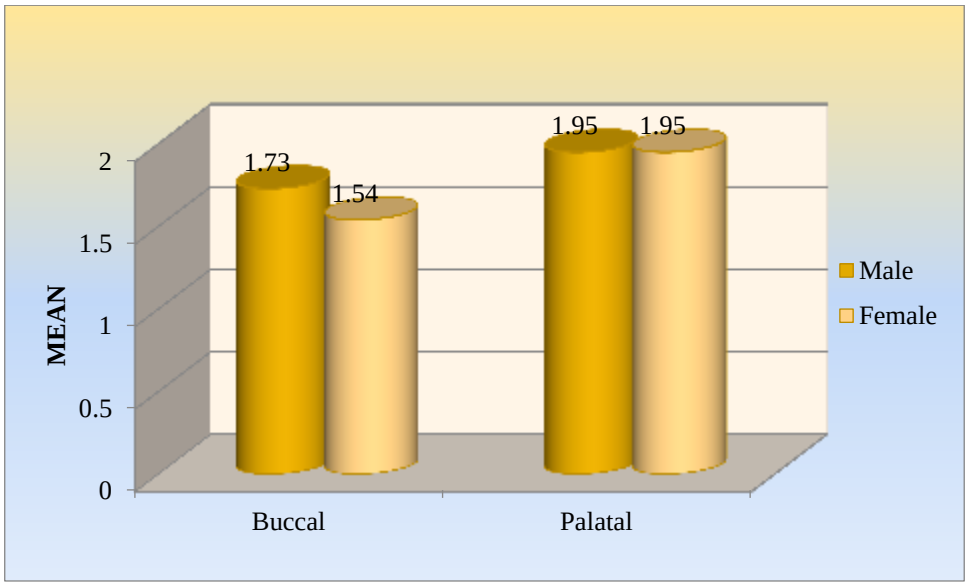
1.d. Average mean distance in mm of Molars between maxillary pre molar apices and MSF in Males and Females



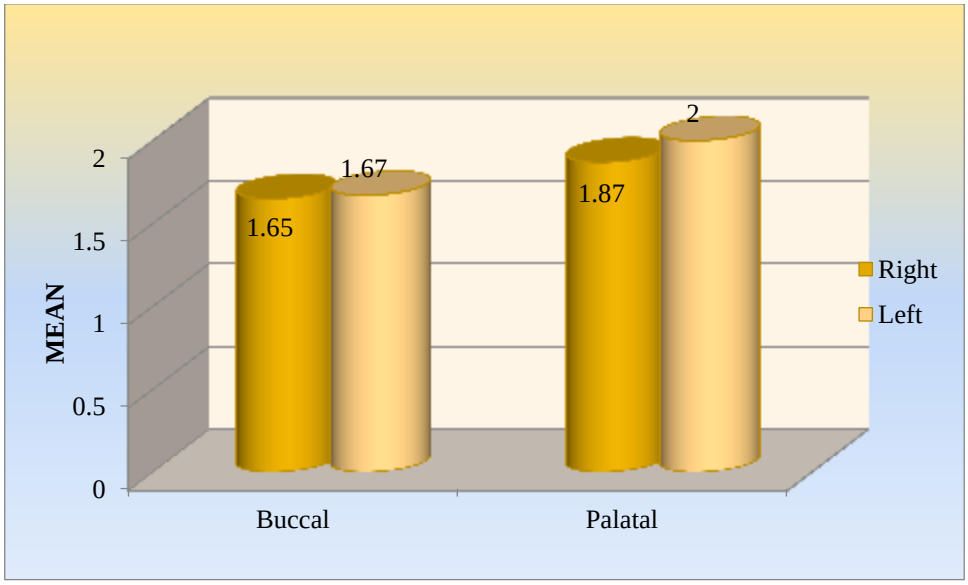
1.e. Average mean distance in mm of Molars between maxillary pre molar apices and MSF in Males and Females



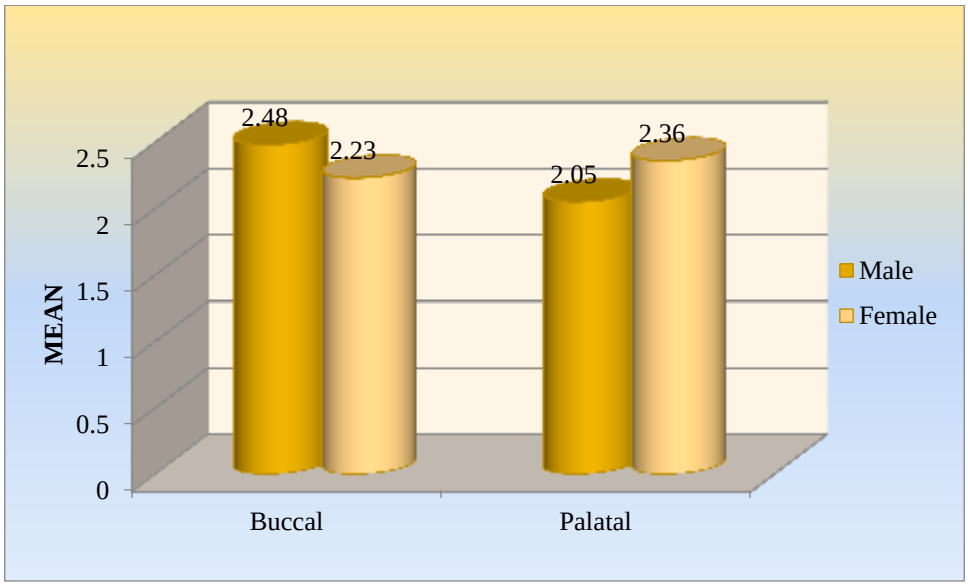
1.f. The mean distance and Standard deviation values in mm between maxillary first and second molar apices and MSF



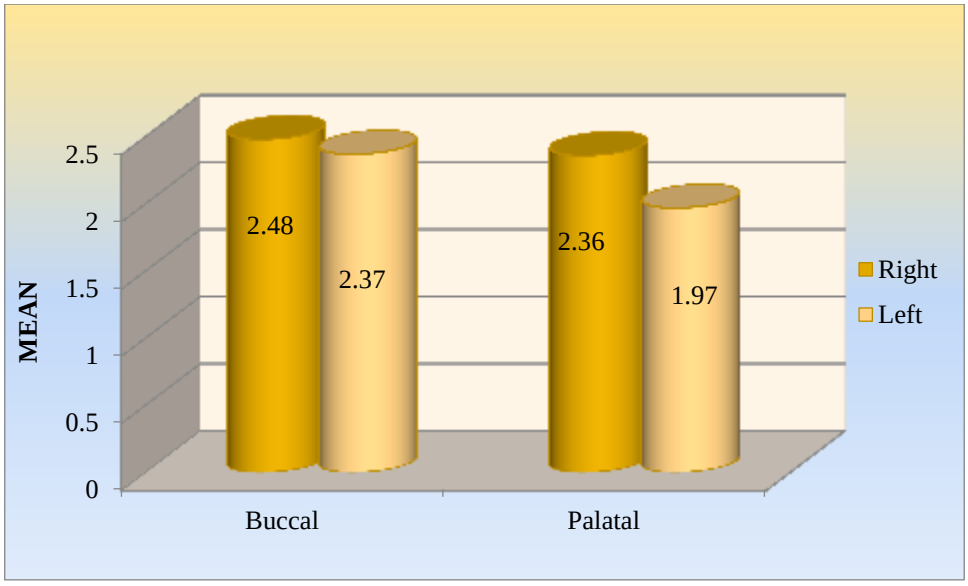
2.a. Average Distance between Root surface and appropriate cortical plates between Male and Female in premolars



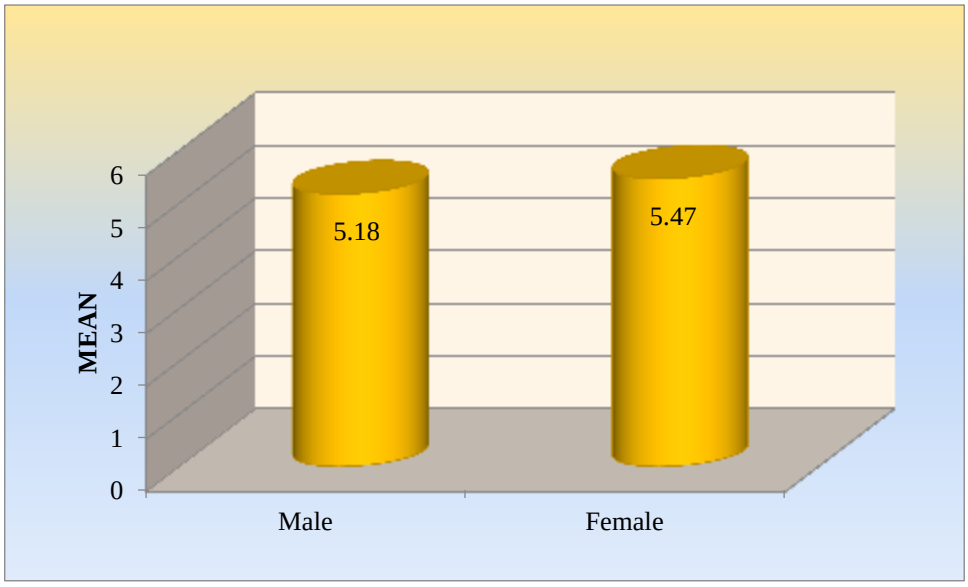
2.b. Average Distance between Root surface and appropriate cortical plates between right and left side in premolars



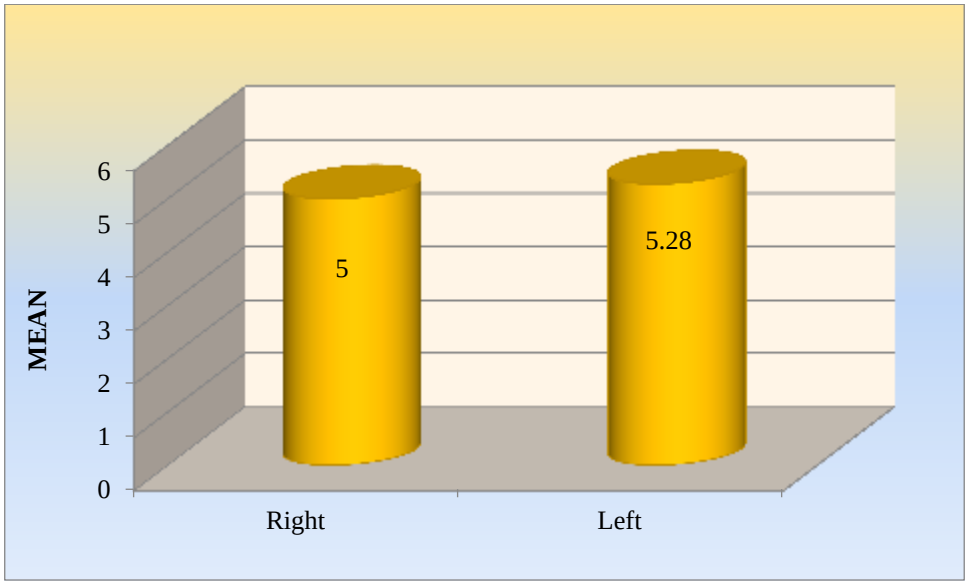
2.c. Average Distance between Root surface and appropriate cortical plates between Male and Female in molars



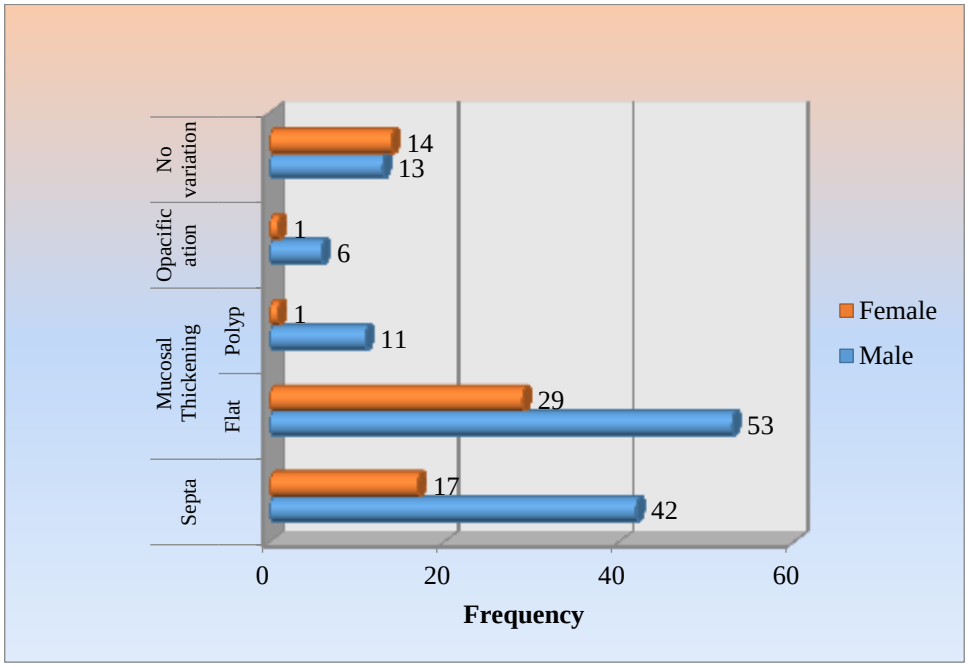
2.d. Average Distance between Root surface and appropriate cortical plates between right and left side in molars



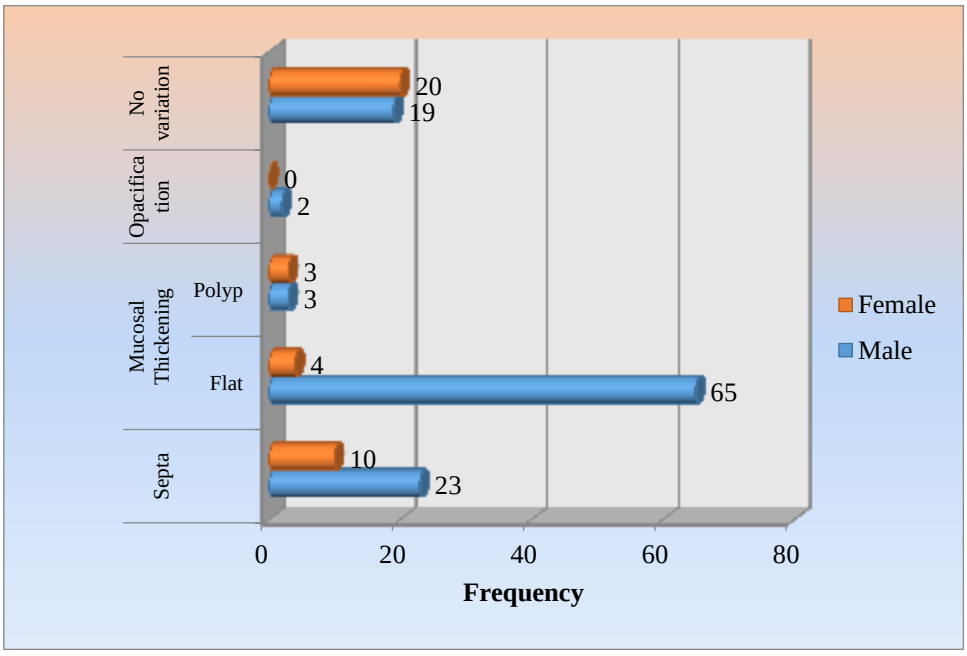
3.a. Average Thickness of bone between Floor of maxillary sinus and furcationin male and females



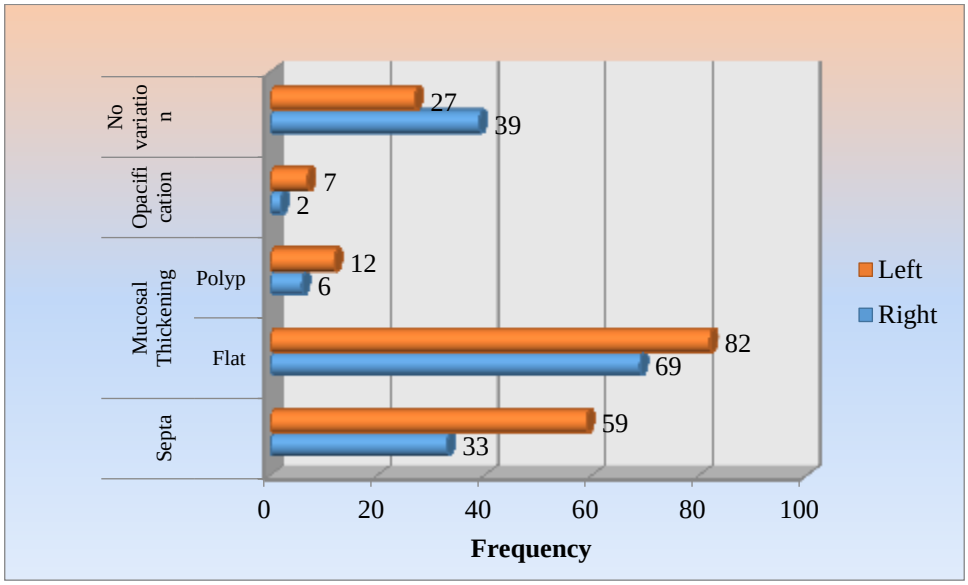
3.b Average Thickness of bone between Floor of maxillary sinus and furcation of right and left side



4a. Variation in Maxillary sinus between Male and Females in right side



4b. Variation in Maxillary sinus between Male and Females in left side



4c. Variation in Maxillary sinus between right and left side

ANNEXURE I

CASE PROFORMA

Name Age/sex:-

Relationship between roots of maxillary posterior teeth according to classification given by Didilescu et al.

Class 0: Distance (d) = 0 mm; Class 1: 0 mm < d < 2 mm, Class 2: 2 mm ≤ d < 4 mm, Class 3: 4 mm ≤ d , Class 4: 6 mm ≤ d.

Tooth	Roots		
	Buccal	Palatal	Single root
14			
15			
24			
25			

Tooth	Roots		
	Mesial	Distal	Palatal
16			
17			
26			
27			

Vertical relationship between roots of maxillary posterior teeth and floor of (MSF) will be assessed by criteria described by Kwak et al.

Tooth/Type	Type I	TypeII	TypeIII	TypeIV	TypeV
16					
17					
26					
27					

Horizontal relationship between roots of maxillary posterior teeth and floor of maxillary sinus will be studied using criteria proposed by Kwak et al.

Tooth/Type	Type 1H	Type 2H	Type 3H	Type 4H	Type 5H
16					
17					
26					
27					

Distance between roots to the appropriate cortical plate below bifurcation.

Tooth/ Distance Between Cortical plates	Buccal cortical plate	Palatal cortical plate
14		
15		
16		
17		
24		
25		
26		
27		

Thickness of bone between floor and furcation area will be measured in mm.

Tooth	Thickness of bone between floor and furcation
16	
17	
26	
27	

The morphologic variation and anypathologies in sinus

Sinus/Variations	Septa	Mucosal thickning	Opacification
Right			
Left			

KEY TO MASTER CHART

Sr. NO	ABBREVIATIONS	FULL FORM
1.	mm	Milimeters
2.	MB	Mesiobuccal
3.	DB	Distobuccal
4.	CP	Cortical plate
5.	Y	Yes

MASTER CHART

RELATIONSHIP BETWEEN ROOTS OF MAXILLARY POSTERIOR TEETH AND MSF ACCORDING TO CLASSIFICATION BY DIDILESCU(mm) (teeth 14, 15, 24, 25)

S.No.	AGE	SEX	14 BUCCAL CLASS	14 BUCCAL DISTANCE(mm)	14 PALATAL CLASS	14 PALATAL DISTANCE(mm)	14 SINGLE CLASS	14 SINGLE DISTANCE(mm)	15 BUCCAL CLASS	15 BUCCAL DISTANCE(mm)	15 PALATAL CLASS	15 PALATAL DISTANCE(mm)	15 SINGLE CLASS	15 SINGLE DISTANCE(mm)	24 BUCCAL CLASS	24 BUCCAL DISTANCE(mm)	24 PALATAL CLASS	24 PALATAL DISTANCE(mm)	24 SINGLE CLASS	24 SINGLE DISTANCE(mm)	25 BUCCAL CLASS	25 BUCCAL DISTANCE(mm)	25 PALATAL CLASS	25 PALATAL DISTANCE(mm)	25 SINGLE CLASS	25 SINGLE DISTANCE(mm)
1	32	F	4	19.4	4	19.4							3	4.5	4	16.5	4	16.5							1	1.7
2	28	F	4	14	4	14							2	2.5					4	9.3					1	0.7
3	27	F		4			3	5.6					2	3.2					3	5.5					1	1.8
4	29	F	4	4	4	9.9			2	2	2	2.8			4	7.9	4	6.5			1	1	1	1		
5	22	F	2	4									1	1.3					4	7.8					3	4.6
6	22	F	4	6.6	4	6.6							1	1.1	1	1.3	1	1.6							0	0
7	27	F					0	0					0	0					0	0					0	0
8	21	F	2	3.1	2	3.9							0	0					3	4.6	1	0.8	1	1.9		
9	32	F	0	0	0	0			0	0	0	0			0	0	0	0			0	0	0	0		
10	20	F					3	4.3					0	0					3	5.2					0	0
11	32	F	1	1.8	1	1.8							0	0	2	2.1	3	5.7							0	0
12	28	F					4	9.4					10	1.3					3	4.1					2	2.6
13	32	F					4	12.3					2	2.6					4	9.2					1	1
14	42	F					4	9.3					3	5.9					4	7.4					1	0.7
15	23	F	4	12.5	4	15.6							4	8	4	7.5	4	8.4							2	2.8
16	25	F					4	11.8					3	5					4	7.8					3	5.5
17	29	F					2	3.3					0	0					2	2.1					0	0
18	41	F					4	9.1					2	2.9					4	9.5					0	0
19	37	F	4	9.5	4	9.5							1	3	4	8	4	8							1	1.7
20	33	F					4	9.3					3	5.9					4	7.4					1	0.7
21	38	F					4	12.6					1	1.3					4	10					0	0
22	42	F					4	13.3					3	5.4					4	9.1					3	4.5
23	25	F					3	5.5					2	3.7					3	5.4					0	0
24	37	F					4	12.6					2	3.1	1				4	8.4					0	0
25	29	F					2	3.6					0	0					2	3.9					0	0
26	27	F	4	12.1	4	11.1							3	4.1					3	4.7					1	1.3
27	21	F	4	12.4	4	12.4							3	4.5	4	13.5	4	13.5							1	1.7
28	25	F	2	2.4	2	2.4							1	1					2	2.6					1	1.3
29	22	F			4		3	4					1	1.3					4	7.8					3	4.6
30	29	F	4	6.6	4	6.6							1	1.1	2	2.1	2	2.1							0	0
31	28	F	3	5.2	3	5.9							1	0.6					1	1					1	1.6
32	21	F					3	5.9					1	1					2	2.5					0	0
33	23	F					3	5.9					1	1					2	2.5					0	0
34	27	F	3	5	3	4.7							0	0					0	0					0	0
35	28	F					2	3.6					0	0					0	0					0	0
36	27	F					2	2.8					0	0					0	0					1	1.3
37	30	F	4	10.9	4	11.7							4	9.5					4	10.1	1	0.7	1	1.7		
38	30	F					4	12					1	1.2					3	5.5						
39	24	F					3	4					1	1.3					4	7.8					4	4.6
40	21	F					0	0					0	0					1	0.7					0	0
41	25	F					2	2.5					1	0.5					2	3					0	0
42	32	F					3	5.4					3	5.2					4	7.5					2	2.3
43	21	F	3	4.7	1	1.5							0	0					4	6.5	4	6.5			1	0.8
44	32	F					3	4.9					0	0					4	10.9					0	0
45	25	F					1	0.7					0	0					1	1.6					0	0
46	32	F					4	6.5					2	3					4	8.1					0	0
47	40	F					4	7.4	0	0	0	0			4	12.2	4	10.1							0	0
48	27	F	4	12.5	4	12.5							3	4.5	4	10.2	4	10.1			4	10.2	4	10.2		
49	37	F					4	12.5					2	3.4					4	7.1					1	1.4
50	22	F	1	1.5	1	1.5							0	0	3	5.7	3	5.5							0	0
51	27	F	4	13	4	13							4	6.5					4	13					4	7.3
52	35	F	0	0	0	0							0	0					3	4	3	4.4			0	0
53	21	F	3	5.2	3	5.9							0	0					0	0					0	0
54	27	M	0	0	1	1.7							0	0					0	0					0	0
55	25	M	1	1.8	1	1.8							0	0	1	1.7	1	1.7							0	0
56	27	M	4	12	4	12.3							0	0	3	4.5	3	4.5							0	0
57	30	M					3	4.1					1	0.8					0	0					0	0
58	33	M	0	0	1	0.7			0	0	0	0			1	1	1	1							0	0
59	40	M					4	7.4	0	0	0	0			4	12.4	4	10.1			0	0	0	0	0	0
60	37	M	4	12.5	4	12.2			0	0	0	0			4	7.3	4	7.3			3	4.6	3	4.6	0	0
61	23	M					1	2.1					0	0					1	1.5					1	0.7
62	25	M	3	5.4	4	6.4							1	1.9	4	12.2	4	13.3							2	2.2
63	37	M					3	5					1	0.7					3	4.9					0	0
64	22	M	1	1.5	1	1.5							0	0	3	5.7	3	5.5							0	0
65	27	M	4	13	4	13							4	6.5					4	13					4	7.3
66	35	M	0	0	0	0							0	0					3	4	3	4.4			0	0
67	21	M	3	5.2	3	5.9							0	0					0	0					0	0
68	28	M	4	13.6	4	15.8			1.3	1.3	1	1.3			4	9.2	4	9.2			0	0	0	0		
69	28	M	4	10.1	4	10.1			0	0	0	0			4	12.1	4	12.4			0	0	0	0		
70	27	M	4	15.3	4	16.3			1	1.4	1	1.4			4	9.8	4	9.8			0	0	0	0		
71	29	M	1	1	1	0.9							0	0	0	0	1	1.1							0	0
72	22	M	4	6.3	4	6.3							1	1.9	4	16.2	4	12.5							2	2.6
73	30	M					1	1					0	0					1	0.7					0	0
74	28	M	2	2.1	1	1.5			0	0	0	0			4	9.5	4	11							2	2.7
75	22	M					4	8.6					4	9.9					2	2.1					0	0
76	22	M	4	6.3	4	6.3							1	1.9	4	16.2	4	18.5							2	3.6

RELATIONSHIP BETWEEN ROOTS OF MAXILLARY POSTERIOR TEETH AND MSF ACCORDING TO CLASSIFICATION BY DIDILESCU(mm) (teeth 16, 17, 26, 27)

S.No.	16 MB CLASS	16 MB DISTANCE(mm)	16 DB CLASS	16 DB DISTANCE(mm)	16 PALATAL CLASS	16 PALATAL DISTANCE(mm)	17 MB CLASS	17 MB DISTANCE(mm)	17 DB CLASS	17 DB DISTANCE(mm)	17 PALATAL CLASS	17 PALATAL DISTANCE(mm)	26 MB CLASS	26 MB DISTANCE(mm)	26 DB CLASS	26 DB DISTANCE(mm)	26 PALATAL CLASS	26 PALATAL DISTANCE(mm)	27 MB CLASS	27 MB DISTANCE(mm)	27 DB CLASS	27 DB DISTANCE(mm)	27 PALATAL CLASS	27 PALATAL DISTANCE(mm)
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	1.1	1	0.8	0	0	0	0	0	0	0	0	1	0.8	1	1.2	1	1.2
4	1	1.8	1	1.6	1	1.6	0	0	1	1.8	1	1.8	0	0	1	1.2	1	1.2	1	0.8	0	0	0	0
5	1	1.6	1	1.6	2	2.9	0	0	1	1.6	1	0.9	1	1.5	1	1	0	0	1	1.1	0	0	2	2.5
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	2	2.3	1	0.9	0	0	0	0	1	0.7	0	0	0	0	3	4.6	0	0	1	0.9	2	2.2	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	1	0.7	0	0	0	0	1	0.6	2	2.2	2	4.1	1	1.3	2	2.4	0	0	1	1.2	0	0	1	1.3
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	2	2.7	1	1.1	1	1.1	0	0	1	0.9	0	0	1	1.2	1	1.3	2	3.1	1	1.8	1	1.2	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	1	1.8	1	0.6	0	0	0	0	0	0	0	0	1	0.8	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	3	4.5	2	2.6	2	2.1	2	3.2	2	2.2	2	2.2	1	1.8	1	0.8	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	1	0.7	0	0	2	2.4	2	3.7	1	1.9	0	0	0	0
22	1	0.9	1	1.1	0	0	0	0	0	0	0	0	1	1.4	0	0	0	0	0	0	0	0	0	0
23	1	0.5	0	0	0	0	1	1.8	0	0	0	0	0	0	0	0	0	0	0	0	1	0.9	1	0.9
24	1	1.3	1	0.5	0	0	0	0	2	3.8	2	3.8	1	0.9	1	1.2	0	0	0	0	0	0	1	1.3
25	0	0	2	2.5	2	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.9	0	0
26	0	0	1	1.1	0	0	1	0.7	0	0	0	0	1	1	1	1.1	0	0	0	0	0	1.8	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	1	1.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.5	0	0	0	0	1	1.1
29	1	1.6	1	1.6	2	2.9	0	0	1	1.6	1	0.9	1	1.5	0	0	2	2.3	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	2	2.6	0	0	0	0	0	0	0	0	0	0	2	2.5	1	1.6	0	0	1	1.4	2	2.9	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.1
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1.1
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	2	2.5	2	2.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.9	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	3	5	0	0	0	0	0	0	0	0	0	0	2	2	1	0.6	2	2.2	0	0	2	3.2	3	4.6
38	0	0	0	0	0	0	0	0	1	0.5	0	0	1	0.9	0	0	2	2.6	2	3.3	0	0	0	0
39	1	1.6	1	1.6	2	2.9	0	0	1	1.6	1	0.9	1	1.5	1	1	0	0	3	5.3	0	0	2	2.3
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	1	1.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	1	1.2	1	0.3	0	0	0	0	1	1.2	1	0.6	1	1	1	1.2	1	0.6	0	0	0	0	1	1.1
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.3	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2.4	0	0	1	1	1	1.3	0	0
46	0	0	0	0	0	0	0	0	1	0.7	0	0	0	0	0	0	0	0	0	0	1	0.8	0	0
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
49	1	1.1	1	0.6	0	0	2	2.2	2	2.1	2	3.7	2	2	1	1.9	1	1.9	1	1.2	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	1	1.1	2	2.1	0	0	0	0	1	1.3	2	2.5	2	2.5	2	3.1	3	4.6	3	4.6	2	2.6	1	1.2
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	1	1.3	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	1	0.6	1	0.6	0	0	0	0	0	0	0	0	1	1.9	0	0
62	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
65	1	1.1	2	2.1	0	0	0	0	1	1.3	2	2.5	2	2.5	2	3.1	3	4.6	3	4.6	2	2.6	1	1.2
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
68	2	2.2	2	2.5	0	0	2	2.1	1	1.8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	2	3.7	1	0.8	0	0	2	3.7	1	0.8	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.6	1	1
74	0	0	0	0	0	0	0	0	0	0	0	0	2	2.7	1	1.7	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0.3	0	0	0	0	0	0	1	1.6
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

VERTICAL RELATION (KWAK) and **HORIZONTAL RELATION (KWAK)**

S.No.	VERTICAL 16	VERTICAL 17	VERTICAL 26	VERTICAL 27	HORIZONTAL 16	HORIZONTAL 17	HORIZONTAL 26	HORIZONTAL 27
1	TYPE II	TYPE II	TYPE II	TYPE II	TYPE IIH	TYPE IIH	TYPE IIH	TYPE IIH
2	TYPE II	TYPE II	TYPE II	TYPE II	TYPE IIH	TYPE IIH	TYPE IIH	TYPE IIH
3	TYPE II	TYPE II	TYPE II	TYPEI	TYPE IIH	TYPE IIH	TYPE IIH	TYPEIVH
4	TYPE II	TYPE II	TYPE II	TYPE II	TYPEIVH	TYPEIVH	TYPEIVH	TYPEIVH
5	TYPE II	TYPE II	TYPE II	TYPE II	TYPEIVH	TYPEIVH	TYPEIVH	TYPEIVH
6	TYPE II	TYPEIII	TYPE II	TYPEIII	TYPE IIH	TYPEIH	TYPEIH	TYPEIH
7	TYPEIII	TYPEIII	TYPEII	TYPEIII	TYPE IIH	TYPEIH	TYPE IIH	TYPEIH
8	TYPEI	TYPEI	TYPEI	TYPEI	TYPEIVH	TYPEIVH	TYPEIVH	TYPEIVH
9	TYPEIII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIH	TYPEIIH	TYPEIIH
10	TYPEI	TYPEIII	TYPE II	TYPE I	TYPEIIH	TYPEIH	TYPEIIH	TYPEIH
11	TYPEI	TYPEII	TYPE I	TYPE I	TYPEIVH	TYPEIIH	TYPEIVH	TYPEIVH
12	TYPEIII	TYPE II	TYPE II	TYPEIII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
13	TYPEI	TYPEI	TYPEI	TYPEI	TYPEIVH	TYPEIVH	TYPEIVH	TYPEIVH
14	TYPEI	TYPEI	TYPEI	TYPEI	TYPEIVH	TYPEIVH	TYPEIVH	TYPEIVH
15	TYPE II	TYPE V	TYPEI	TYPE V	TYPE IVH	TYPEVH	TYPEIVH	TYPEVH
16	TYPEI	TYPEI	TYPEI	TYPEI	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
17	TYPEIII	TYPEIII	TYPEIII	TYPEII	TYPEIH	TYPEIIH	TYPEIH	TYPE IVH
18	TYPEII	TYPEIII	TYPE V	TYPEI	TYPEIIH	TYPEIIH	TYPEVH	TYPE IVH
19	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
20	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
21	TYPE I	TYPE I	TYPE I	TYPEIV	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
22	TYPEII	TYPE V	TYPE II	TYPEII	TYPEIIH	TYPE VH	TYPEIIH	TYPEIIH
23	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
24	TYPEII	TYPE I	TYPE I	TYPE I	TYPEIIH	TYPE IVH	TYPE IVH	TYPE IVH
25	TYPE I	TYPE I	TYPEII	TYPE I	TYPE IVH	TYPE IVH	TYPEIIH	TYPE IVH
26	TYPE I	TYPE I	TYPEIV	TYPE I	TYPE IVH	TYPE IVH	TYPE IIIH	TYPE IVH
27	TYPEII	TYPEII	TYPEIII	TYPEII	TYPEIIH	TYPEIH	TYPEIIH	TYPEIIH
28	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
29	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
30	TYPE I	TYPE I	TYPE I	TYPEIII	TYPE IVH	TYPE IVH	TYPE IVH	TYPEIH
31	TYPE I	TYPEIII	TYPE I	TYPE I	TYPE IVH	TYPEIH	TYPE IVH	TYPE IVH
32	TYPEII	TYPE I	TYPE I	TYPE I	TYPEIIH	TYPE IVH	TYPE IVH	TYPE IVH
33	TYPEII	TYPE I	TYPE I	TYPE I	TYPEIIH	TYPE IVH	TYPE IVH	TYPE IVH
34	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
35	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
36	TYPEII	TYPEII	TYPEIII	TYPE I	TYPEIIH	TYPEIIH	TYPEIH	TYPE IVH
37	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
38	TYPEIV	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
39	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
40	TYPEII	TYPE I	TYPEIII	TYPEII	TYPEIIH	TYPE IVH	TYPEIIH	TYPEIIH
41	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
42	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
43	TYPE I	TYPEII	TYPE I	TYPEII	TYPE IVH	TYPEIIH	TYPE IVH	TYPE IVH
44	TYPEIII	TYPEIII	TYPEIII	TYPEII	TYPEIH	TYPEIH	TYPEIH	TYPEIIH
45	TYPEII	TYPEIII	TYPEII	TYPEII	TYPEIIH	TYPEIH	TYPEIIH	TYPEIIH
46	TYPE I	TYPE I	TYPEIV	TYPE I	TYPE IVH	TYPE IVH	TYPE IIIH	TYPE IVH
47	TYPEII	TYPEII	TYPEII	TYPE I	TYPEIH	TYPEIH	TYPEIIH	TYPE IVH
48	TYPEII	TYPE I	TYPEII	TYPEII	TYPEIH	TYPE IVH	TYPEIH	TYPEIH
49	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
50	TYPEIV	TYPEII	TYPEII	TYPEII	TYPE IIIH	TYPEIIH	TYPEIIH	TYPEIIH
51	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
52	TYPE V	TYPEIII	TYPEII	TYPEII	TYPE VH	TYPEIH	TYPEIIH	TYPEIIH
53	TYPEIII	TYPEII	TYPEII	TYPEII	TYPEIH	TYPEIIH	TYPEIIH	TYPEIIH
54	TYPE II	TYPE II	TYPE II	TYPE II	TYPE IIH	TYPE IIH	TYPE IIH	TYPE IIH
55	TYPE II	TYPE II	TYPEI	TYPEIII	TYPE IIH	TYPE IIH	TYPEIVH	TYPEIH
56	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
57	TYPE II	TYPEIII	TYPEII	TYPE I	TYPEIIH	TYPEIH	TYPEIIH	TYPE IVH
58	TYPE II	TYPE I	TYPEII	TYPEIII	TYPEIIH	TYPE IVH	TYPE IVH	TYPEIH
59	TYPEIII	TYPEIII	TYPEII	TYPE I	TYPEIH	TYPEIH	TYPEIIH	TYPE IVH
60	TYPE I	TYPE I	TYPEII	TYPEII	TYPE IVH	TYPE IVH	TYPEIIH	TYPEIIH
61	TYPEIII	TYPE I	TYPEIII	TYPE I	TYPEIIH	TYPE IVH	TYPEIIH	TYPE IVH
62	TYPEII	TYPEII	TYPEII	TYPEII	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
63	TYPEIV	TYPEIV	TYPEII	TYPE I	TYPE IIIH	TYPE IIIH	TYPEIIH	TYPE IVH
64	TYPEIV	TYPEII	TYPEII	TYPEII	TYPE IIIH	TYPEIIH	TYPEIIH	TYPEIIH
65	TYPE I	TYPE I	TYPE I	TYPE I	TYPE IVH	TYPE IVH	TYPE IVH	TYPE IVH
66	TYPE V	TYPEIII	TYPEII	TYPEII	TYPE VH	TYPEIH	TYPEIIH	TYPEIIH
67	TYPEIII	TYPEII	TYPEII	TYPEII	TYPEIH	TYPEIIH	TYPEIIH	TYPEIIH
68	TYPE I	TYPEII	TYPEII	TYPEII	TYPE IVH	TYPEIIH	TYPEIIH	TYPEIIH
69	TYPEII	TYPEII	TYPEII	TYPEIII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIH
70	TYPEII	TYPE I	TYPEII	TYPEII	TYPEIIH	TYPE IVH	TYPEIIH	TYPEIIH
71	TYPEII	TYPEIII	TYPEIII	TYPEIII	TYPEIIH	TYPEIH	TYPEIH	TYPEIH
72	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH
73	TYPEII	TYPE I	TYPE I	TYPE I	TYPEIIH	TYPE IVH	TYPE IVH	TYPE IVH
74	TYPE V	TYPEIII	TYPE I	TYPE I	TYPE VH	TYPEIH	TYPE IVH	TYPE IVH
75	TYPEII	TYPE I	TYPEII	TYPEII	TYPEIIH	TYPEIH	TYPEIH	TYPEIH
76	TYPEII	TYPEII	TYPEII	TYPEII	TYPEIIH	TYPEIIH	TYPEIIH	TYPEIIH

DISTANCE BETWEEN ROOT SURFACE AND APPROPRIATE CORTICAL PLATES; **THICKNESS OF BONE BETWEEN FLOOR OF MAXILLARY SINUS AND FURCATION AREA**; **VARIATIONS IN MAXILLARY SINUS**

S.No.	14 BUCCAL CP	14 PALATAL CP	15 BUCCAL CP	15 PALATAL CP	16 BUCCAL CP	16 PALATAL CP	17 BUCCAL CP	17 PALATAL CP	24 BUCCAL CP	24 PALATAL CP	25 BUCCAL CP	25 PALATAL CP	26 BUCCAL CP	26 PALATAL CP	27 BUCCAL CP	27 PALATAL CP	THICKNESS 16	THICKNESS 17	THICKNESS 26	THICKNESS 27	RIGHT SEPTA	RIGHT MUCOSAL THICKENING	RIGHT OPACIFICATION	LEFT SEPTA	LEFT MUCOSAL THICKENING	LEFT OPACIFICATION
1	1	1.1	1.8	2.8	1	1.8	2.2	1	1.3	1.4	1.3	2.9	1.1	1	1.8	1.6	2.3	4.9	4.3	5.3		Y		Y	Y	
2	1.4	1.3	1.5	1.2	3	2.5	1.7	1	4	1.6	2.1	1.3	2.4	1.9	1.6	1	3	4	2.3	4.3		Y			Y	
3	1	1.6	1	2	2.3	2.9	2.6	1.6	1.9	3.3	1.4	2.9	1.8	3.7	2.4	3.5	6.3	9.6	6.8	7.3		Y		Y		
4	0.6	0.9	2.6	1.4	3.1	1.4	2.6	1.4	0.5	1.2	1.9	1.2	2.2	2.1	2.6	2.2	5.2	9.6	9.1	9.2	Y	Y		Y		
5	2.2	2.1	1.2	2.1	2.1	2.4	1.4	2	1.7	1.5	1.4	1.6	2.1	1	2.3	1.3	8.9	7.1	8.8	5.2		Y			Y	
6	2	2.2	4.4	2.9	8.4	1.6	3.1	3	1.3	1.6	3.9	2	3.3	2.6	1.9	4.6	3.2	2.9	1.9	3.7		Y			Y	
7	1	2.1	2.5	2.1	3.6	2.8	3.6	2.6	1.4	1.6	1.1	1	2.5	1.6	2.4	3.8	1.7	8.6	1	6.7		Y		Y	Y	
8	1	1.3	1.5	1.4	1.6	2.4	3.7	1.3	1.7	1.4	2	1.8	3.9	2.2	4	2.3	6.5	3.8	6.5	9	y	y		y	y	
9	1.5	1.6	1.8	1.1	1.6	1.5	1.7	2	0.6	2.5	1.7	1.5	1.7	2.1	2.1	2.3	0.9	3.1	1.5	6.1	Y	Y		Y	Y	
10	1.7	2.5	1.5	1.8	1.8	1.8	2.2	1.9	0.7	2.3	1	2.2	1.8	1.5	2.3	2.3	7.9	7.4	5.5	7.8		Y			Y	
11	1.8	1.3	1.8	1.7	2.4	1.8	3.9	2.8	1.5	1.6	1.3	2.8	2.9	1.5	1.5	2.5	6.7	7.2	7.3	5.9		Y		Y	Y	
12	1.3	2.8	0.7	1.4	3.1	1.9	3.2	2.2	0.8	3.1	1.1	2.5	2.5	2.2	3.7	1.4	3.1	4	4	5.8	Y	Y		Y	Y	
13	0.6	1.6	0.8	1.7	0	1	1.2	2.3	0	2.2	1.4	2.6	0.6	0.6	0.2	1.2	8.3	12.5	9.3	7.8						
14	0.5	1.8	0.5	2.2	1.4	1.3	1	1.8	0.6	2	1.1	1.3	2.9	1.2	1.8	1.2	7.5	5.2	4.2	3.2						
15	0.6	1.4	0.4	1.6	1.7	0.6	2.5	1.5	0.3	2	0.6	1.3	1.3	1.1	2	1.4	6.2	7.2	2.7	6.4		Y			Y	
16	1.1	2.4	1.1	3.1	1.9	2.8	2.4	2.4	1	3	1.6	3.1	1.9	2.7	2.2	1.8	7.7	8.2	7.8	11.4		Y			Y	
17	1.7	1.1	3.6	5.2	3.3	2.9	2.6	1.4	1.4	1.4	2.8	2.1	2.5	2	2.8	1.4	4.5	6.8	3.1	5.1				Y		
18	1.2	1.7	1	1.4	1.4	1.4	2.2	2.2	1.2	1.6	0.6	1.6	1.8	2.4	1.5	2.2	7.3	7.5	6.7	8.2						
19	1.4	1.9	1.4	2.2	0.7	0.8	2.5	2	1.4	1.6	2	2.9	0.9	1	2.2	1.7	3.6	4.7	5.5	4.7				Y		
20	0.5	1.8	0.5	2.2	1.4	103	1	1.8	0.6	2	1.1	1.3	2.9	1.2	1.8	1.7	7.5	5.5	4.2	3.3						
21	2.3	1.8	3.3	1.5	3	1.7	2.5	1.6	1.1	2.2	3.4	2.2	2.1	2.4	1.8	2	5.6	7	9.2	6.3						
22	0.3	1.5	1.2	2.3	1.6	1.8	1.2	2.7	0.6	3.1	1.5	2.1	1.5	1.7	1.6	3.9	6.3	8.9	5.9	8.7						
23	1	2.5	0.9	3	2.1	3.3	2.1	1.5	0.7	2.5	2.6	3.6	1.8	3.2	2.1	3.9	6.7	9.6	6.1	7.5						
24	0.9	2	1.3	2	0.9	1.3	1.5	2	0.4	3.2	0.4	2.4	1.1	1.3	1.1	0.8	8.7	10.7	9.1	8		Y			Y	
25	1.2	3.7	3.6	2.9	2	1.3	4.1	2	2.5	1.9	2.7	2.1	2.1	1.3	3.3	1.9	8.3	4.9	6.2	6.5		Y			Y	
26	3.1	1.7	2.9	1.6	2.8	2.2	3.5	1.9	2.6	2	2.4	1.7	3.7	1.8	4.3	2.5	5.3	8	5.5	6.4		Y		Y	Y	
27	1	1.1	1.8	2.8	1	1.8	2.2	1.8	1.3	1.4	1.3	2.9	1.1	1	2.2	1	2.3	4.9	4.3	5.3	Y	Y			Y	
28	1.4	0.7	2.5	1.7	1	1	1	2.3	1.8	1.1	1.9	1.7	1.4	1.8	1.4	1.3	6.2	6.8	3.3	6	Y			Y		
29	0.7	0.7	1.3	1.2	2.1	2.4	1.4	1.2	1.1	1.6	2.1	1	2.3	1.3	2.3	1.2	8.9	0.9	8.8	10.2		Y			Y	
30	2	2.2	4.4	2.9	3.4	1.6	3.1	1.6	3.1	3	1.3	1.6	3.9	2	3.3	2.6	3.2	2.9	1.9	3.7						
31	1.5	4.1	3.7	4.2	1.4	1.7	4.8	1.5	1.5	1.7	1.7	1.5	3.5	2.6	4.1	2.5	6.3	3.4	1.2	1.3	Y			Y		
32	0.6	0.8	0.5	1.2	1.8	1	2.4	1.3	0.8	1	0.6	1.2	0.6	1.2	1.2	0.8	3.3	5.8	5.2	6					Y	
33	1.1	1.2	0.5	0.2	1.8	1	2.4	1.3	1.1	0.3	0.7	0.5	0.5	0.7	0.3	0.2	3.3	5.8	5.2	6					Y	
34	2	3	4.6	3	2.8	2.2	3.5	3.3	2.9	3	2.7	2.5	2.7	2.1	2.3	2.1	4.5	7.2	4.7	7						
35	1.2	3.7	3.6	2.9	2	1.3	4.1	2	2.5	1.9	2.7	2.1	2.1	1.3	3.3	1.9	8.3	4.9	6.2	6.5		Y			Y	
36	1.7	1.8	3.5	6.1	3.2	2.8	1.9	1.8	2.6	2.5	2.6	2.5	3.5	1.3	2.6	1.6	3.6	6	2.4	8.1					Y	
37	0.6	1.6	1.2	2.7	0.6	1.3	1.6	1	0.3	1	0.7	1.8	1	1.7	1.7	1.3	1.3	8.2	2.5	1.2		Y			Y	
38	2.2	1.6	3	1.1	2.4	1.5	2.4	1.6	1.4	2.7	3.2	1.7	2.4	1.4	1.8	1.8	5.8	7.3	9.6	7						
39	0.7	1.2	1.1	1.6	2.1	1	1.4	2	0.7	1.2	1.1	1.6	2.1	1	2.3	1.3	8.9	7.1	8.8	8.2		Y			Y	
40	1	1.5	0.4	1.2	2.6	1.8	2.2	2.9	0.9	1.8	1.3	1.5	2.4	2.2	2	2.2	1.6	7.3	2.1	3	Y			Y	Y	
41	1.4	1.7	1.3	1.8	2.5	1.4	3.8	1.8	1.1	2.7	1	2.7	3.7	2.4	3.6	3.1	0.4	4.7	1.5	2.4		Y				
42	0.8	1.6	0.7	1.4	0.5	1	2.8	1.8	1.3	2.1	1.6	1.6	1.1	1.1	2.3	1.7	8.7	8	6.1	6.4						
43	1	1.4	1.6	2.1	2.5	2.4	3.5	3.4	0.2	1.5	2.9	0.4	2.9	2.4	3.5	1.9	5.3	6	4.3	4.7						
44	1.6	2	1.1	1.7	1.5	2.1	1.9	2.6	1	2.7	1.9	1.6	1.3	1.3	1.5	1.8	0.9	2.5	1.3	3.6					Y	
45	1.2	1.6	1.1	2.5	4.7	2.4	4	1.9	0.5	1.9	1.5	1.6	3.3	2	2	1.3	4.3	6	4.4	6		Y			Y	
46	1.1	1.9	0.8	1.3	1.5	1.3	2.6	2.4	1.3	1.7	1.2	1.8	1.8	0.1	1.7	2.3	7.2	8	5.3	7.6						
47	1.4	2.1	2.3	1.5	2.5	3.6	2.5	3	1.3	2.2	1.7	2	2.7	3.2	3.5	2.1	1.8	3.3	2.1	6	Y			Y		
48	1	1.1	1.8	2.8	1	1.8	2.2	1	1.3	1.4	1.3	2.9	1.1	1	1.8	1.6	2.3	4.9	4.3	5.3	Y			Y		
49	0.8	1.4	1.1	1.4	0.8	1.3	1.5	1.6	0.7	1.9	1.1	2.2	0.4	0.5	1.1	1.3	8.7	8.5	9.5	7.8		Y(POLYP)			Y	
50	1.9	2.1	3.3	2.6	3.9	2.4	3.9	2.9	2.2	2.3	2.9	2.8	3.9	2.4	3.7	1.9	1.1	1.9	4.1	3.7		Y(POLYP)		Y	(POLYP)	
51	1.9	1.9	2.1	1.8	2.4	1.7	2.9	3.7	1.4	2.9	2.3	2.5	2	2.7	2.3	3.7	1.8	6.9	5.6	7.3		Y(FLAT)			Y(FLAT)	
52	0.4	1.7	1.8	2.1	1.9	1.9	3.4	1.2	2	1.2	1.5	2.1	1.6	2.4	2.7	2.4	2.5	1.7	3.3	2.4		Y(FLAT)			Y(FLAT)	
53	1.7	0.9	2.9	1.3	2.8	1.8	2.8	2.9	1.8	2.1	2.2	2.4	2	1.7	2.1	2.5	3.5	3.4	2.4	2.5						Y
54	2.5	0.8	2.5	1.6	1.8	1.1	2.2	1.3	2.2	2.3	3.3	1.6	2.9	1	1.5	0.8	1	1.3	4.5	4.5		Y(FLAT)		Y	(POLYP)	
55	0.9	1.9	1.3	1.3	1.6	1.1	2	2.1	1.3	1.6	1.4	1	1.5	1.1	2.5	1.8	4.4	5.7	5.6	7.2		Y(FLAT)		Y	Y(FLAT)	
56	2.4	2.3	4.8	2	5.3	2.4	8.9	2.9	4.9	3.1	7.9	1.4	9.4	1.4	3.5	3.3	3.8	4.1	3.1	4.1		Y(FLAT)			Y(FLAT)	
57	1.3	1.4	1.4	1.9	1.5	2.1	1.5	2.1	1.2	1	1.1	1	1.4	1.7	1.6	2	5.3	3.5	4	8.1		Y(POLYP)			Y(POLYP)	
58	1.1	1.2	1.8	1.1	1.8	1.9	1.4	1.9	1.7	1.4	1.9	1.4	4.3	1	2.9	1.9	6.3	6	6	6	Y					
59	1.4	2.1	2.3	1.5	2.5	3.6	2.5	3	1.3	2.2	1.7	2	2.7	3.2	3.5	2.1	1.8	3.3	2.1	6	Y			Y		
60	1.5	1.7	1.8	2.5	2.8	3	2	3	1.4	2.1	2	2.3	2.1	2.5	1.5	1.1	4.9	9.4	3.8	6		Y(FLAT)			Y(FLAT)	
61	1.5	2.5	2.6	2.2	2.2	2	3	2.6	1.9	2.6	2.7	2.6	3.3	1.8	2.9	1.7	4.6	9.3	6.6	8.1		Y(FLAT)			Y(FLAT)	
62	1.2	1.6	1.1	2.5	4.7	2.4	4	1.9	0.5	1.9	1.5	1.6	3.3	2	2	1.3	4.3	4.4	4.4	6						
63	0.9	2.6	1.4	2.6	2.3	1.1	2.3	1.2	0.5	2.2	1.2	2.3	1.6	2	1.4	3.3	8.6	7.5	7.5	8.2		Y(FLAT)		Y	Y(FLAT)	
64	1.9	2.1	3.3	2.6	3.9	2.4	3.9	2.9	2.2	2.3	2.9	2.8	3.9	2.4	3.7	1.9	1.1	1.9	4.1	3.7		Y(POLYP)		Y	(POLYP)	
65	1.9	1.9	2.1	1.8	2.4	1.7	2.9	3.7	1.4	2.9	2.3	2.5	2	2.7	2.3	3.7	1.8	6.9	5.6	7.3		Y(FLAT)			Y(FLAT)	
66	0.4	1.7	1.8	2.1	1.9	1.9	3.4	1.2	2	1.2	1.5	2.1	1.6	2.4	2.7	2.4	2.5	1.7	3.3	2.4		Y(FLAT)			Y(FLAT)	
67	1.7	0.9	2.9	1.3	2.8	1.8	2.8	2.9	1.8	2.1	2.2	2.4	2	1.7	2.1	2.5	3.5	3.4	2.4	2.5						Y
68	1.2	1.3	1.6	1.3	2.9	3.4	2.5	1.7	1.5	1.8	2.1	1.6	2.1	1.5	3	2.4	8.6	3.5	3.7	5		Y(FLAT)			Y(FLAT)	
69	1.4	1.7	2.6	1.9	3.3	3	4.3	4.9	1.4	1.7	2	109	2.3	1.7	3.4	4	5.7	6.9	5.3	7	Y	Y(FLAT)			Y(FLAT)	
70	1.3	0.8	1.2	1.3	2.9	2.4	2.9	2.4	1.5	1.7	2.1	1.6	2.9	1.9	3.1	2.4	3.4	3.5	3.5	4.9		Y(FLAT)			Y(FLAT)	
71	1.6	2.2	2.9	2.5	3	2.8	4.5	2.2	1.9	3	2.4	3	2.1	6.3	2.5	5.5	2.7	5.4	5.1	5.1					Y(FLAT)	
72	0.9	1.3	1.3	2.2	1.9	2.7	3.2	2.9	0.8	2	1.5	1.6	2.3	2.5	1.9	1.9	4.2	4.4	4.3	5.5						
73	0.6	2.1	0.8	1.6	2.1	1.4	1.7	1.6	1.7	1.6	0.4	2.5	0.7	1.9	1.2	1.8	2	2	6.1	9.2		Y(FLAT)			Y(FLAT)	
74	0.6	1.2	1.3	1.6	2.1	1.6	2.1	2.1	0.4	0.7	1.5	2	1.3	1.4	2.5	0.9	6.2	6.4	9.2	6.2		Y(POLYP)			Y(FLAT)	
75	2.7	3.5	3.6	2.5	3.3	2	3.3	1.4	1.8	3	2.6	1.9	2.1	2.3	2.4	2.3	7.2	5	7.2	5.2		Y(FLAT)			Y(FLAT)	
76	0.9	1.3	1.3	2.2	1.9	2.7	3.2	2.9	0.8	2	1.5	1.6	2.3	2.5	1.9	1.9	4.2	4.4	4.3	5.5						