EVALUATION OF ANATOMICAL VARIATIONS OF POSTERIOR SUPERIOR ALVEOLAR ARTERY AND MAXILLARY SINUS USING COMPUTED TOMOGRAPHY.

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LIST OF ABBREVIATIONS

S NO	ABBREVIATIONS	FULL FORM
1.	CT	Computed tomography
2.	CBCT	Cone beam computed tomography
3	MS	Maxillary sinus
4	PSAA	Posterior superior alveolar artery
5	IOA	Infraorbital artery
6	ASAA	Anterior superior alveolar artery
7	IO br	Intraosseous branch
8	EObr	Extraosseous branch
9	MSS	Maxillary sinus septa
10	PSAN	Posterior superior alveolar nerve
11	2D	Two dimensional
12	3D	Three dimensional
13	mm	millimeter
14	cm	centimeter
15	kV	Kilovolts
16	mA	milliamperes
17	P value	Probability value

INTRODUCTION

Now days the implants are the preferred way for replacement of missing teeth. Sufficient bone quantity and quality are essential for proper dental implant placement, especially in the posterior maxilla where resorption of alveolar bone is more[1]. Implant placement in the maxilla is challenging when the maxillary sinus is extended into the alveolar ridge. Sinus augmentation is the routine surgical procedure utilized to increase the vertical height of the posterior alveolar ridge for the successful placement of dental implants[2]. The sinus augmentation procedure was first published by Boyne & James and it involves the use of bone grafts. (1980)[1].

Thorough knowledge of the anatomy of the sinus blood supply is important before performing any sinus lift and bone grafting procedures in maxillary sinus[3].The blood supply of the maxillary sinus and overlying membrane (Schneiderian membrane) comes from the maxillary artery basically. The posterior superior alveolar

artery (PSAA) and infraorbital artery (IOA) are the branches of the maxillary artery that supply the lateral sinus wall and overlying membrane[4].

Bone grafts can be placed in maxillary sinus by 2 approaches: one is the lateral approach introduced in the 1970s by Tatum, and the other is the alveolar ridge approach introduced in the 1980s by Summers. If the amount of residual bone is insufficient, the survival rate of the alveolar ridge approach is low. Therefore, the lateral approach has been used widely for the maxillary sinus bone graft[5].During the sinus lift surgery if PSAA get traumatized accidentally; it causes mild to severe hemorrhage leading to perforation of the maxillary sinus membrane[6].

Variations or pathologies in the maxillary sinus can also pose difficulties during surgeries in this region. For eg.septa, sinusitis, cyst, polyps etc. In the presence of sinus septae certain modification of the surgical approach will be needed in order to prevent perforation of the Schneiderian membrane, the lining of the maxillary sinus[7]. Presence of maxillary sinus septa (MSS) increase the chances of perforation of Schneiderian membrane which leads to profuse bleeding during implant placement surgeries. MSS can obstruct proper visualization of the maxillary sinus and hamper the preparation of the bony window along the lateral wall of maxillary sinus during sinus floor augmentation[8].

Therefore it is necessary that before we perform any surgeries in the maxillary sinus not only should we be aware about the anatomical variations of the vascular supply of the region but also about any morphologic variations of the maxillary sinus.

Computerized tomography (CT) is a digital imaging technique that allows proper visualization of hard and soft tissues for examining the anatomy of the paranasal sinus. CT provides three dimensional information about the sinuses and also provides detailed information that is not available from standard radiographs[9]. Arteries and other anatomical structures can be examined in CT images[10]. They provide an accurate assessment of the craniofacial bones, extent of pneumatization of the sinuses, bone dimension, recognize specific anatomical landmarks and detect pathologies in maxillary sinus[11].

As the maxillary sinus occupies a strategic position it is connected directly to nasal cavity and related indirectly to the oral cavity and maxillary alveolus. It is therefore imperative that the oral and maxillofacial radiologist should be well versed with the normal anatomy and pathologies in maxillary sinus.

Hence, this study was conducted to evaluate anatomical variations in the vascular morphology of the posterior superior alveolar artery and maxillary sinus using Computed Tomography scans.

AIM AND OBJECTIVE

AIM

Evaluation of anatomical variations of posterior superior alveolar artery and maxillary sinus using CT images.

OBJECTIVES

1. To evaluate the location of the PSAA on lateral wall of maxillary sinus.
2. To evaluate the relationship of PSAA with medial wall and floor of maxillary sinus.
3. To correlate the location and diameter of PSAA according to age and gender.
4. To evaluate and compare the anatomical variations and pathologies in maxillary sinus bilaterally.

REVIEW OF LITERATURE

Understanding the anatomical area of posterior superior alveolar artery (PSAA) is important to avoid damage to the neurovascular bundle and to avoid mechanical damages. This artery can be damaged during surgical procedures that includes osteotomy of the lateral wall of the maxillary sinus, during the treatment of Le fort I fractures, maxillary sinus augmentation, removal of pathologic lesions and infections in the maxillary sinus, orthognathic surgery, and dental implant placement. An incorrect injection technique of nerve block PSAN can lead to hematoma development secondary to vascular invasion of the needle. During surgery for maxillary sinus augmentation, the artery can cause vascular trauma or may interfere with graft angiogenesis that may produce heavy bleeding during surgical procedures. As the nerve fibers lie in the proximity (PSAN and PSAA), there is a high risk of ischemia, pain and inflammation during surgical treatments in the area. So it is necessary to identify the PSAA and PSAN to avoid these accidents[12].

The most common cause of tooth loss in the maxillary posterior area is due to periodontal disease or dental caries. For the implant placement in the maxillary posterior area, the relationship between the residual alveolar bone and maxillary sinus should be consideredwhen the maxillary sinus is pneumatized, extending upto the alveolar process[5]. In such cases sinus augmentation surgeries is the treatment of choice for the tooth replacement in the posterior maxillary region by dental implants. If the amount of bone between the ridge crest and the maxillay sinus floor is inadequate, (<5mm), then sinus lift surgery is indicated. This surgery is a form of preprosthetic surgery for increasing the quality and quantity of bone[13].

Two approaches can be used to place bone grafts in maxillary sinus, one is by the lateral approach and the other is by alveolar ridge approach. If the amount of residual bone is insufficient, the survival rate of the alveolar ridge approach is low. Therefore, the lateral approach has been used widely for the maxillary sinus bone graft[5].

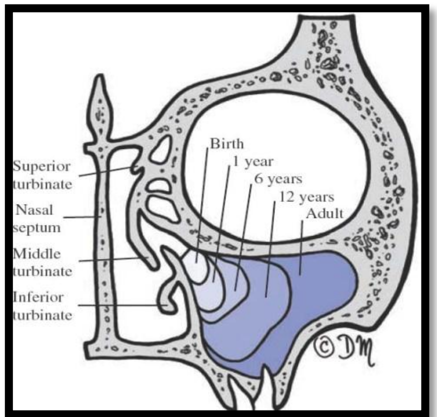
Hence, knowledge of the anatomy of maxillary sinus and PSAA is essential as severe hemorrhage due to such injuries can make it complicated.

MAXILLARY SINUS

Maxillary sinus is the largest of all the paranasal sinuses of the body which are two air filled spaces located in the body of maxilla and can have various shapes and sizes. The sinus can be described as a four sided pyramid, the base is facing medially towards the nasal cavity and the apex is pointed laterally towards the body of zygomatic bone[14].

During fetal development, the paranasal sinuses originateas invagination of the nasal mucosa into the lateralnasal wall, frontal, ethmoid, maxilla and the sphenoidbones. This unique development explains the enormousamount of anatomical variation found in this anatomical structure. The maxillary sinusis the first to develop, at 10 weeks in utero. After birth, the sinus continues to pneumatize into thedeveloping alveolar ridge as the permanent teeth fully erupt.At 12‑13 years, the sinus floor is level with the nasal floorand at the age 20, with the completion of the eruption ofthe third molars, the pneumatization of the sinus endsand the sinus floor reaches 5 mm inferior to the nasal floor [15].

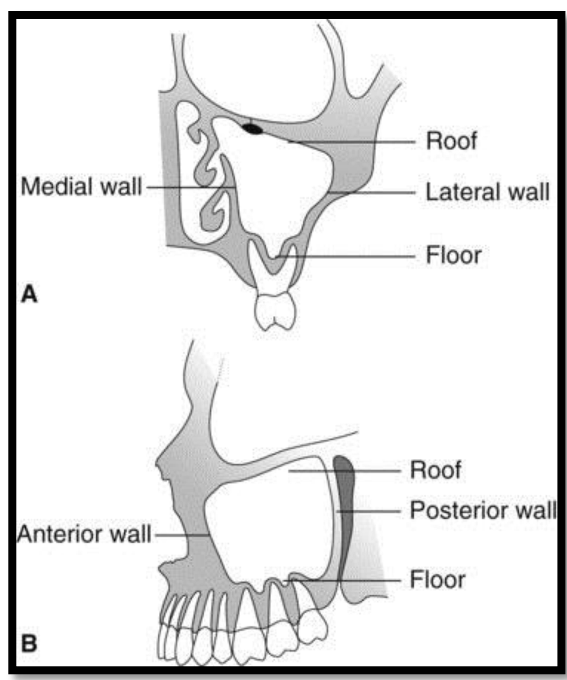
Due to genetic diseases or due to loss of teeth during adulthood or postinfectionsand environmental factors the shape and size of the adult maxillary sinus is variable with the average measurements being, 3.7cm of height, 2.5cm of width and 3.7cm of anteroposterior depth[16]. Smaller maxillary sinuses usuallyextend from the second premolars to the secondmolars, while larger sinuses extend from the first premolars or from the canine or evenbeyond the third molars[17].



Developmental pattern of maxillary sinus

Maxillary sinus has four walls namely:

1) Superior wall or roof
2) Anterior wall
3) Posterior and lateral wall (posterolateral wall)
4) Floor of sinus



Anatomy of maxillary sinus

The maxillary sinus roof is formed by the floor of orbit, and is traversed by the infraorbital canal. The floor is formed by the alveolar process of maxilla and lies about 1.2cm below the floor of nose. The floor is marked by several conical elevations produced by the roots of maxillary molars and premolars that may even penetrate the bony floor to lie beneath the mucosal lining. The anterior wall is formed by the facial surface of maxilla. The posterolateral wall formed by the infratemporal surface of maxilla[16].

The sinus opens into the middle meatus of the nose by two openings one of which is closed by mucous membrane[16].

Maxillary sinus was divided into four bases according to their shapes namely triangular, leaf, scapular and renalshaped. It has been reported thattriangular sinuses were the most common in both females and males. Maxillary sinuses have also been classified into triangular, oval, curved, rectangular and square shapes[18].

Anatomical variations or pathologies like septae, spurs, polyps, sinusitis or mucosal thickening can pose difficulties while performing surgeries in the maxillary sinus. The Schneiderian membrane is the lining of the maxillary sinus can be perforated, so certain modifications of the surgical approach will be needed to prevent the perforation[7].

POSTERIOR SUPERIOR ALVEOLAR ARTERY

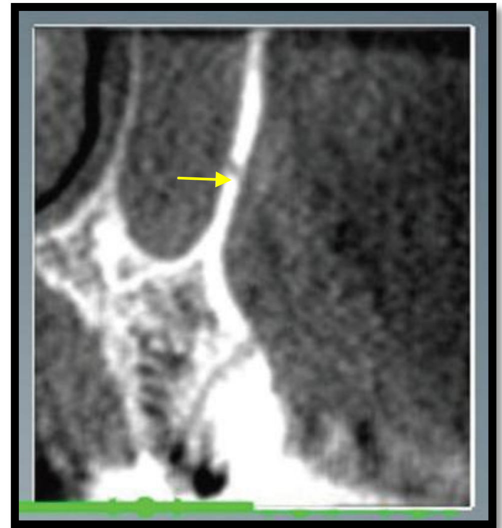
Maxillary artery is the larger terminal branch of the external carotid artery. It supplies external and middle ears, auditory tube, dura mater, upper and lower jaws, muscles of temporal and infratemporal regions, paranasal sinuses, palate, root of pharynx.

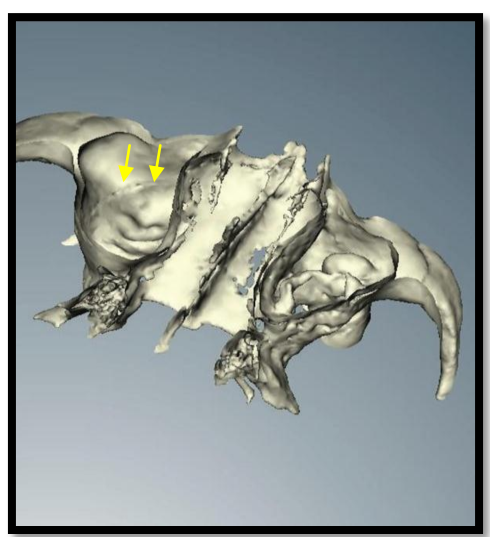
The blood supply of maxillary sinus is derived from 3 branches of the maxillary artery, one is the posterior superior alveolar artery (PSAA) and second is the infraorbital artery (IOA) and third is the anterior superior alveolar artery (ASAA)[12]. The infraorbital artery arises just before the maxillary artery enters the pterygomaxillary fissure. It enters the orbit through the inferior orbital fissure. It then runs forward in relation to the floor of the orbit, first in the infraorbital groove and then in the infraorbital canal and then emerge on the face through infraorbital

foramina. It gives off orbital branches to supply the orbit, anterosuperior alveolar branches that supply the incisors and canine and branches to the lacrimal sac, nose and upper lip[16].

PSAA is the third branch of the maxillary artery. The PSAA arises just before the maxillary artery enters the pterygomaxillary fissure[16]. PSAA meets the posterior superior alveolar nerve (PSAN) and accompanies it through the lateral and posterior walls of the maxillary sinus via bony canal through PSA foramina and passes down adjacent to the maxillary tuberosity and the infratemporal fossa[12].

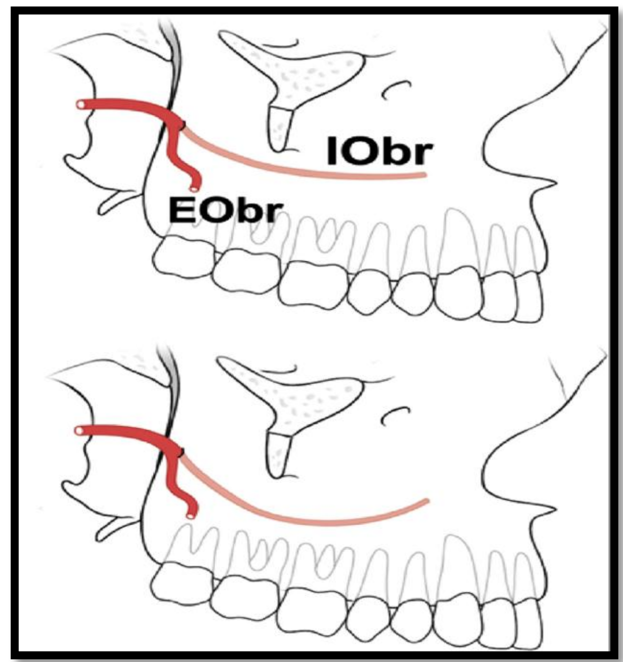
This canal is classifiedinto three types namely canal, groove-shaped (tunnel-like), andfragmented (intraosseous and extraosseous route)[12]. Before entering the PSA foramina, PSAA is divided into 2 branches namely extraosseous branch (EO br) and intraosseous branch (IObr). The IObr runs through the bony groove inside the lateral wall of maxillary sinus in the maxillary first molar or may be located at the bony canal within the lateral cortical plate of maxillary sinus. The introsseous branch supplies the maxillary molar and maxillary sinus and the extraosseous branch supplies the attached gingival and mucosa of posterior teeth[19].





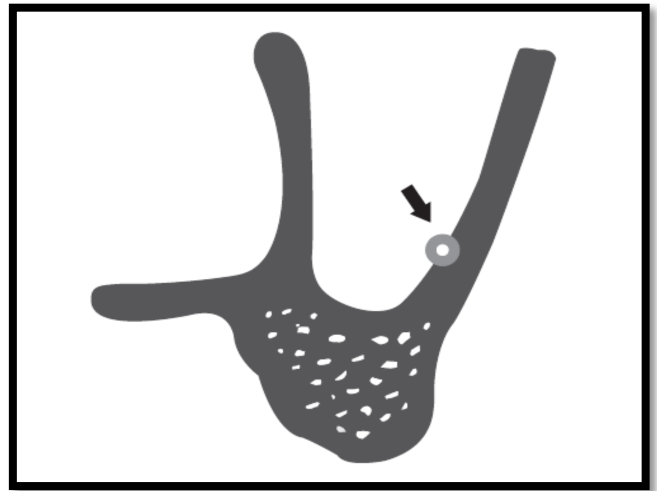
Coronal reconstruction showing the route of the bony canal (yellow arrow). B) Three-dimensional reconstruction of the bony canal (yellow arrows).

The direction of the infraorbital artery and the PSAA hasbeen classified into two categories, type 1 (straight) and type 2 ("U" shaped). In type 1 the direction is straight along the second and third molars. In type 2, changes of direction occureither in the region between the first and second premolar or between the second premolar and the first molar[12].

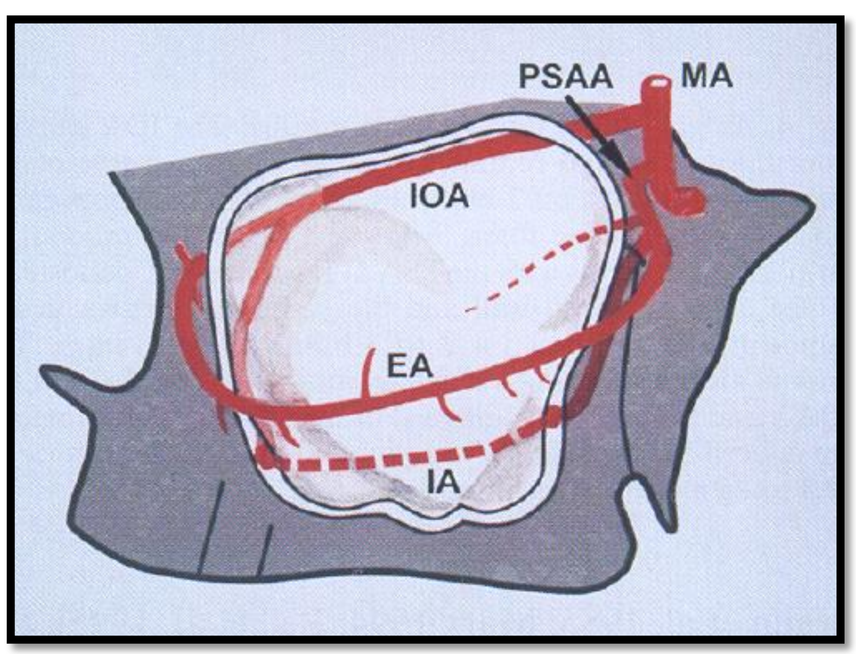


Direction of intraorbital and PSAA artery

Maximum diameters of the PSAA range from 2mm to 2.7 mm[1]. Lesser the dimension of the artery less is the intra and postoperative complications where as if the dimension of the PSAA is greater there are more chances of intra and post operative complications.



Schematic representation of cross section of maxillary sinus and PSAA



Schematic representation of saggital section of maxillary sinus with blood vessels (MA- maxillary artery, IOA- infraorbital artery, PSAA- posterior superior alveolar artery, EA (extraosseous anastomosis), IA (intraosseous anastomosis)

The maxillary sinus evaluation can be only done by radiographic methods as clinical examination of the sinus is not possible per se. Several radiographic techniques are used for the assessment ofmaxillary sinuses, conventional techniques used are Water's view, lateral cephalogram, panoramic radiography,computed tomography (CT), and cone-beamcomputed tomography (CBCT).

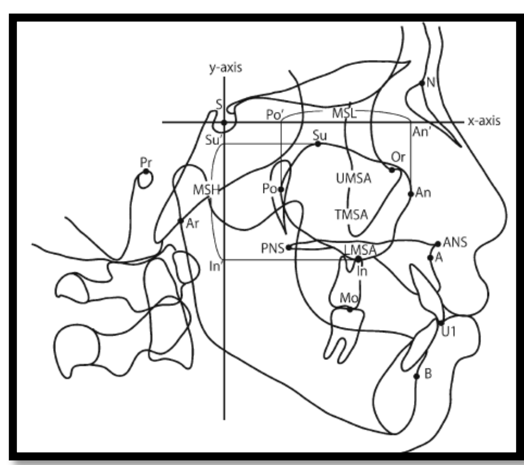
The drawbacks of the lateral cephalograms is that it provide two dimentional image hence total visualization of the sinus is limited. The image boundaries of the maxillary sinus are superimposed over adjacent structures in the deep regions of nasomaxillary complex and cannot be determined properly and also lateral cephalograms cannot be used to determine the transverse dimension of the maxillary sinus[20].

Although, panoramicradiography is a commonly used imaging modality in dentistry, it cannot provide exact information about the sinusstructure due to the overlapping ofadjacent anatomical structures.

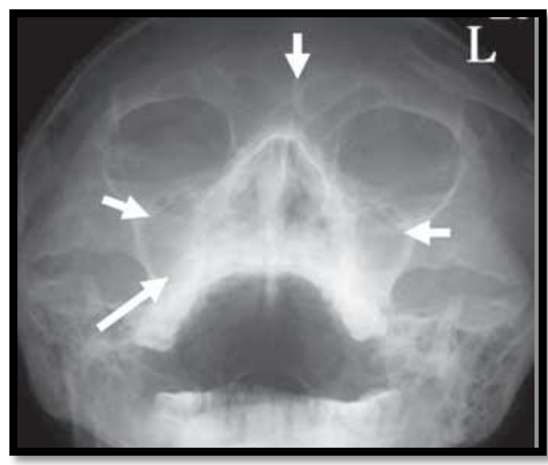
When Water's view is used to detect pathologies in the maxillary sinus like maxillary sinusitis, it has limited value in the diagnosis of maxillary sinusitis and isless sensitive to detect abnormalities in the sinuses. Anormal X-ray of the paranasal sinuses is not significantly potential to detect pathologies in the sinuses so one should therefore not be relied upon as a guide to treatment. Therefore to confirm the diagnosis, the imaging of the paranasal sinuses should be obtained bya low dose, high resolution CT study, rather than the Waters'projection X-ray[21].

CT and CBCT can provide beneficialinformation about the sinus structure by capturing two-dimensional (2D) and three-dimensional (3D) images. CBCT scans havebeen increasingly used as a diagnostic tool in recent years in oraland maxillofacial surgeries. CBCT has certain advantages over conventionalas it is cost-effective, it requires shorter scan time, it has higherresolution, it has excellent spatial resolution, patient radiation dose is reduced[6].

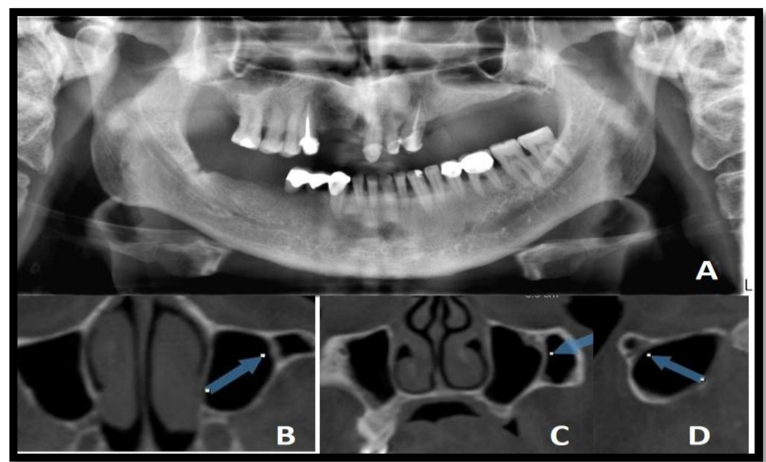
Even though CBCT has many advantages over CT scan we did the following study using CT scan, because it is feasible and possible and practical to do the study easily and conveniently. It has a smaller field of view, therefore maxillary sinus evaluation, posterior superior alveolar artery location, bilateral comparison is not possible, hence CT scan has been used.



Reference points and maxillary sinus



Waters' view reveals opacification (short arrows) and fluid accumulation (long arrow) in the frontal and bilateral maxillary sinuses



Septa on panaromic and CBCT images measurements

Matsubara K (1982)[22]conducted a study to compare the diagnostic accuracy of computed tomography and frontal tomography. They included histologically confirmed carcinoma of maxillary sinus of 38 patients with an age range of 38 to 68 years. The sensitivity, specificity, and accuracy of CT are significantly greater than those of frontal tomography of the anterior walls of the maxillary sinuses. The sensitivity of CT (78 ± 21 %) is significantly greater than that of frontal tomography (55 ± 26%), but the specificity of CT (37 ± 27%) is less than that of frontal tomography (63 ± 22%) of the posterior-lateral walls of the maxillary sinuses. The accuracy of CT (66 ±6%) is almost the same as that of frontal tomography (70 ± 10%) of the inferior walls of the maxillary sinuses. He concluded that the diagnostic accuracy of CT in diagnosing tumor densities was greater than that of frontal tomography.

Ariji Y, Kuroki T, Ariji E, Kanda S (1994)[23] analyzed the relationship of maxillary sinus to age, presence of the maxillary teeth, midfacial skeletal size and general physique in 115 adults (58 males and 57 females), ranging in age from 4-94

years using CT axial images. They found that the volume of the sinus increased up to age of 20 years and ranged from 4.56-35.21cm^3 in patients aged over 20 years. A close correlation with no significant sex difference between the two sides of maxillary sinus was found. The difference in right and left dentitions had no influence on the maxillary sinus volume over the age of 20 years. The study suggested that the volume changes with age might be related to skeletal size and physique.

Ariji Y, Ariji E, Yoshiura K, Kanda S (1996)[24] measured the transverse, anteroposterior dimensions, height and volume of the normal maxillary sinus in 107 subjects (53 males and 54 females) on axial CT and evaluated the correlation with volume, age, dentition status and skeletal size. The mean transverse and anteroposterior widths of the normal adult maxillary sinuses were 2.70 cm and 3.56 cm, respectively. The volume of sinus increased up to the age of 20 years and correlated negatively with sinus height which fell with age up to 20 years and then rose again. It was concluded that transverse and anteroposterior widths of the maxillary sinus on axial CT are convenient indices for its size. The height of the sinus floor altered with changes in sinus volume, but was not directly influenced by the status of the dentition.

Krennmair G, Ulm C, Lugmayr H (1997)[25] carried out a study to examine incidence, morphology and clinical implication of antral septa. Antral septa were found in 18 (27.7%) patientsin clinical diagnosed patients(group I) whereas 32(16%) patients diagnosed by CT (group II). In group II, 21 (13.2%) septa were nonatrophic and 11(26.8%) septa were atrophic maxillary segments. ($p<0.01$). there is greater diamension of septa in nonatrophic maxillary segments than atrophic one. CT

examination revealed one complete septum(0.5%), 21 incomplete septa on sinus floor and 10 incomplete septa on anterior antral wall. In atrophic maxillary sinus between clinical and CT examinations, the incidence (27.7% vs 26.8%), morphology (all septa located on sinus floor) and height (8.1±2.5mm vs 6.8mm) did not differ. So detailed knowledge about location, morphology, and height of antral septa is clinically relevant to reduce the rate of complications.

Uchida Y, Goto M, Katsuki T, Soejima Y(1998)[26]conducted this study to measure maxillary sinus volume as an aid in determining the volume of graft bone needed before grafting autogenous bone to the maxillary sinus floor. The study group comsisted of 11 male patients (18 sinuses) and 11 female patients (20 sinuses) ranging in age from 25 to 87 years. When the sinus-lift procedure was simulated, volumes of the inferior portion of the sinuses were 4.02 ± 1.44 cm^3 for 15-mm lifting and 6.19 ± 1.77 cm^3 for 20-mm lifting When bone grafting in the maxillary sinus floor was simulated, the sinus volumes measured on CT images were 0.70 ± 0.47 cm^3 in 5- mm lifting, 1.92 ± 0.84 cm^3 in 10-mm lifting, 4.02 ± 1.44 cm^3 in 15-mm lifting, and 6.19 ± 1.77 cm^3 in 20-mm lifting. The total maxillary sinus volume measured on CT images was 13.6 ± 6.42 cm^3. The minimum maxillary sinus volume was 3.5 cm^3 and the maximum was 31.8 cm^3. They inferred that the preoperative measurement of maxillary sinus volume in situations where autogenous bone grafting is to be incorporated into the treatment plan involving implant placement may be of assistance in determining the donor sit.

Solar P, Geyerhofer U, Traxler H, Windisch A, Ulm C, Watzek G (1999)[27] studied the maxillary arteries relevant to sinus lift surgery and examine the

vascularisation of lateral wall after tooth loss on cadaver. Total of 18 maxillary segments obtained from cadavers (10 males, 8 females) with the mean age of 67 years. The PSAA had the mean diameter of 1.6mm at its origin with 2 endosseos and 1 extraosseous branches. while IOA also had the mean diameter of 1.6mm at its origin but with 1 endosseos and 3 extraosseous branches . The vestibular anastomosis between PSAA and IOA was found in 44% of the specimens. The endosseous anastomosis between PSAA and IOA was found in 100% of the specimens. They inferred that both the arteries should be taken into consideration while performing surgeries.

Kawarai Y , Fukushima K, Ogawa T, Nishizaki K, Gunduz M, Fujimoto M et al (1999)[28] evaluated the volume of paranasal sinuses using CT. 20 healthy volunteers (10 males, 10 females) with an age range of 21 to 36 years were examined in this study. The volume of the right maxillary sinus was 23.6±6.4 ml in males and 20.9±6.8 ml in females. The volume of the left maxillary sinus was 24.9±7.6 ml in males and 21.1±5.5 ml in females. The right ethmoidal sinus was 6.5±1.2 ml in males and 6.4±2.1 ml in females, while the left ethmoidal sinus was 6.4±1.4 ml in males and 5.8±1.7 ml in females. The frontal sinus was 11.6±4.2 ml in males and 4.6±3.2 ml in females, while the sphenoidal sinus was 17.1±7.4 ml in males and 13.7±6.2 ml in females.. The average size of all paranasal sinuses taken together was 90.1 ml in males and 72.5 ml in females. They concluded that there was no statistically significant difference between the right and left sinuses.

Krennmair G, Ulm C, Lugmayr H, Solar P (1999)[29] evaluated the incidence, location, and height of antral septa and demonstrates their clinical

implications. One hundred ninety-four maxillary posterior regions, subdivided into four groups (group 1, 61 clinically 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), were examined for the incidence, location, and height of antral septa. The incidence of antral septa was significantly greater in atrophic edentulous regions (groups 1,2, and 3) than in dentate regions (group 4). The septa were lower in atrophic maxillae, about 70% of antral septa were located in the anterior (premolar) region. Antral septa are more commonly found in edentulous atrophic maxillae than in dentate maxillae. The septae in edentulous atrophic maxillae are shorter than those found in dentate maxillae. CT scanning is the preferred radiographic method for detecting the presence (or absence) of sinus septae.

Traxler H, Windisch A, Surd G, Solar P, Firbas W (1999)[30]this study was conducted to describe the arterial architecture of the maxillary sinus region in respect to sinus lift procedures in 18 human cadavers. The posterior superior alveolar artery had a mean caliber of 1.6 mm at its origin while infraorbital artery had a mean caliber of 1.64mm. the gingival branch of the of the posterior superior alveolar artery wasat a distance of 22.8–26 mm from the alveolar margin while the dental branch is at a distance of 18.9–19.6 mm. In all specimens they found an intraosseous anastomosis between these two vessels. The oral mucosa is supplied by the posterior superior alveolar artery and the infraorbital artery, and an extraosseous anastomosis was found in 44% of our cases. The two anastomoses build up a double arterial arcade, supplying the lateral wall of the antrum and parts of the alveolar process.

Chen LC, Huang JL, Wang CR, Yeh KW, Lin SJ (1999)[31]compared standard radiography with CT scan for the diagnosis of sinusitis in asthamatic patients. Fifty-three asthmatic patients (42 males and 11 females) with a mean age of 9 years (range 4-14) were included in the study and evaluated the maxillary sinuses, ethmoidal sinuses, frontal sinuses, and sphenoidal sinuses using standard radiography (Waters' view, Caldwell view, and lateral view) and compared with computed tomography (coronal views). Computed tomography (CT) showed paranasal sinusitis in 58% (31/53)of the asthmatic children. Compared with the results of computed tomography, standard radiography revealed a sensitivity of 81.1 % and a specificity of 72.7% for maxillary sinusitis. The sensitivity and specificity for ethmoidal, frontal, and sphenoidal sinusitis were 51.8%, 84.8%; 47.3%, 87.2%; and 40.8%, 93.3%, respectively. The study showed that standard radiography missed approximately 13% -24% of the abnornal sinuses found on CT. They inferred that the standard radnmviography can be recommended as a screening method for maxillary sinusitis and not recommended for the diagnosis of other paranasal sinusitis.

Konen E, Faibel M, Kleinbaum Y, Wolf M, Lusky A,Hoffmanet C et al (2000)[21] performed a study to evaluate the diagnostic accuracy of a Waters' view vs computed tomography (CT) in the diagnosis of paranasal sinusitis. A total of 134 patients(58 women, 76 men) with a age ranged from6-88years (mean age -36.6) included in the study. The mean sensitivity for diagnosis of any abnormality in the maxillary sinus was 67.7%, specificity 87.6%, accuracy 78.6%, positive predictive value 82.5% and negative predictive value 76.9%. The sensitivity for diagnosis of any disease in the frontal and ethmoid sinuses were 1.9±54.0% and 0±58.9%, respectively whereas the sensitivity for the sphenoid sinus was very low (range 0±3.8%) even in

radiographs which seemed to demonstrate it well. They concluded that the diagnosis of sinusitis of the maxillary sinuses was very poor in waters view compared to CT.

Rudralingam M, Jones K, Woolford TJ (2002)[32] checked for the opacity in the maxillary sinus using CT. There was a total of 372 scans, 352 from the ENT department and 20 from the maxillofacial department. 340 scans showed mucosal thickening, 20 patients had unilateral opacity of a maxillary sinus ,three had infective sinusitis, one had mucus retention cyst and one had mucormycosis. Two had benign conditions (inverted papilloma and ameloblastic fibroma) and four patients with malignant disease (two cases of adenoid cystic carcinoma, one squamous cell carcinoma, and one lymphoma). They concluded that Computed tomography (CT) is the imaging method of choice for conditions that affect the paranasalsinuses.

Norie A, Ahmad R, Liew W, Zahiah M (2005)[33] conducted a study to determine the intra-observer and inter-observer agreement between the two radiologists when reporting the Waters view and 3 views series of the paranasal sinus radiographs. A total of 90 sets of paranasal sinus radiographs were reviewed by 2 radiologists. The overall prevalence of sinusitis among the 90 patients was 33% (n = 30 patients) out of which 50% had unilateral or bilateral maxillary sinusitis. 37% had maxillary sinus have disease in at least one other sinus. 6% each had isolated frontal and ethmoid sinuses changes. No patient had isolated sphenoid sinus. The results revealed that the intra-observer and inter-observer agreement varied from almost perfect to good for maxillary and frontal sinuses, but poor for sphenoid and ethmoidal sinuses. Therefore, a single waters view is accepted for diagnosing sinusitis for the maxillary and/or frontal sinuses but not for the ethmoid and sphenoid sinuses.

Mardinger O, Abba M, Hirshberg A, Schwartz-Arad D(2007)[2] conducted a study to see prevalence, diameter and course of intraosseous anastomosis between PSA and IOA (bony canal) in relation to sinus augmentation procedure. The study group consisted of 104 patients (69 women and 35 men) with a age range of 24-76 years scheduled for implant supported restorations. Out of 208 CT images, bony canal was identified in 114 (55%) images. The diameter of canal less than 1mm was seen in 26% of cases, 1.2mm in 22.1% and 2-3mmin 6.7% of cases. The course of the bony canal formed a concave arch, with the first molar area being the lowest point of the course.

Teke HY, Duran S, Canturk N, Canturk G (2007)[34] investigated the width, the length and the height of the maxillary sinuses measurements for determination of gender in 127 adult patients using CT of 127 patients, 62 were females and 65 were males. The accuracy of gender identification by maxillary sinus measurements was found to be 69.4% in females and 69.2% in males. It was concluded that measurements of maxillary sinuses may be useful to support gender determination in forensic medicine; however, with a relatively low accuracy rate (less than 70%).

Gosau M, Rink D, Driemel O, Draenert FG (2008)[35] conducted a study on 65 cadaver heads and measured volume, location height of antral septa and location of semilunar hiatus in correlation to nasal floor. The volume of the maxillary sinus ranged from 5 to 22mL with a female predominance of 75% and males 25%. Linear measurements from the semilunar hiatus and the nasal floor is between 18 and 35mm with a female predominance. Antral septas are found in 24 (27%) patients. The medium height of the septa was 5.4 mm (2.5–11 mm). The main location of the septa

was the region of the first molar(29%), the second molar (23%), and the second premolar (23%). They concluded that the operator should know the knowledge of the maxillary sinus volumes as well as the location, morphology, and height of antral septa is relevant for maxillary sinus surgery or sinusfloor elevation procedures.

Hur MS, Kim JK, Hu KS, Bae HE, Park HS, Kim HJ (2009)[19] studied PSAA in 42 hemifaces (18 men, 24 women) of Korean cadavers with the age range of 47 to 94 years. It was found that straight course of intraosseous branch (IObr) of PSAA was seen in 78.1% of cases while U- shaped course in 21.9%. The minimum mean height from the cervix to the IObr was 21.1 mm in the first molar region. The mean height from the maxillary sinus floor to the IObr of the PSAA were were 9.4 mm (4.5Y17.4 mm) at the first premolar region, 10.3 mm (2.5Y19.4 mm) at the first molar region, and 9.5 mm (2.4Y16.8 mm) at the maxillary tuberosity region. They inferred that the information about the course is important for the various surgical procedures of the maxilla.

Dakhli I, Abdelsalam Z, Salem D, Omar G(2009)[36] used CT and 3D volume rendering techniques to evaluate buccolingual bone width, remaining bone height, and the angulations of the maxillary sinus floor at the potential implant site. They included twenty one adult patients with the age range from 30-50 years of both sexes, with bilateral or unilateral edendulous arches. The total maxillary sinus volume and the inferior sinus volume needed to be grafted in the potential implant site at 5mm, 10mm and 15mm were measured. Results showed that bone height ranged from 0.33 to 1.7 cm with SD 0.37, and bone width ranged from 0.65 to 1.14 cm with SD 0.11 at the potential implant site. Significant difference was observed between the angle of the

inner wall of maxillary sinus in bicuspid (mean 25.82°) and first molar region (mean 42.22 °). They concluded that the use of combination of multi slice CT and 3D volume rendering techniques using computer graphics systems allows the measurement of the amount of bone present and bone graft needed for sinus lifting.

Uthman AT, Al-Rawi NH, Al-Naaimi AS, Al-Timimi JF (2010)[11] carried out a research on 88 patients (43 men and 45 women) to study the accuracy and reliability of maxillary sinus dimensions measurement in gender classification through the use of reconstructed helical CT images. The width, length and height of maxillary sinuses in addition to the total distance across both sinuses were measured and analysed using multiple regression analysis. Maxillary sinus height was found to be the best discriminant parameter that could be used to study sexual dimorphism with an overall accuracy of 71.6% . 74.4% of male sinuses and 73.3% of female sinuses were sexed correctly, with an overall percentage of 73.9% using multivariate analysis. It was concluded that reconstructed CT image can provide valuable measurements for maxillary sinuses and could be helpful in gender determination when other methods are not conclusive.

Endo T, Abe R, Kuroki H, Kojima K, Oka K, Shimooka S (2010)[20] analysed the maxillary sinus in different malocclusion classes using lateral cephalogram. A total of 120 cephalometric radiographs were used in the study including 20 boys and 20 girls with the age range from 12 to 16 years. The mean maxillary sinus lengths (MSLs) of skeletal Class I, II, and III malocclusion groups were 44.9, 46.2, and 45.0 mm for males, and 45.0, 44.8, and 44.8 mm for females, respectively. The mean maxillary sinus heights(MSHs) of the skeletal I Class I, II, and

III malocclusiongroups were 46.1, 45.7, and 47.2 mm for males, and 44.9,45.1, and 44.9 mm for females, respectively. The mean lowermaxillary sinus areas of the skeletal Class I, II, and IIIgroups were respectively 144.3, 132.2, and 136.5 mm2 inboys, and respectively 131.8, 140.6, and 136.4 mm2 in girls. They concluded that there was no significant association betweenmaxillary sinus size and the sagittal skeletal jaw relationship. The patients withlarger cranial bases and nasomaxillary complexes tended tohave larger

Chiu PY, Chen JD, Chang CF, Wei JW, Chang CY (2010)[37] conducted a study to evaluate the diagnostic value of sinus radiography for diagnosing sinusitis by comparing with sinus CT. They included 42 patients (26 males and 16 females) with age ranging from 5 to 83 years and images of both sinus radiography and CT were compared with each other. The results showed that sinus fluid accumulation was revealed by CT in all patients, while sinus radiography showed 39 cases of sinus fluid accumulation or opacification. The overall sensitivity of sinus radiography for detecting fluid accumulation or opacification in paranasal sinuses was 92.9%. The sensitivities of sinus radiography for fluid accumulation or opacification in maxillary, frontal, ethmoid, and sphenoid sinuses were 88.6%, 88.9%, 57%, and 28.6%, respectively. They inferred that sinus radiography had a higher sensitivity in detecting fluid accumulation or opacification in the paranasal sinuses.

Güncü GN, Yildirim YD, Wang HL, Tozum TF (2010)[1] examined the prevalence , diameter, location of PSAA in relation to maxillary sinus using CT scan. Patients who underwent implant surgery were included in the study. 121 CT scans (242 sinuses) were evaluated, out of which artery was seen in 64.5% of all 242

maxillary sinuses. 36.1% of the artery was ≤ 1mm in diameter, 51.4% was 1-2 mm and 12.3% was ≥ 2mm. PSAA was located mostly intraosseously (68.2%). In right side the relation of PSAA to alveolar crest was 18.1±4.9mm whereas for left side it was 18±4.9mm. No correlation of artery diameter and age was noticed. They concluded that CT scan is a valuable tool in evaluating maxillary sinus before surgery

Sahlstrand- Johnson P, Jannert M, Strombeck A, Abul-Kasim K (2011)[38] aimed to estimate different dimensions of 120 maxillary and frontal sinuses measured on head CT retrospectively. Results showed the mean value of maxillary sinus volume to be 15.7 ± 5.3 cm^3 being significantly larger in males than in females. In 52 patients the automatically estimated volume was 14-17% greater than the calculated volume in the right sided maxillary sinuses. There was no statistically significant correlation between the volume of maxillary sinuses with age or side. Similarly, anteroposterior diameter of the frontal sinus was larger in men. Twenty-one patients (35%) showed different types of incidental findings of paranasal sinuses. They concluded that CT is a valuable tool for the measurement of dimensions of maxillary sinus.

Maillet M, Bowles WR, McClanaban SL, John MT, Ahmad M (2011)[39] conducted a study to describe the radiographic characteristics of odontogenic maxillary sinusitis as seen on CBCT scans. 871 CBCT scans were included with the age range from 18 to 87 years (49 men and 33 women). Out of 871 CBCT scan images 135 showed maxillary sinusitis with odontogenic origin. Out of these, 37sinusitis was from nonodontogenic causes, whereas 98 sinisitis were from odontogenic causes. The average amount of mucosal thickening among the sinusitis

cases was 7.4 mm. The root most frequently associated with odontogenic sinusitis was the palatal root of the first molar followed by the mesiobuccal root of the second molar. They concluded that there was 50% association of the changes in the maxillary sinuses appearance with periapical pathology. The use of CBCT scans can provide the identification of changes in the maxillary sinus and potential causes of the sinusitis.

Anwar K, Din G, Zada B, Khan AI (2011)[40] conducted a study to evaluate the maxillary sinus pathologies in waters view. A total of 120 cases were included in the Study (male to female ratio was 1.26:1) with the age ranged from 18 to 70 years. All the 120 cases showed radiologically, evidence of maxillary sinusitis. The radiological findings on sinus radiography were; Opacification (40.83%), Mucosal thickening (23.33%), Haziness (19.16%) and Air fluid levels (16.66%). The antral lavage was positive in: Air fluid levels: 100%, Opacification: 81%, Haziness: 61%, and Mucosal thickening 39%. In the study, there was a 71% positive correlation of sinus radiography with antral lavage. They concluded that the presence of air fluid levels and sinus opacification on plain radiography are more reliable evidences of maxillary sinusitis as compared to haziness and mucosal thickening.

Kim JH, Ryu JS, Kim KD, Hwang SH, Moon HS (2011)[41] evaluated the differences of the prevalence and diameter of the posterior superior alveolar artery (PSAA) and the distance of its inferior border from the alveolar crest on computed tomography (CT) images according to age and sex in 200 patients. PSAA was found in 52.0% of patient. It is higher in males (64%) than in females (40%). The diameter of the PSAA was 1.52 ±0.47 mm (mean ±SD), and is larger in males. The distance from the PSAA to the alveolar crest was greater in the premolar area (18.90 ± 4.21

mm) than in the molar area (15.45±4.04 mm), and it did not differ significantly with age or sex. They inferred that The evaluation of the PSAA in maxillary sinus on CT images before surgery could reduce the likelihood of excess bleeding during surgery especially in molar areas.

Amin MF, Hassan EI (2012)[42] conducted a study for sex identification of maxillary sinus in Egyptian population using Multidetector Computed Tomography. 96 MDCT scans were collected (48 males , 48 females) with a age range of 20 to 70. The accuracy rate of the cephalo caudal of the left maxillary sinus measurements was 66.7% in males and 50% in females, with a mean of 58.3% .The accuracy rate of the size of the left maxillary sinus measurements was 58.3% in males and 62.5% in females, with a mean of 60.4% The accuracy rate of the both, cephalo-caudal and size of the left maxillary sinus measurements was 70.8% in males and 62.5% in females, with a mean of 66.7% . They concluded that Cephalo-caudal and size of the left maxillary sinuses by MDCT may be useful to support gender determination in Egyptians.

Park WH, Choi SY, Kim CS (2012)[5] conducted a study on the position of the posterior superior alveolar artery in relation to the performance of the maxillary sinus bone graft procedure in a Korean population. They included CT scans of 58 patients (19 males, 39 females) with the age ranging from 20 to 79 years and evaluated location and distance from the inferior border of the artery in the premolar and molar areas to the alveolar ridge and sinus floor. PSAA was found in 66.7% in males and 50% in females. The mean distance from the alveolar ridge to the posterior superior alveolar artery in the dentate group was 20.62±3.05 mm in the premolar region and

17.50±2.84 mm in the molar region and for the edentulous group it was18.83±2.79 mm in the premolar region and 15.50±1.64 mm in the molar region which was statistically significant (P<0.05). Whereas there was no statistically significant difference (P>0.05) between the mean distance from the sinus floor to the posterior superior alveolar artery in the dentate group and in the edentulous group They concluded that the premolar area is safer than the molar area for performing the maxillary sinus bone graft without bleeding.

Attia AM, El-Badrawy AM, Shebel HM (2012)[43]studied the accuracy and reliability of maxillary sinus dimensions in gender identification. Maxillary sinus measurements (width, length and height) , and total distance across both sinuses were measured using CT scanner in 73 persons (39 men and 34 women) with age range 17-50 years. The results found the mean value for the height of maxillary sinus to be significantly higher in male group than females. On the other hand, there were no significant right and left side differences for male and female groups regarding maxillary sinus width, length and height. The study revealed, that among all maxillary sinus measurements the right maxillary sinus height was the best discriminate variable between genders with overall accuracy 69.9%. It was concluded that maxillary sinus dimensions measurements, especially the right height, can be valuable in studying sexual dimorphism.

Lim CG, Spanger M (2012)[44] conducted a study where 262 CT scan images of age 18-70 years and above was viewed and incidental finding in maxillary sinus was noticed. Mucosal thickening was seen in 44 patients (16.8%) out of which 19 (7.3%) occur bilaterally. Polypoid mucosal thickening was seen in 20 patients (7.6%).

Bilateral polyps existed in 5 patients (1.9%). 6 patients (2.3%) had partial opacification while 7 patients (2.7%) had total opacification. No correlation was found between age and pathology. They concluded that maxillary sinus should be evaluated in CT as the incidental findings are prevalent.

Orhan K, Seker BK, Aksoy S, Bayindir H, Berberoglu A, Seker E (2013)[45] conducted a study to determine the prevalence, height, location and morphology of maxillary septa using CBCT. 554 sides in 272 patients (30 children and 242 adults) with a age range of 17-83 years were studied. The prevalence of maxillary sinus segments with septa was 58%. The mean height of septa for males was 4.86 ± 2.01 mm, for females 5.02 ± 2.14 mm while the mean height for children and adult patients was 4.33 ± 1.92 and 5.5 ± 2.64 mm, respectively. 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. However, maxillary sinus septa are higher in partially edentulous patients than edentate and CE ones. Significant differences in the angle of the septum were noted between the anterior maxillary sinus region and posterior region. They concluded that, to prevent possible complications during sinus surgery, extensive evaluation with an appropriate radiographic technique is indispensable.

Anamali S, Avila-Ortiz G, Elangovan S, Qian F, Ruprecht A, Finkelstein M et al (2013)[46] conducted a study to determine the prevalence of the posterior superior alveolar (PSA) canal in cone beam computerized tomography (CBCT) scans. A total of 254 CBCT scans were selected for this study (120 males and 134 females)

with an age range of 20–87 years. The prevalence of the PSA canal in CBCT scans was 94.4% and 91% on the right and left side, respectively. Maxillary sinus pathologies were observed on the right side in 60 subjects (24%), and on the left side in 76 subjects (30%). Maxillary sinus pathologies was identified in the scans of 22 and 31 female subjects on the right and left sides, respectively. They inferred that the PSA canal can be visualized on CBCT scans with a high level of reproducibility regardless of the presence of pathologies.

Ilguy D, Ilguy M, Dolekoglu S, Fisekcioglu E (2013)[4]evaluated the location of the PSAA and its relationship to the alveolar ridge and maxillary sinus using cone beam computed tomography (CBCT). They included 135 CBCT scans (55 males and 80 females) that is 270 sinuses with an age range of 18 to 83 years. The distance between the lower border of the artery and the alveolar crest, bone height from the sinus floor to the ridge crest, distance from the artery to the medial sinus wall, and the diameter and location of the artery were determined. The prevalence of PSAA was observed in 89.3% of sinuses. About 71.1% of arteries were located intraosseously with diameter of ≤ 1 mm was seen in 68.9%. The prevalence of sinus septa was 55.2%, and sinus pathology was 57.4%. There was a statistically significant difference between the location of the artery and gender. The prevalence of sinus membrane thickening was 57.4%. They conclude that preoperative imaging with CBCT is helpful for assessing the location of the PSAA and the maxillary sinus morphology, before dental implant treatments.

Jasim HH, Al-Taei JA (2013)[17] correlated volume and dimension of maxillary sinus to gender and age using CT. The study included 120 patients (60

males and 60 females), divided equally into 2 groups, dentate group and edentulous group. The mean values of volumes of the maxillary sinus for males (24.02 ± 0.34) cm3,(24.81 ± 0.63), (36.85 ± 0.52) mm, (41.98 ± 1.29) mm and for females (23.05 ± 0.76) cm3, (22.67 ± 0.98) mm, (35.1 ± 1.12) mm, (37.22 ± 0.66) mm respectively. It was found that the volumes and dimensions of maxillary sinuses were larger in males than in females, in addition to that they tend to be less with the older age. So it was concluded that the CT measurements of maxillary sinuses may be useful to support gender and age determination in forensic medicine.

Vidhya CS, Shamasundar NM, Manjunatha B, Raichurkar K (2013)[47]The aim of the present study was to evaluate size and volume of maxillary sinus to determine gender. 80 skulls were studied using 3D CT. The volume of the maxillary sinuses of both sides was significantly greater in males compared to female skulls. The p value of left width with and right sided volume of maxillary sinuses 0.015 and 0.021 respectively were considered statistically significant. They inferred that Computerized tomography measurements of maxillary sinuses may be useful to support gender determination in forensic medicine.

Masri AA, Yusof A, Hassan R (2013)[48] conducted a study to determine and compare the size and volume of the maxillary sinus, between the left and right, and between the males and females. Three dimensional computed tomography (3D CT) images of 144 (288 maxillary sinuses) subjects with the age range from 0.4 to 30 years no clinical evidence of craniofacial and maxillary sinus abnormalities were selected. Linear dimensions and volume of maxillary sinus were measured for different age categories and gender. Females had larger maxillary sinus width

(p=0.02), height (p=0.04) and depth (p<0.01) than males in 0-6 years age category. In 7-12 years (p<0.001) and 21-30 years (p=0.02)age categories, width and height of maxillary sinus in males were larger than females. Maxillary sinus depth were larger in males than females in 21-30 years age category (p<0.01). Males exhibited larger maxillary sinus volume than females in 7-12 (p<0.01) and 21-30 (p<0.01) years age categories. They concluded that the maxillary sinus sizes and volume showed sexual dimorphism at most age categories. Gender consideration should be taken into account in clinical assessment and procedures which may affect the maxillary sinus.

Danda TF, Santos KC, Oliveira LV, Shintaku W, Oliveira JX (2014)[49] conducted a study to compare the diagnostic accuracy of digital panoramic radiography (PR) and CBCT in evaluating opacification involving the MS. Panoramic and CBCT images of Fifty-one patients of age 18 to 72 years, of both genders, were included in the study and were randomly assessed for the presence or absence of MS opacification by two evaluators (evaluators 1 and 2) in two reading sessions. A third oral radiologist evaluated the imaging findings in the CBCT (Evaluator 3). Of the 51 cases, 33 patients, 20 females (61%) and 13 males(39%) presented MS opacification. MS opacification was identified by Evaluator 1 in 39 cases(76.5%) and by Evaluator 2 in 31 cases (60.8%). Of the 51 patients, Evaluator 3 diagnosed opacification in 33 patients (65% of the population). Agreement between evaluators 1 and 2 was observed in 35 cases (68.6%).The results showed significant disagreement between the diagnosis of evaluators 1 and 2 and Evaluator 3 (76.5% and 60.8%), and fair agreement between evaluators 1 and 2 (68.7%). They inferred that panoramic images were able to identify opacification correctly but did not locate it

whereas CBCT images were more accurate in evaluating and locating opacification involving the MS.

Kurt M, Kursun E, Alparslan E, Oztas B(2014)[50] evaluated the position of PSAA on CBCT. They included 146 patients (81 female and 65 male) and checked for the visibility and location of vascular canal on crosssectional images and the distances from its inferior border to maxillary sinus floor and to the alveolar crest in the premolar and molar area. The artery was visible in 114 (78%) patients (60 female and 54 male). The mean distance between the artery and the alveolar crest was shortest in 2nd molar region. The longest distance was detected in 1st premolar region. The mean distance between the artery and alveolar crest was detected 26.2 mm in males and 24.84 mm in females. The mean distance between the artery and maxillary sinus floor was detected 13.2 mm for the male and female patients. They concluded that the CBCT scan is recommended as a routine examination prior to a sinus floor elevation surgery.

Sidhu R, Chandar S, Devi P, Taneja N, Sah K, Kaur N(2014)[15]conducted a study to check the accuracy and reliability of maxillary sinus in gender determination using morphometric parameters using lateral cephalogram. Lateral cephalogram of 50 subjects (25 males and 25 females) were taken and morphometric parameters of maxillary sinus were analyzed using AutoCAD 2010 software (Autodesk, Inc.) above 18 years of age. The mean area and perimeter of maxillary sinus in males was 1.7261 cm^2 and 5.2885 cm respectively. The mean area and perimeter in females was 1.3424 cm^2 and 4.3901 cm. The overall sensitivity and specificity was found to be 80% and

72%. They concluded that morphometric analysis (area and perimeter) of maxillary sinus using AutoCAD 2010 software can assist in gender determination.

Hussein AO, Ahmed BH, Omer MA, Manafal MF, Elhaj AB (2014)[51]conducted a study to compare CT-PNS and x-ray PNS for diagnosing paranasal sinus diseases. A total of 240 patients were included in the study (129 females and 111 males) with the age range from 8 to 95 years old. All patients presented with clinically suspected paranasal sinuses diseases. The analysis revealed that the paranasal sinus pathologies were common in female (54%) than males (46%). 29.2% of sinuses pathologies were common in 19-29 years old patients. The common pathologies involving sinuses were polyp, chronic sinusitis and acute sinusitis with a percent of 33.8%, 23.8% and 17.1, respectively, while the symptom were the nasal obstruction, nasal discharge and headache with a percent of 87.9%, 69.2% and 60.4 respectively. Involvement of maxillary sinus was 72.1%, followed by the ethmoidal, frontal and the sphenoidal sinuses with a percent of 45.4%, 31.7%, 27.2% respectively. They concluded that the clinical diagnosis has a considerable sensitivity and specificity in diagnosis of acute and chronic sinusitis as 97.6%, 91% when compared to CT (93%, 75.4%). Whereas water's view technique had 87.8% and CT had 92% when the sensitivity and specificity of both wee correlated.

Ekizoglu O, Inci E, Hocaoglu E, Sayin I, Kayhan FT, Can IO (2014)[52]analysed the maxillary sinus in 140 subjects (70 women and 70 men) in age range between 18 and 63 years. The size of each subject's maxillary sinus was measured and in each measurement, the size of the maxillary sinus was significantly small in female gender. When discrimination analysis was performed, the accuracy

rate was detected as 80% for women and 74.3% for men with overall rate of 77.15%. It was thus concluded; with the use of 1mm slice thickness CT, morphometric analysis of maxillary sinus can be helpful for gender determination.

Oliveira RA, Pedrazini Mc, Wassall T (2014)[53] conducted a study to evaluate the relative area of the maxillary sinus in edentulous posterior maxilla with regard to linear area, bone septa and sinus pathologies. They included 60 individuals with the age range of 35 to 75 years with the inclusion criteria of completely, unilaterally or bilaterally edentulous posterior maxillae. Out of 101 maxillary sinuses, 14 (13.86%) sinuses showed sinus pathologies and 22 (21.78%) bone septa. The mean width and height was found to be 38.4 mm and 34.52 mm respectively. The mean area observed in the males was 1367.53 $mm^2$and in the females it was 1315.13 mm^2. The total mean relative area of the edentulous maxillary sinuses was 1335.88 mm^2. They concluded thatthe presence of septa and/or sinus pathologies guides the dental surgeon to adopt the best procedure for the prevention of problems and plan the surgery accordingly.

Kiruba LN, Gupta C, Kumar S, D'Souza AS (2014)[54] conducted a study on 200 normal subjects (age group of 18-80 years) to estimate and correlate different dimensions of the maxillary sinuses measured on head CT to sex of the individuals. The height, width and depth of the maxillary sinuses were measured and statistical analysis for sex and age comparison for all the parameters was done. The discriminative analysis showed that the accuracy of maxillary sinus measurements to identify gender was 55% in females and 69.5% in males. It was concluded that this study on CT dimensions of maxillary sinuses may be beneficial to support gender

determination in forensic medicine but with a fairly low accuracy rate (less than 70%).

Kanthem RK, Guttikonda VR, Yeluri S, Kumari G(2015)[9] used different dimensions such as height, length, width and volume of the maxillary sinus to determine sex using coronal and axial sections of plain CT scan. The dimensions of right and left maxillary sinuses of 30 subjects including 17 male and 13 female were measured using SYNGO software. The sexual dimorphism of maxillary sinus right side height, length, width, and volume showed the percentages of 29.44%, 20.51%, 17.937, and 85.46%, respectively. The sexual dimorphism of maxillary sinus left side height, length, width, and volume showed the percentages of 28.01%, 19.5512%, 15, and 78.38%, respectively. Results demonstrated statistically significant results for sex determination using height, width and volume of the maxillary sinus of both sides with a higher % of sexual dimorphism in the case of volume. The authors concluded that volume of right maxillary sinus can be used as accurate diagnostic parameter for sex determination.

Ilavenil K, Guru AT, Gugapriya TS, Nalinakumari SD (2015)[7] studied presence of septation in maxillary sinus by CT. They included 314 coronal CT images of 157 patients with a age range of 10 to 68 years (78 females and 79 males) and analysed for the presence of septae. Out of 157 patients, septae were found in 33 patients in which 17 (51%) were unilateral and 16 (49%) were bilateral. 54.54% of septae was observed in males whereas 45.46% in females. They conducted that the presence of septae in maxillary sinus should be considered when planning sinus lift surgeries.

Ahmed AG, Gataa IS, Fateh SM, Mohammed GN (2015)[55] aimed to determine the reliability and accuracy of maxillary sinus dimensions for gender and racial identification through the use of reconstructed helical CT images of 119 (males 57 and females 62) with a age range of 20-75 years of the Kurdish population, Iraq. The study showed that the left maxillary sinus width was the best discrimination parameter, that could be used to study sex dimorphism with prediction of 69.4% for female and 52.6% for male (overall accuracy = 61.3%). The discriminative analysis showed that the accuracy of maxillary sinus measurements i.e. the ability of the maxillary sinus size to identify gender was 71% in females and 56.1% of males (overall accuracy + 63.9%). They concluded that the diameters of the maxillary sinus can be used as a guide and a useful tool for racial and sex determination.

Gandhi KR, Wabale RN, Siddiqui AU, Farooqui MS (2015)[8] did a cadaveric study and determine the incidence and morphology of maxillary sinus septa in dentate and edentulous maxillae. They examined 210 maxillary sinuses on cadavers that were fixed in 10% neural formalin with a age range from 45 to 80 years. Out of 210 maxillary sinus, 121 specimens were completely dentate, 51 were partially edentulous and 38 were completely edentulous. Distance between maxillary sinus floor and ostium was 36±4mm on right side and 37±5mm on left side. Distance between nasal floor and maxillary sinus floor was 8±2mm on right side and 7±1mm on left side. Out of 210 maxillary sinus, septae were observed in 59 sinuses. They concluded that the morphologic details of maxillary sinus septa will guide dentists in performance of safe implant surgeries.

Tanushri, Naeem A, Nadia K, Saluja SA, Taseer B, Akhtar H (2015)[56] evaluated gender by measuring the size of maxillary sinus using CT in Indian population. They included 40 individuals (20 males and 20 females) with the age range from 20-60 years and divided into 3 groups; 21-30 years, 31-40 years, 41-60 years. The results showed that there is higher supero-inferior dimension (SID) (33.93 mm) and antero-posterior dimension (APD) (38.06 mm) of right maxillary sinus in males than in females (SID- 28.19mm, APD- 32.69 mm) ; whereas the left supero-inferior dimension (34.13 mm) of maxillary sinus was found to be higher in males than in females (30.65 mm). When age groups were compared, younger age group 21-30 years, had higher mediolateral dimension than other age groups. They conducted that the length, height and width of maxillary sinus predict gender with a fair degree of accuracy.

Guerra-Pereira I, Vaz P, Faria-Almeida R, Braga AC, Felino A (2015)[57] conducted a study to find out the maxillary sinus pathologic changes using CT scan. 504 CT scan images were selected with a age range of 18-82 years. 32.40% of patients presented normal sinus (without any etiological factor associated), 29.00% showed presence of etiological and imaging findings in the maxillary sinus, 20.60% had only imaging changes in the maxillary sinus and 18.00% of patients presented only etiological factors and no change in the maxillary sinus. They concluded that radiological imaging is an important tool for establishing the diagnosis of maxillary sinus pathology. The results indicate that the CT scan should be an excellent tool for complement the odontogenic sinusitis diagnosis.

Kannaperuman J, Natarajarathinum G, Rao AV, Muthusamy N (2015)[58]conductedthis study is to analyze the location and prevalence of maxillary sinus septum using digital orthopantomogram images. Total of 921 sinuses (527 males, 394 females) were included in the study. Out of 921 sinuses, 217 (23.6%) sinuses had maxillary sinus septum. Out of 527 males, 125 patients had the maxillary sinus septum and out of 394 females, 92 patients had the maxillary sinus septum. 118 septum located in right sinuse whereas 99 septum in left sinus. They inferred that to prevent complications during surgery and postoperative complications, the clinician must have accurate information and clear understanding of the patient's maxillary sinus.

Hayek E, Nasseh I, Hadchiti W, Bouchard P, Moarbes M, Khawam G et al (2015)[3]evaluated the location ofthe posterior superior alveolar artery in correlation with the maxillary sinus anatomy. The study included 348 patients (696 sinuses) including 159 males and 189 females with the mean age of 44 years. The PSAA was identified in 171 cases(49.1%). The canal was located in the intraosseous wall in 241 cases (69.25%). In 30.75% of cases the diameter of canal was between 1 to 2mm. The distance between the canal and alveolar crest was between 10 and 20 mm in 68.6% of dentate group and 79.4% in edentulous group. No statistically significant difference was found between the right and left sides. They concluded that the PSAA must be examined with CBCT before external sinus lift is being performed.

German IJ, Buchaim DV, Andreo JC, Shinohara EH, Capelozza AL, Shinihara AL et al (2015)[12] conducted a study to assess the bony canal of the neurovascular bundle of the PSAA and PSAN through different methodologies (CT,

panoramic radiographs, posterior anterior radiographs, and evaluation by dry skulls and dissected anatomical specimens). Twenty-four patients were analyzed by panoramic radiographs, cone beam CT, and posterior anterior radiographs with equal sex distribution. 90 dry skulls with the mean age of 60 years and equal sex distribution and 21 dissected anatomical specimens were also analyzed. In the CBCT images PSAA and PSAN on the lateral wall of the maxillary sinus appeared as a tunnel shape in 60% of patients, 58% on right side and 62% on left side. Bony canal was identified in only one patient in the panoramic radiograph while in PA radiograph bony canal was found in 80% of patients. On dry skulls the route of the bony canal was found to be tunnel shape in 65% of cases while fragmented in 20%of the cases. Out of 21 dissected specimens, 15% showed a “U” shaped bony canal whereas the remaining 85% of the specimens showed a “straight” shape. They concluded that the most common shape of the bony canal of the PSAA and PSAN is the tunnel shape with a straight route by CBCT and posterior anterior radiography and macroscopic evaluation whereas it was not easily identified upon panoramic radiographs

Khojastehpour L, Dehbozorgi M, Tabrizi R, Esfandnia S (2015)[59] The purpose of this study was to examine the diameter, location, and frequency of the appearance of the posterior superior alveolar artery (PSAA) in preoperative cone beam computed tomography (CBCT) scans. A total of 211 sinus CBCT scans from the 150 patients were included in this study (116 from men and 95 from women). The distance between the artery and the medial sinus wall and the diameter of the artery, were greater in patients with an alveolar bone height ≤10 mm than in those with a bone height >10 mm. The diameter of the PSAA increased with increasing age. In both male and female patients, type I(intra sinus location) was the most common type

of PSAA and type III (superficial location) was the least common type and was present in only 2.1% of females and 1.7% of males. They inferred that the distance between the artery and the medial sinus wall and the diameter of the artery were both positively correlated with the number of missing teeth.

Bokkasam V, Muddepalli P, Jayam R, Devaki S, Pakerla A, Koduri S (2015)[60] presented a study to know the accuracy of panoramic radiograph in assessment of relationship between maxillary sinus floor and posterior teeth roots, and the distance from alveolar crest to nasal floor by comparing it with that of cone-beam computed tomographic (CBCT) image. Panoramic and CBCT images of 30 patients were analyzed. The relationship of each root of posterior teeth to the maxillary sinus floor was evaluated in panoramic radiograph and CBCT and classified into three classes. Class 0 — no contact between maxillary posterior teeth roots and sinus floor, class 1 — sinus floor is in contact with maxillary posterior teeth roots, and class 2 — roots of maxillary posterior teeth project into the sinus. It was observed that 61.6% of all roots showed class 1 in panoramic radiograph, while 71.1% showed class 1 in the CBCT image. There was a significant deviation of panoramic radiograph from the CBCT image in assessment of distance of alveolar crest to nasal floor with a *P* value of 0.018. They concluded that two-dimensional panoramic images are sufficient to provide the information about the relation between teeth roots and sinus but is less reliable in assessing the distance between the crest of alveolar bone and the nasal floor than CBCT.

Tadinada A, Fung K, Thacker S, Mahdian M, Jadhav A, Schincaglia GP (2015)[61]performed a study to evaluate the diagnostic efficacy of panoramic

radiography and cone-beam computed tomography (CBCT) in detecting sinus pathology. A total of 100 maxillary sinuses of patients who underwent panoramic radiograph and CBCT were evaluated. Four examiners with various levels of expertise evaluated the images using a five-point scoring system. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic efficacy of the two modalities. Results showed that maxillary sinus pathology was detected in 72% of the patients. Statistical analyses using ROC curves showed that the CBCT images had a larger area under the curve (0.940) than the panoramic radiographs(0.579). They concluded that three-dimensional evaluation of the sinus with CBCT was significantly more reliable in detecting pathology than panoramic imaging.

Malina-Altzinger J, Damerau G, Gratz KW, Stadlinger PB (2015)[62] conducted a study to evaluate the validity and the inter- and intra-examiner reliability of panoramic-radiograph of different maxillary sinus anatomic variations and pathologies. Maxillary sinus conditions was initially performed on CBCT images by two blinded consultants individually using a questionnaire. Using the questionnaire, these consultants performed the evaluation of the panoramic radiographs later. Twenty-eight patients were selected (63 % males, 37 % females) with a mean age 47.8 years(range: 20–85 years). . No significant differences between 2D and 3D imaging methods were found for the detection of a complete opacity ($p = 0.998$), a basal opacity ($p = 0.714$), a foreign body ($p = 0.571$), an oro-antral communication ($p = 0.998$), a basal septum ($p = 0.911$), a polypoid mucosal thickening (0.123), a fluid level ($p = 0.253$), and a status post sinus lift ($p = 0.998$). in CBCT were basal septa was seen in 54 % cases, followed by basal opacities (43 %), and foreign bodies (15

%). They concluded that the persistent and precise evaluation of specific conditions of the maxillary sinus was only possible by using CBCT compared to panoramic radiography.

Alkurt MT, Peker I, Degerli S, Cebeci AR, Sadik E (2016)[63] conducted a study to compare cone-beam computed tomography (CBCT) and panoramic radiography in detecting the presence and location of maxillary sinus septa.They included 104 maxillary sinuses of 52 individuals (26 females, 50% and 26 males, 50%) with a age range between 16 to 75 years of age.The septa were found 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.They inferred that CBCT images can provide valuable information to the clinicians about the presence and location of maxillary sinus septa than panoramic radiography.

Shahidi S, Zamiri B, Danaei SM, Salehi S, Hamedani S(2016)[64] evaluate the anatomic variations of the maxillary sinus and location of PSAA using cone-beam computed tomography (CBCT). In a total of 198 CBCT images, 396 sinuses were evaluated in which 130 cases belonged to females (65.7%) and 68 to males (34.3%) with age range between 18 to 45 years. 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%). The minimum and maximum distance from the artery to the medial wall on the right sinus was 10.60mm and 37.50mm, respectively and 13.20mm and 36.60mm on the left side. They concluded that preoperative imaging with CBCT is helpful for assessing the location of PSAA and the maxillary sinus morphology and used to adjust the surgical treatment plan to yield more successful treatments.

Ibrahim AA, Al Nakib LH (2016)[10] conducted a study using CT and evaluated location and diameter of PSAA among Iraqi patients. They included 180 patients (99 males and 81 females) of age not less than 16 years. The location of PSAA was mostly intraosseous (61.94%) followed by 10% below the schneiderian membrane and 1.67% outer cortex. Less than 1mm of diameter seen in 33.96% of patients, 1-2mm in 62.26% and more than 2mm in 3.77% of patients. They concluded that CT scan is a valuable tool in evaluation of PSAA.

Haghanifar S, Moudi E, Gholinia H, Mohammadian P(2016)[65]to evaluate the location of PSAA using cone beam computed tomography (CBCT) scans. 160 CBCT scans of 80 females and 80 males with age range of 20 to 86 years were selected. The mean PSAA diameter from the first premolar to the third molar was 0.75, 0.82, 0.92, 0.95 and 1.03mm, respectively. The closest distances of the artery to alveolar crest were seen in the first and second molars areas with mean 16.11 and 16.65 mm in which, PSAA is close to the maxillary sinus membrane. The distances of artery to sinus floor and alveolar crest and artery diameter were higher in males than females ($p<0.001$). The distance of the PSAA to the medial wall of the sinus is

decreased with increasing age. Left and right sides showed no significant differences. They concluded that anatomical variation, evaluation of maxillary sinus using CBCT before sinus augmentation surgery by a surgeon or radiologist can be useful in planning a more precise treatment and avoiding unwanted side effects.

Souza A, Rajagopal K, Ankolekar V, Souza AS, Kotian S(2016)[66] conducted a study to explore the anatomy of maxillary sinus and relationship of the MSO (maxillary sinus ostium) with the major anatomical landmarks using CT. CT images of 50 individuals were included in the study (34 males, 16 females) with the age range of 20 to 60 years. Out of 50 CT images, the MSO was located in the upper third in 40 cases and in the middle third in 10 cases. The most common location of MSO was in the upper third. The dimensions of the maxillary sinus was bilateral symmetrical and there were no significant gender differences. The distances of the MSO from the major anatomical landmarks (MSO-Inferior Turbinate and MSO- Hard Palate)were significantly different between males and females. They concluded that there is variability in the morphology of the maxillary sinus and has practical significance during surgical procedures.

Bornstein MM, Seiffert C, Maestre-Ferrin L, Fodich I, Jacobs R, Buser D et al (2016)[67] conducted a study to evaluate the frequency, morphology and locations of maxillary sinus septa using CBCT. They included 294 maxillary sinuses in 212 patients (126 females, 86 males) with a mean age of 53.8 years. 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% sagittally. Most septa were located in the region of first and second molar (60.7%) and in the floor of maxillary sinus (58.6%). Healthy maxillary sinus were diagnosed in 36.4% of

cases. Sinus were pathologic in 57.7% of cases in females and 72.3% in males. They concluded that to prevent complications during sinus floor elevation procedures maxillary septas should be taken into consideration.

Ravali CT (2017)[68] evaluated gender determination by different parameters (width, length, height, area, perimeter and volume) among 30 patients (15 males and 15 females) using CBCT. The results showed slightly lower value among females with regard to height, length and width. They concluded that maxillary sinus can be used as a aid in forensic medicine for gender determination.

Bangi BB, Ginjupally U, Nadendla LK, Vadla B (2017)[69] conducted a study to determine the accuracy of gender determination using maxillary sinus using computed tomography. They included 100 subjects (50 males and 50 females) with the age group of 20 years and volume of maxillary sinus were calculated. For the right side maxillary sinus, the mean value of ML, SI, and AP for males is 3.30 ± 3.21 cm, 3.16 ± 0.51 cm, and 3.57 ± 0.41 cm, respectively, and in case of females it was 2.48 ± 0.44, 2.92 ± 0.53, and 3.37 ± 0.41, respectively. For the left side maxillary sinus, the mean value of ML, SI, and AP for males is 2.61 ± 0.54, 3.17 ± 0.5, and 3.55 ± 0.38, respectively, and in case of females it was 2.44 ± 0.42, 2.93 ± 0.54, and 3.38 ± 0.38, respectively, which showed statistically significant larger dimensions in males when compared to females. The mean volume of right maxillary sinus in males is 15.23 ± 6.17 whereas in females it is 15.38 ± 6.1. For left maxillary sinus, the mean value in males is 13.35 ± 6.1 and for females it is 12.77 ± 5.49. Volume of left maxillary sinus of males is larger than females. They concluded that gender determination can be done using measurements of maxillary sinus through CT.

Sigaroudi AK, Kajan ZD, Rastgar S, Asli HN (2017)[14] 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.

Panjnoush M, Ghoncheh Z, Kaviani H, Moradzadehkhiavi M, Shahbazi N, Kharazifard MJ(2017)[6] conducted a study on CBCT and evaluate the position and course of the Posterior Superior Alveolar Artery. 600 CBCT scans were examined, out of which PSAA was identified in 150 scans (75 scans men, 75 scans women) with a age range from 15 to 79 years. PSAA was detected in 25% of cases. The position of PSAA canal as intraosseous was seen in 51.30% of cases. The smallest distance between the vascular canal and maxillary sinus floor was observed in the first premolar and first molar regions, respectively. They concludedthat the preoperative assessments of the position of the PSAA by CBCT are beneficial for reducing the risk of intraoperative and postoperative bleeding

Tehranchi M, Taleghani F, Shahab S, Nouri A (2017)[70] conducted a study to characterize the position of the posterior superior alveolar artery (PSAA) within the maxillary sinuses using cone-beam computed tomography (CBCT). A total of 300 patients with edentulous posterior maxillae (138 females and 162 males) with an age

range of 33-86 years were included in the study. The PSAA was detected on the CBCT scans of 87% of the patients; it was located beneath the sinus membrane in 47% of cases and was intraosseous in 47% of cases. The diameter of the artery was between 1 and 2 mm in most patients (72%). The mean diameter of the artery was 1.29±0.39 mm, and the mean distances from the PSAA to the zygomatic arch, nasal septum, and alveolar crest were 22.59±4.89 mm, 26.51±3.52 mm, and 16.7±3.96 mm, respectively. They concluded that the exact location of the PSAA should be known preoperatively to prevent it from being damaged during surgery.

Mudgade D, Motghare P,Kunjir G, Dharwade A, Raut A (2018)[71]conducted a study to assess the prevalence of anatomic variations in MS by using conebeam computerized tomography (CBCT). CBCT scans of 150 subjects werecollected (67 females, 83 males) between age group of 18 years to 70 years.. Average height, width, and anteroposterior (AP) dimensions for right MS are 34.13 mm, 26.09 mm, 37.39 mm and that of left MS are 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 is 1.67 mm. Prevalence of obstructed ostium and septa was 23.3% and 66.7% respectively. 97 subjects (64.7%) showed presence of septa in right MS and 99 subjects (66%) showed presence of septa in left MS. Their 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.

Ozdikici M (2018)[72] conducted a study to estimate volume of the maxillary sinus using cavalieri method on CT. 125 coronal CT images were studied, incliding

68 males and 57 female with the age range from 18 to 75 years. The mean volumes of unilateral sinuses were 6.0 ± 4.3, 19.1 ± 6.1, 5.7 ± 1.5 and 7.1 ± 3.9 cm^3; the mean volumes of bilateral sinuses were 12.5 ± 0.9, 37.2 ± 1.4, 11.9 ± 0.4 and 13.8 ± 0.8 $cm^3$for the frontal, maxillary, ethmoidal and sphenoidal sinuses, respectively. The total volume of all four paranasal sinuses was 82.1 ± 22.1 and 66.1 ± 14.6 $cm^3$for males and females, respectively. The paranasal sinuses of female subjects were 20% smaller than those of males. They concluded that the data obtained using the Cavalieri method will be useful in distinguishing between normal and pathological paranasal sinus volumes.

MATERIALS AND METHOD

A hospital based observational study was carried out in the Department of Oral Medicine and Radiology and Department of Radiodiagnosis. CT scan images of 200 subjects who were referred for CT imaging of skull to the Department of Radiodiagnosis for various reasons and fulfilled our inclusion criteria were selected for the study.

Ethical clearance was obtained from the Ethics committee of the institution. CT head was performed using Toshiba Activation 16 Multislice helical CT scanner. (figure 1) All the scans were made at 1.0mm slice thickness with the tube current at 150 mA and tube voltage at 120kVp

Four groups were formed according to age, each comprising of 25 males and 25 females:

Group 1: 20-29 yrs

Group 2: 30-39 yrs

Group 3: 40-49 yrs

Group 4: 50-59 yrs

INCLUSION CRITERIA

1. CT images of head and neck region of patients above 20 years of age.

EXCLUSION CRITERIA

1. CT images of patients with edentulous posterior region.

2. Patients below 20 years of age

3. Patients with history of trauma to the maxillary sinus

4. Patients with history of surgery in the maxillary sinus region.

METHODOLOGY

All CT scan images were evaluated in the coronal and axial sections.

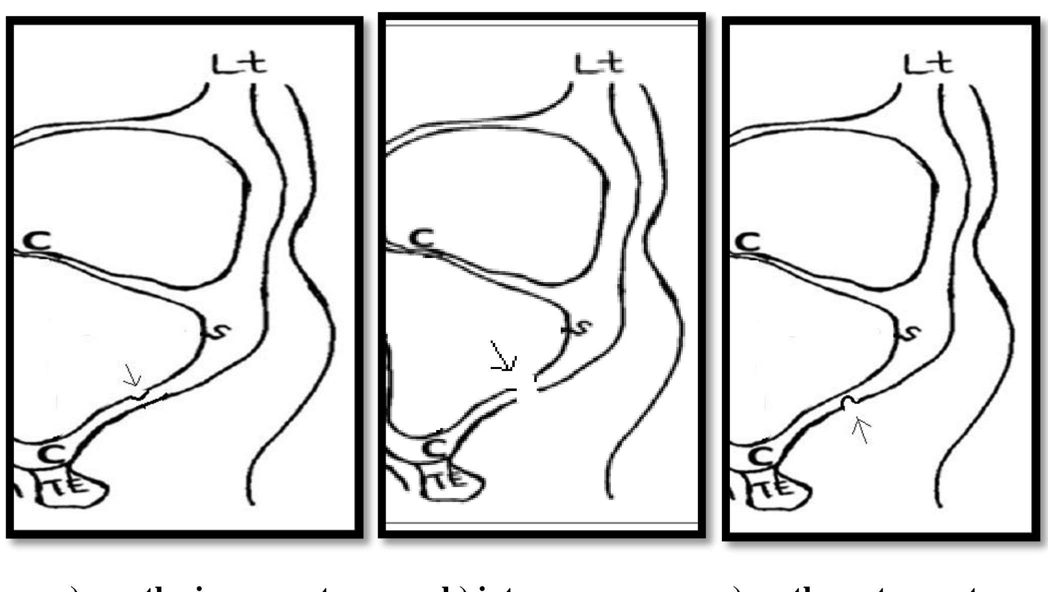
In the subjects who were not positioned symmetrically or if there were anatomic variations, the images were rotated in various sections to obtain appropriate coronal view using the tools available in the software.

All the images were evaluated for the following:

1. Location of PSAA :

The location of PSAA was checked on the coronal images of the CT scan. All sections through the maxillary sinus were evaluated so as to ascertain the presence or absence of PSAA.

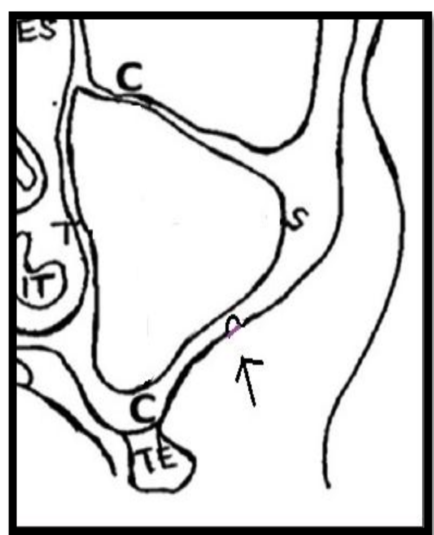
PSAA is usually located on the lateral wall of the maxillary sinus, either (a)on the inner cortex, (b)intraosseous (on the Schneiderian membrane) or (c) on the outer cortex.



a) on the inner cortex **b) intraosseous** **c) on the outer cortex**

2. The diameter of PSAA

Diameter of the posterior superior alveolar artery on the lateral wall of maxillary sinus was measured using linear measurement tool on CT scan.



Linear measurements were taken to calculate the diameter of PSAA (purple line)

Diameters were measured and divided under the following groups:

(a) < 1 mm,

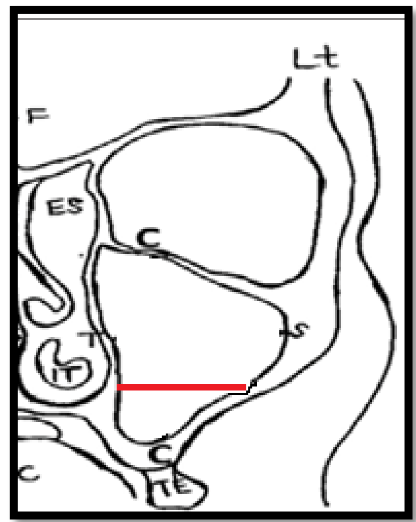
(b) 1–2 mm, and

(c) > 2 mm

3. Relationship of PSAA with a) medial wall and b) floor of maxillary sinus

On the coronal scans, the distance between the posterior superior alveolar artery to the medial wall of maxillary sinus and the distance between the posterior superior alveolar artery to the floor of maxillary sinus was noted.

With the help of linear sliding caliper measurement tool the distance was measured.



a) **Relationship of PSAA to medial wall of MS(red line)**

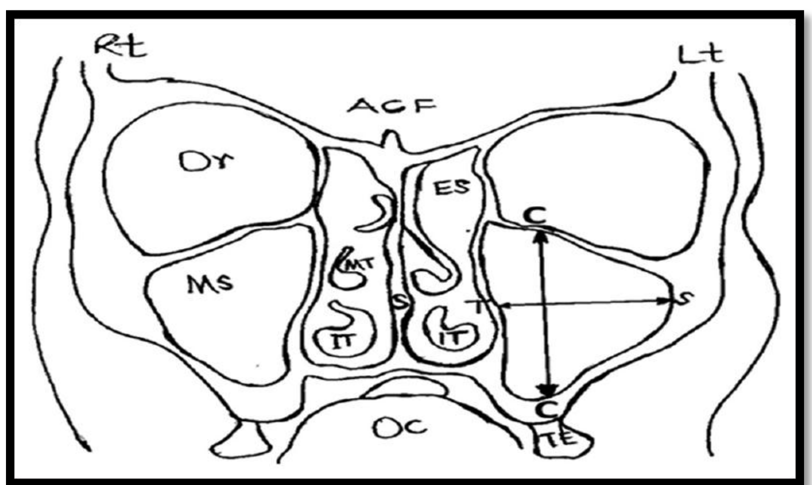
b) **Relationship of PSAA to floor of MS (green line)**

4. Area of maxillary sinus of right and left side

Area was measured in coronal section by taking the maximum value of craniocaudal and transverse distance.

Craniocaudal- distance from the highest point of sinus roof to the lowest point of sinus floor was measured using linear sliding caliper measurement tool.

Transverse- distance perpendicular to the medial wall to the outermost point of lateral wall of maxillary sinus was measured using linear sliding caliper measurement tool.



Coronal section of maxillary sinus showing craniocaudal and transverse distance.

Area of maxillary sinus was calculated by the following equation:

Area = (craniocaudal distance x transverse distance) mm^2

5. Volume of maxillary sinus of right and left side

Volume was measured in coronal and axial section by taking the maximum value of craniocaudal, transverse and anteroposterior distance.

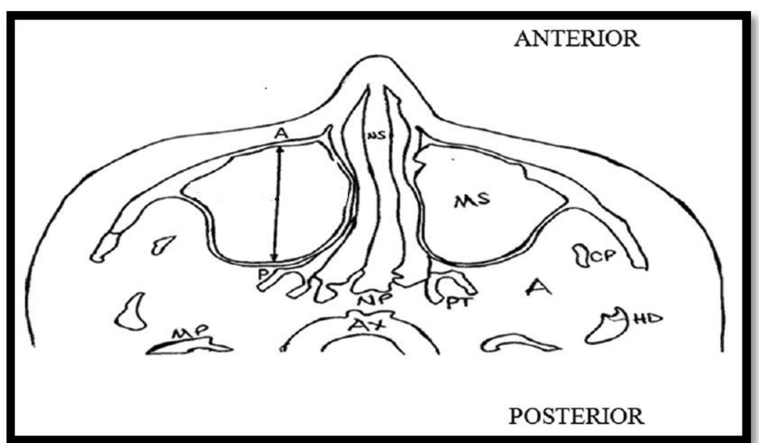
Craniocaudal (height)- distance from the highest point of sinus roof to the lowest point of sinus floor was measured in coronal section using linear sliding caliper measurement tool.

Transverse (width)- distance perpendicular to the medial wall to the outermost point of lateral wall of maxillary sinus was measured in coronal section using linear sliding caliper measurement tool.

Anteroposterior (length)- distance from the most anterior point to the most posterior point of maxillary sinus was measured in axial section using linear sliding caliper measurement tool.

Formula for Volume of sinus- the volume of the sinus was calculated from the values obtained by above distances using the following equation[70].

Volume = (height x length x width x 0.5)mm^3



Axial section of maxillary sinus showing anteroposterior distance

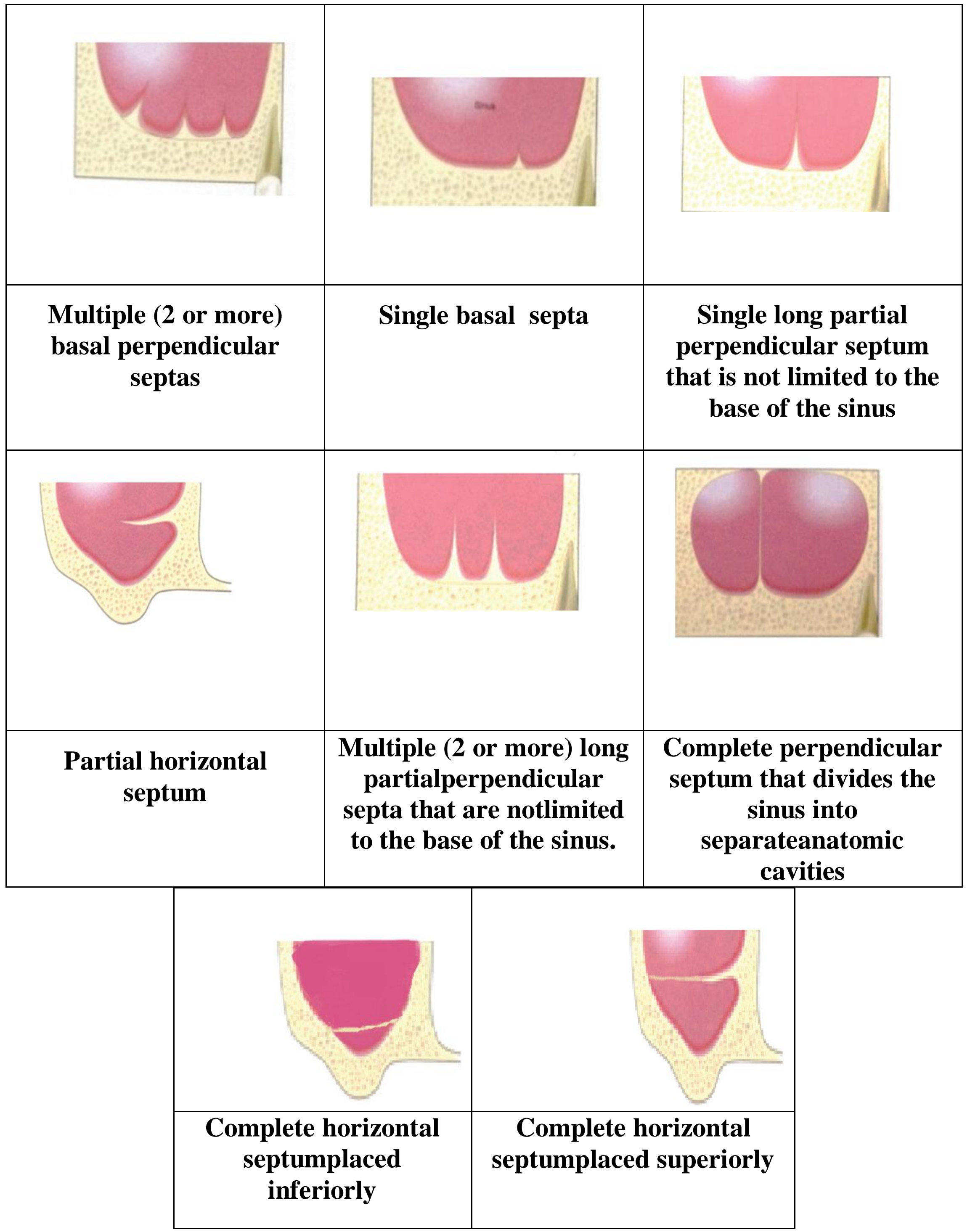
6. Anatomic variations

The CT scanswere also evaluated for anatomic variations like septas, nasal spurs as they pose difficulties during surgeries in this region.

- **Septa:**

Septa seen in the maxillary sinus may be unilateral or bilateral or both.

Septae can be seen in many patterns like complete horizontal, partial horizontal, complete perpendicular, partial perpendicular, single of multiple(2 or 3)[1]



Multiple (2 or more) basal perpendicular septas	**Single basal septa**	**Single long partial perpendicular septum that is not limited to the base of the sinus**
Partial horizontal septum	**Multiple (2 or more) long partialperpendicular septa that are notlimited to the base of the sinus.**	**Complete perpendicular septum that divides the sinus into separateanatomic cavities**
Complete horizontal septumplaced inferiorly	**Complete horizontal septumplaced superiorly**	

7. Pathologies of maxillary sinus

The sinuses were also evaluated for the presence of any pathologies in the maxillary sinus like mucosal thickening(mucositis), polyps, sinusitis.

Mucosal thickening: Thickening of more than 1 mm in any wall of the maxilla.

Polypoid lesions: Homogenous round opacities with distinct demarcating boundaries at the base of the maxillary sinus.

Complete opacification: Completely opacified maxilla in all axial and coronal slices suggestive of maxillary sinusitis[45]

STATISTICAL METHODS

The data on PSAA and maxillary sinus parameters was obtained on 200 subjects. The frequency distribution according to age and gender was obtained, also the descriptive statistics like mean, standard deviation and range for demographic parameters were obtained. These descriptive statistics were obtained for maxillary sinus and foremen magnum parameters. The comparison of each parameters between males and females and also the comparison between different age groups was performed using one way ANOVA test. The anatomical variations were analyzed using chi-square test. The correlation of diameter of PSAA with gender and age was performed using pearson's correlation test.

The entire analysis was performed using RStudio-3.2.4 programming language with validated scripts and excel. The statistical significance was tested at 5%.

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

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

ii. 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.

iii. One Way ANOVA Test:

The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of two or more independent (unrelated) groups. Your independent variable should consist of two or more categorical**,** independent groups**.** Typically, a one-way ANOVA is used when you have three or more categorical, independent groups, but it can be used for just two groups. You should have independence of observations, which means that there is no relationship between the observations in each group or between the groups themselves.

A one-way ANOVA was used to determine whether there was a statistically significant difference between independent groups.

Hypothesis under consideration in one way ANOVA is:

The null hypothesis (H0) tested in the One-way ANOVA :

that the population means from which the K samples are selected are equal. Or that each of the group means is equal.

H_0: μ1 = μ2 = = μk ; K ... 1 2 Where K is the number of levels of the independent variable.

The alternative hypothesis (H_1) :

At least one group mean significantly differs from the other group means. Or – that at least two of the group means are significantly different.

H_1: μi ≠ μk for some i, k.Where i and k simply indicate unique groups.

Mathematical model :

In this case Linear model will be:

Yij = μi +Ɛij ; (i=1,2,……k ; j= 1,2,……ni)

Yij is the observation against i^{th} patient of each group.

μi is the fixed effect due to j^{th} parameter.

Source of variation	**Degrees of freedom**	**Sums of square**	**Mean sums of square**	**F statistics**
Factor A	k-1	SSA	SSA/(k-1)	F=MSA/MSE
Error	N-k	SSE	SSE/(N-k)	
Total	N-1	TSS		

- Least square estimates of parameters:
- Sums of square of parameter:

$$SSA = \sum_{i=1}^{k} \sum_{j=1}^{n} (\bar{y}i. - \bar{y}..)^2$$

- Sums of square due to error :

$$SSE = \sum_{i=1}^{k} \sum_{j=1}^{n} (y\text{ij} - \bar{y}\text{i}.)^2$$

- Mean sums of square (MSA) = SSA/(k-1)
- Mean sums of square (MSE) = SSE/(N-k) ; N=nk

F= MSA/MSE ~ $F_{(k-1,N-k)}$

- If the test statistics gives the p-value > 0.05, then H_o is accepted i.e. groups are statistically insignificant and the alternate hypothesis that groups are significantly different is rejected.

i. Chi-Square test:

The chi-squared test is used to determine whether there is a significant difference between the expected frequencies and the observed frequencies in one or more categories.

If Yi's are independent random variables, then chi-square is given by:

$\chi^2 = \sum_{i=1}^{n} \frac{(Y-\mu)^2}{s^2}$, is a chi-square variate with 1 degrees of freedom.

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

μ= mean of Y_i's

The hypothesis under consideration is:

H_0 : There is no significant difference between variables under consideration.

H_1 : There is significant difference between variables under consideration.

If the statistics gives the p-value>0.05, $H_0$is accepted which means there is no significant difference and it also concludes that the hypothesis statement that there is significant difference is rejected.

Chi-square test for independence of attributes:

This is used to test independence of variables using contingency tables.

There are several types of chi square tests depending on the way the data was collected and the hypothesis being tested.

Consider a case: a 2 x 2 contingency table. If we set the 2 x 2 table to the general notation shown below in Table 1, using the letters a, b, c, and d to denote the contents of the cells, then we would have the following table:

Table 1.General notation for a 2 x 2 contingency table.

Variable 1

Variable 2	**Data type 1**	**Data type 2**	**Totals**
Category 1	A	b	a + b
Category 2	C	d	c + d
Total	a + c	b + d	a + b + c + d = N

For a 2 x 2 contingency table the Chi Square statistic is calculated by the formula:

$\chi^2 = \frac{(ad-bc)^2(a+b+c+d)}{(a+c)(b+d)(a+b)(c+d)}$; is the chi-square variate with (r-1)(s-1) degrees of freedom.

Where r= no. of rows and s = no. of columns.

If the chi-square statistics gives the p-value >0.05, then indicates that variables are independent and if p-value<0.05, indicates that variables are dependent.

ii Pearson's Correlation Test:

It is a measure of the linear correlation between two variables *X* and *Y*. According to pearson it has a value between +1 and −1, where 1 is total positive linear correlation, 0 is no linear correlation, and −1 is total negative linear correlation.Pearson's correlation coefficient is the Covariance of the two variables divided by the product of their standard deviations.

Pearson's correlation coefficient when applied to a Sample statistics, is commonly represented by the letter *r* and may be referred to as the sample correlation coefficient or the sample Pearson correlation coefficient. We can obtain a formula for *r* by substituting estimates of the covariances and variances based on statistical sample into the formula above. Given paired data *X*, *Y*, $\{(x_1, y_1),...,(x_n,y_n)\}$ consisting of *n* pairs, *r* is defined as:

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

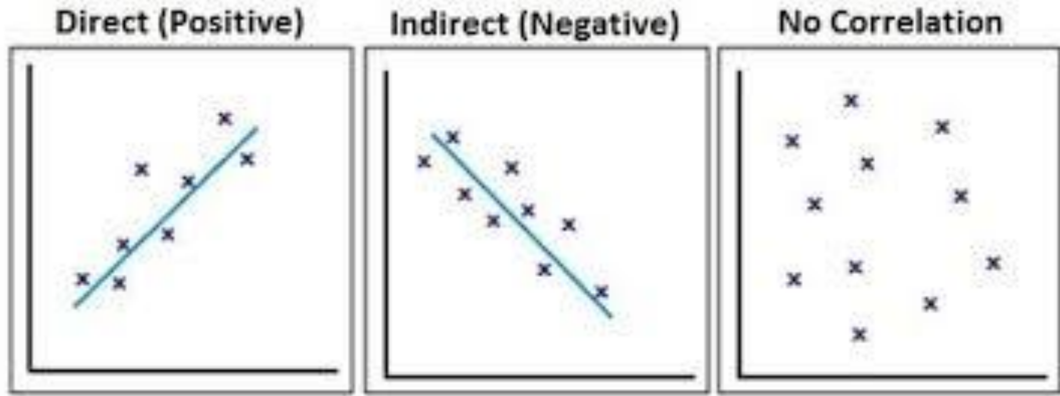
where:

n is the sample size

x_i and y_i are the individual sample points indexed with *i*.

$\bar{Y} = \frac{1}{n}\sum_{i=1}^{n} yi$; (the sample mean); and analogously for $\bar{x}$.

Line plots were plotted to show the relationship between variables.



The above line graph show correlation between variables X and Y.

Direct(positive) shows positive correlation, which means as value of X increases Y also increases. Indirect(negative) plot shows negative correlation, which means as X increases Y decreases. No correlation plot shows that there is no relation between X and Y.

COLOUR PLATE 1

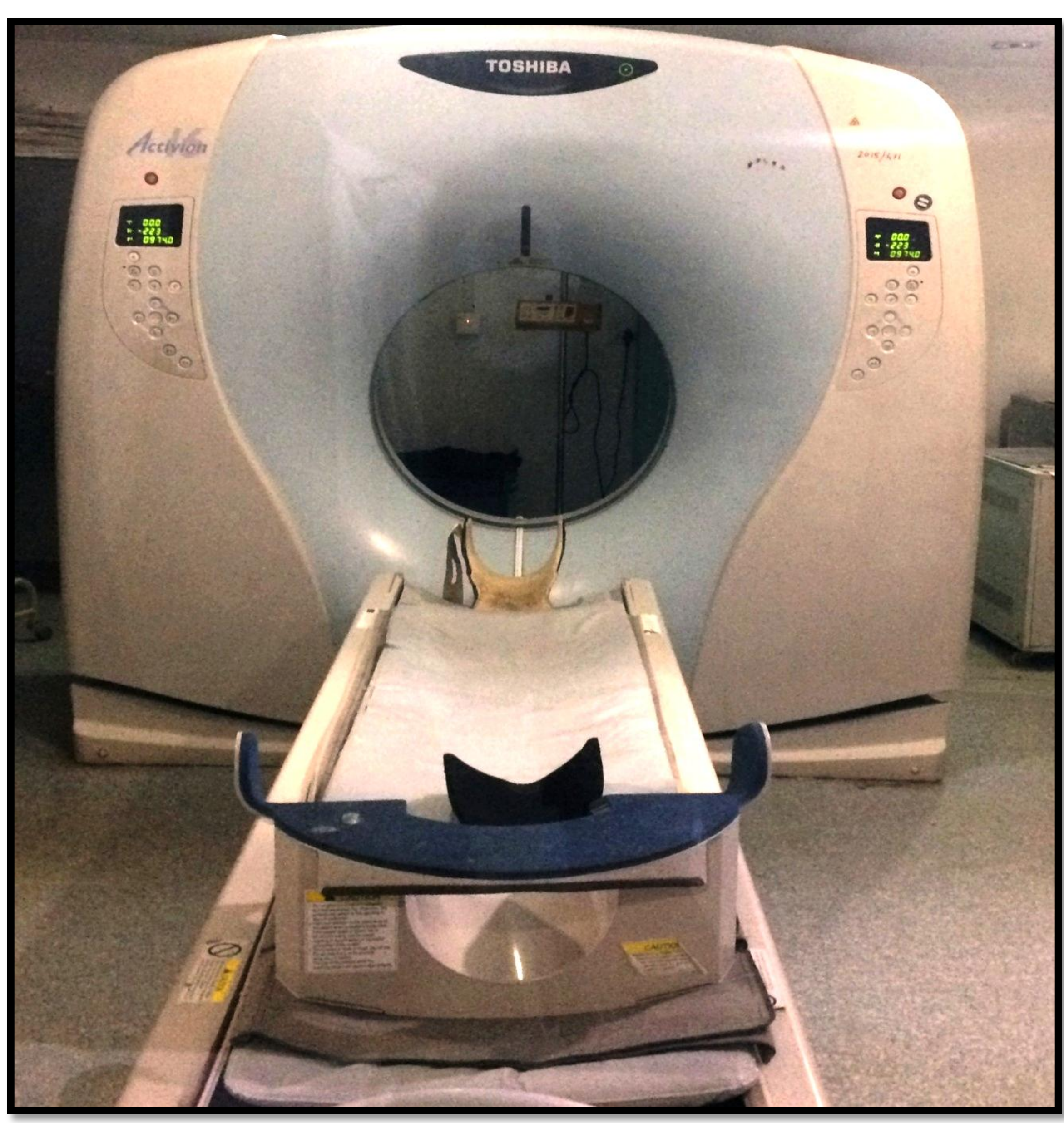


Figure 1: CT scan machine

OLOUR PLATE 2

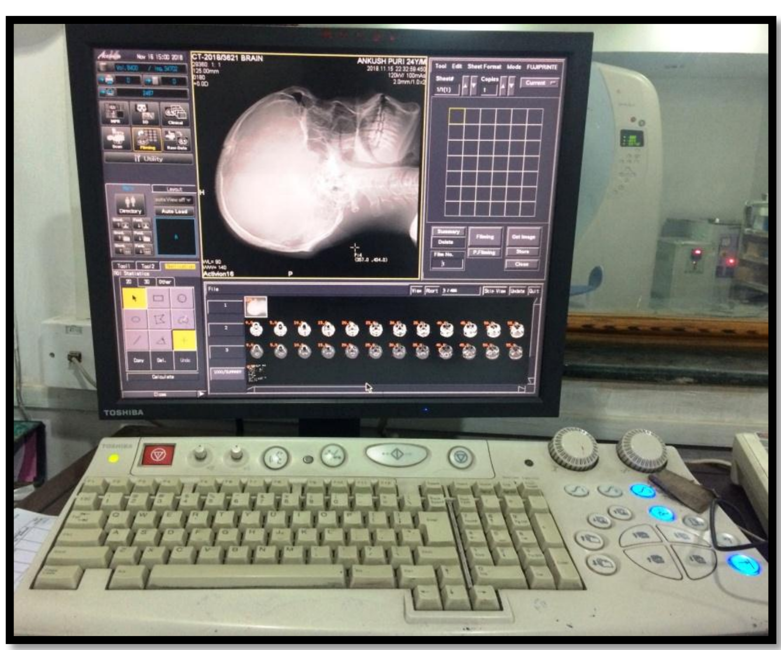


Figure 2- Workstation in console room

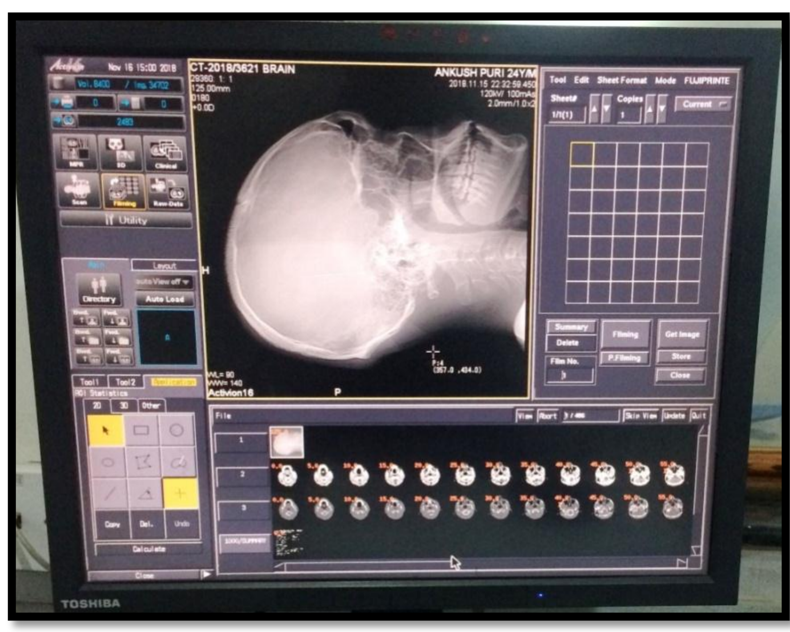
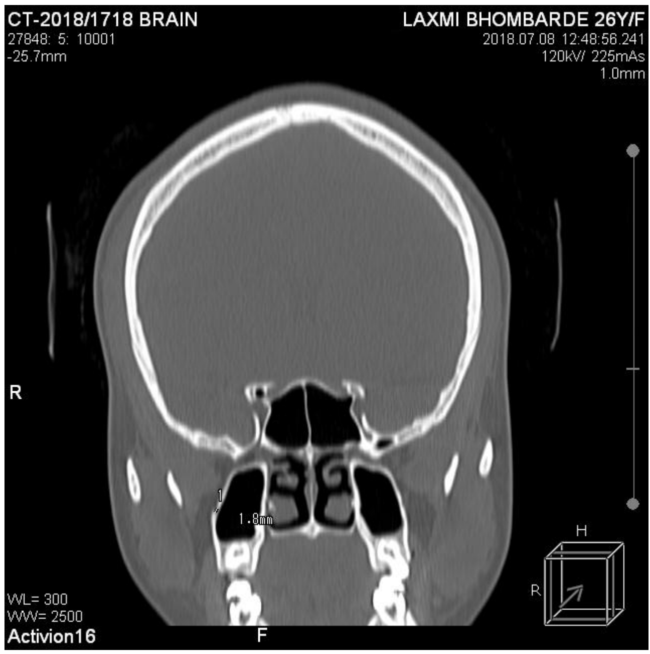


Figure 3- Linear and free hand measurement tools (highlighted with yellow)

COLOUR PLATE 3



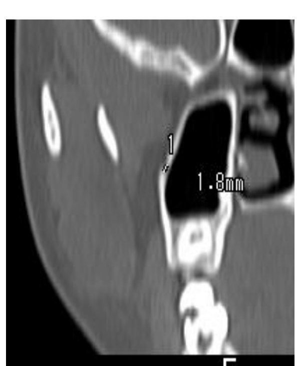
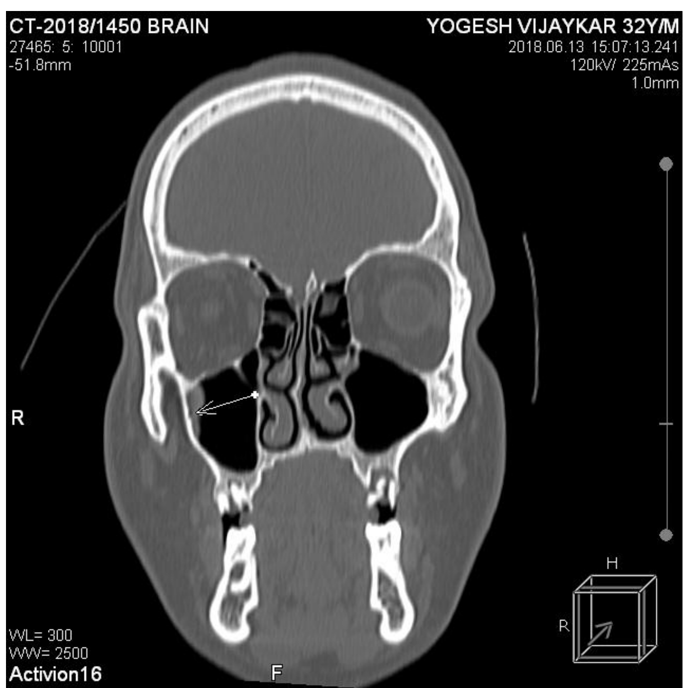


Figure 4- Diameter of PSAA



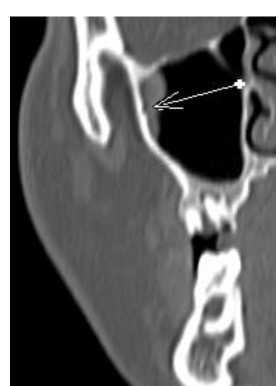
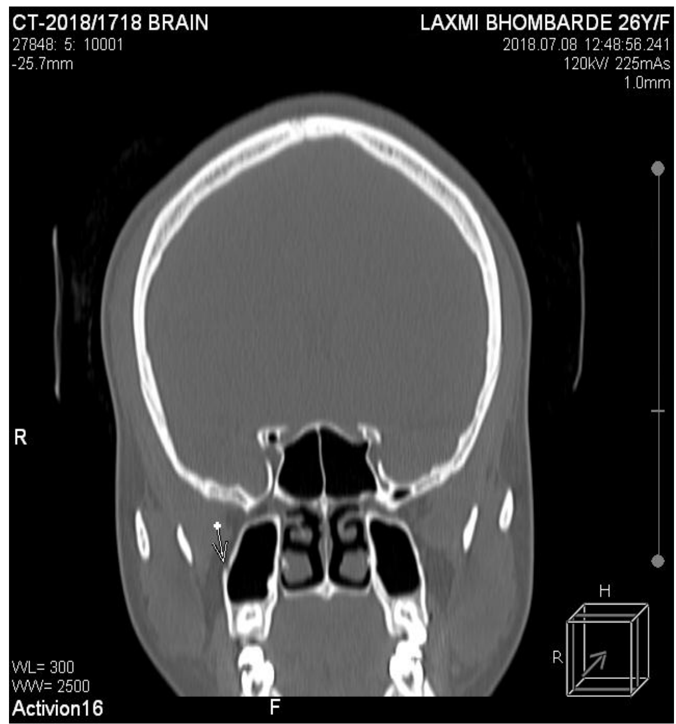


Figure 5- Location of PSAA in the Inner Cortex

COLOUR PLATE 4



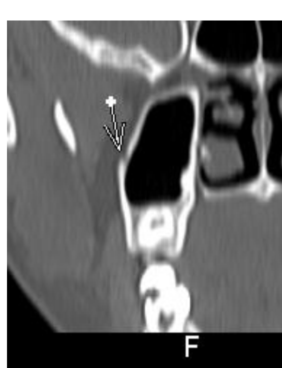
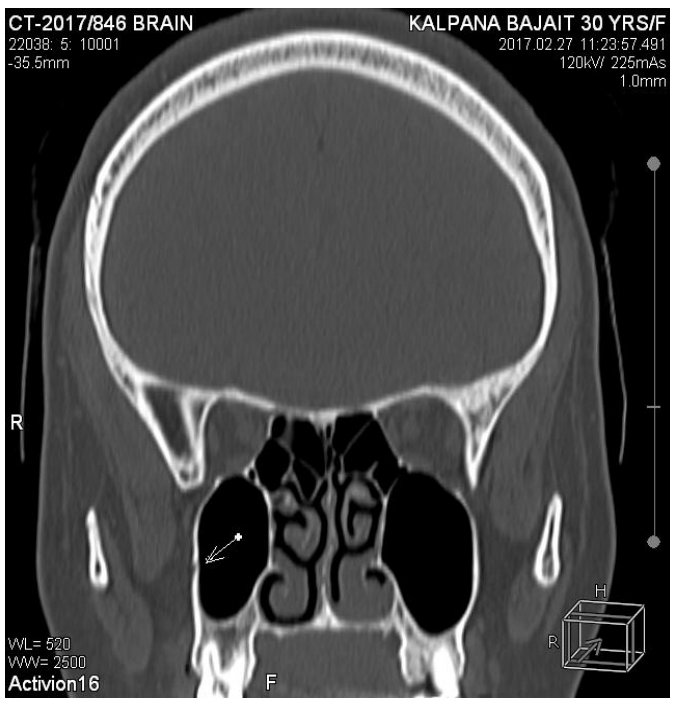


Figure 6- Location of PSAA Intraosseously



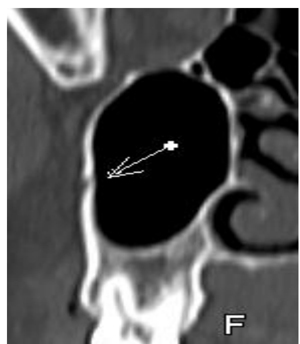


Figure 7- Location of PSAA in the Outer cortex

COLOUR PLATE 5

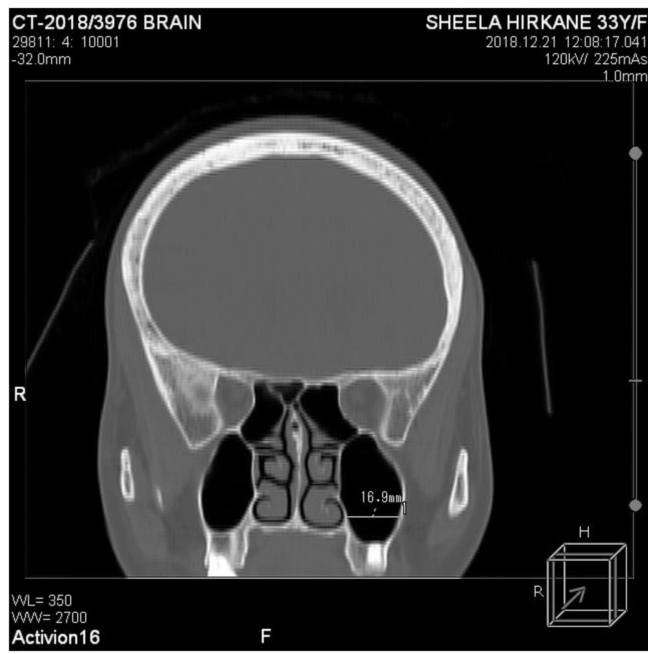


Figure 8- Distance of PSAA to medial wall of maxillary sinus

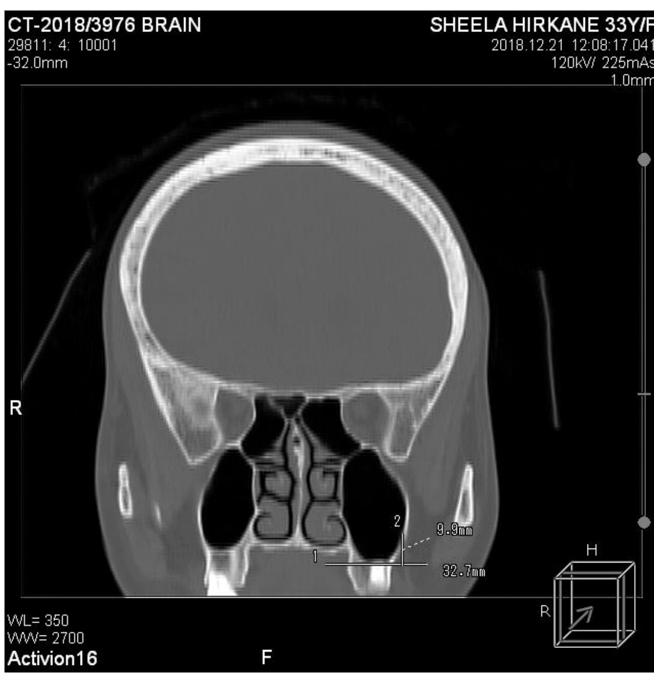


Figure 9- Distance of PSAA to floor of maxillary sinus

COLOUR PLATE 6

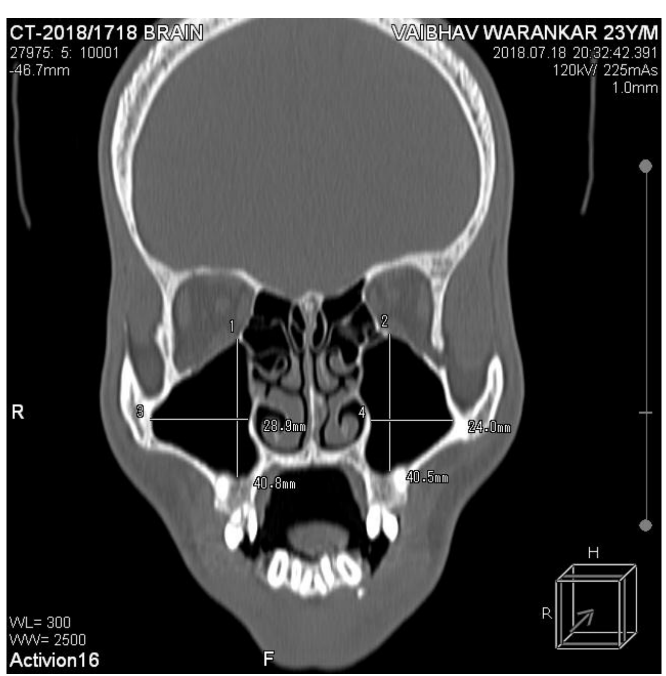


Figure 10- Measurements of maxillary sinus on coronal section

[Area = (craniocaudal distance x transverse distance) mm^2]

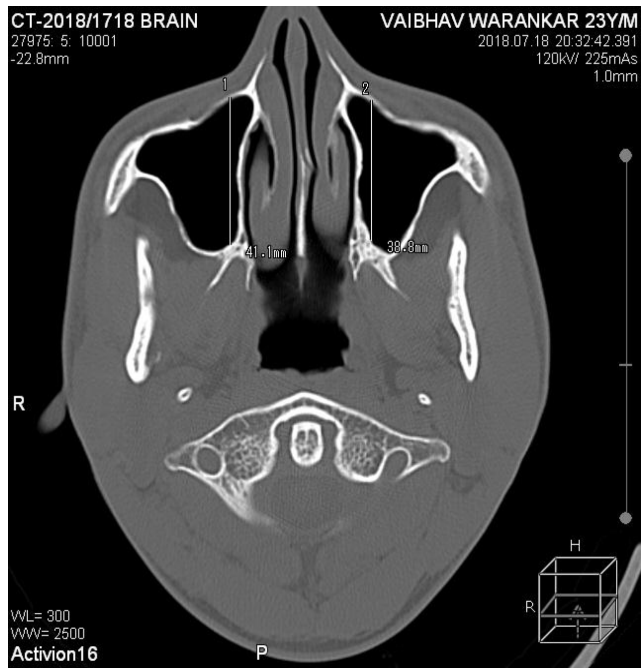


Figure 11- Measurements of maxillary sinus on axial sections

[Volume = (height x length x width x 0.5) mm^3]

COLOUR PLATE 7

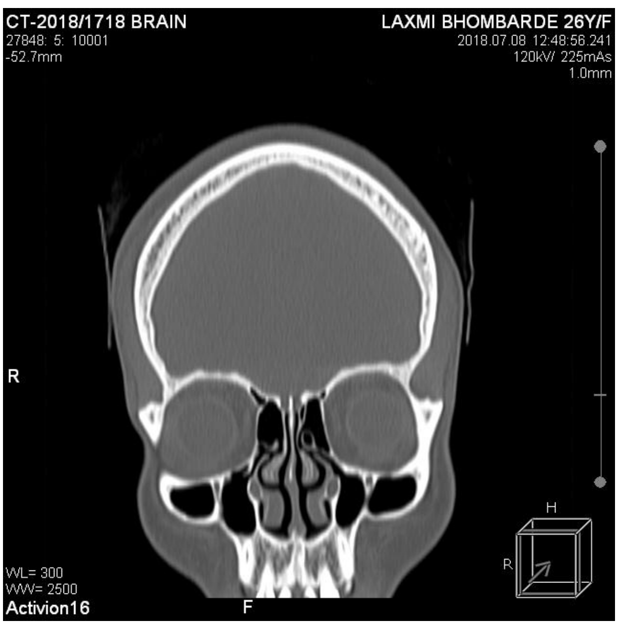


Figure 12- Septa seen on right and left maxillary sinus

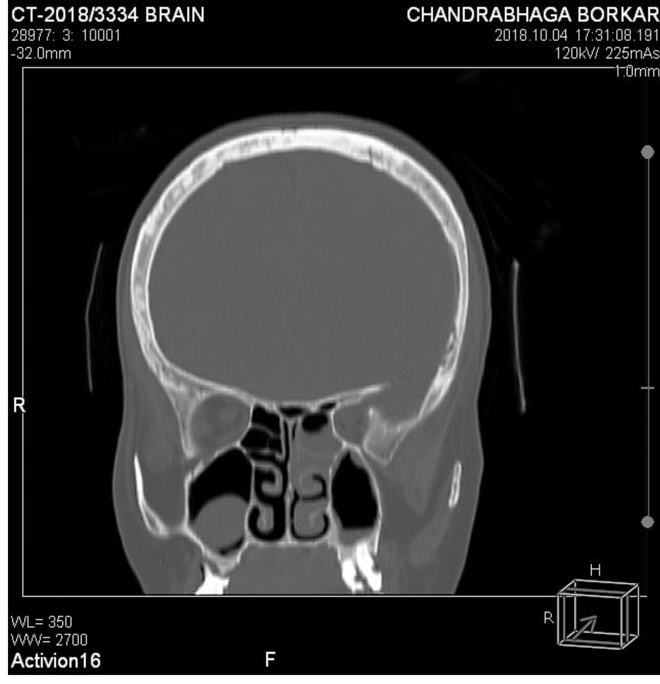


Figure 13- Polyp seen on Right Maxillary Sinus

COLOUR PLATE 8

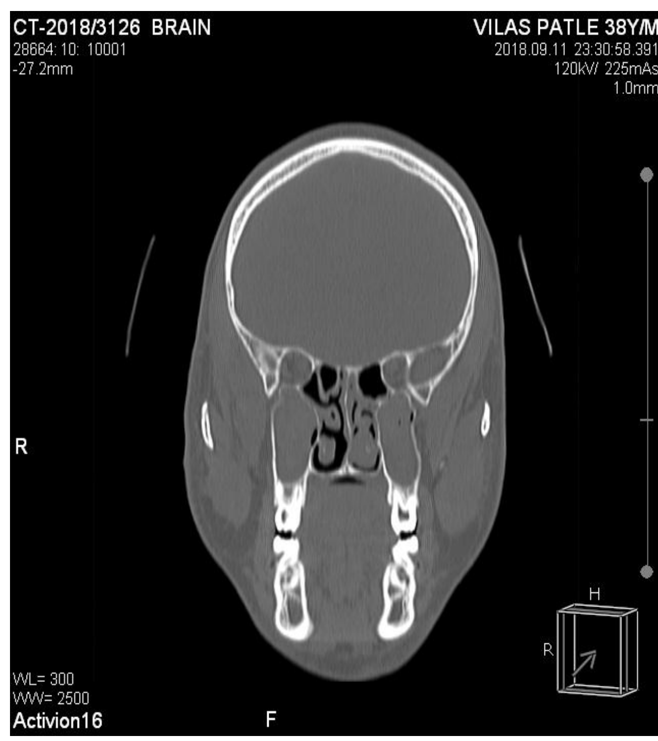


Figure 14- Opacification (sinusitis) on right and left maxillary sinus

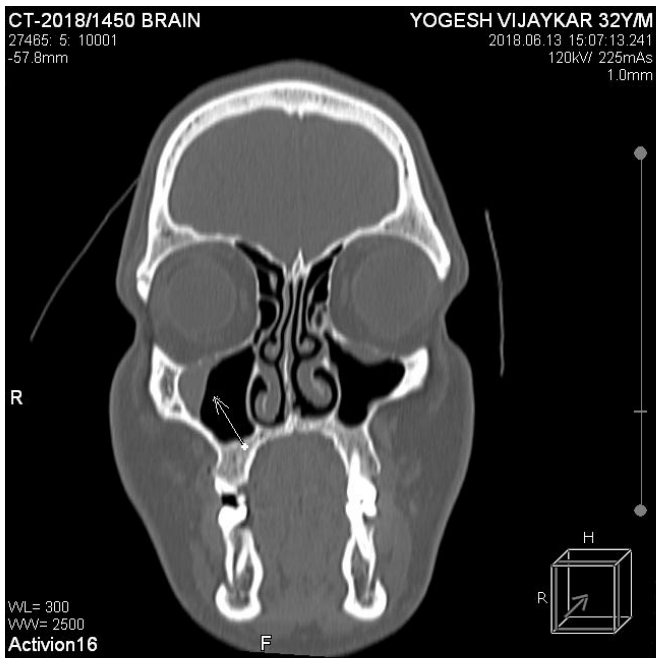


Figure 15- Mucosal thickening (mucositis) seen on lateral wall of right maxillary sinus and roof of left maxillary sinus

RESULTS

The present study evaluated the anatomical variations of posterior superior alveolar artery and maxillary sinus using CT Scan. The study comprised of four groups according to age, each comprising of 25 males and 25 females:

Group 1: 20-29 yrs

Group 2: 30-39 yrs

Group 3: 40-49 yrs

Group 4: 50-59 yrs

Table 1. Overall distribution of location of PSAA according to age groups in different sites.

Table 1 provides the overall distribution of location of PSAA according to age groups in different sites. In this study, when 400 maxillary sinuses were evaluated the PSA artery was found in 86 (21.5%)maxillary sinus. Of all the PSAA's identified, intraosseous location (55.8%) was the most commonly found followed by outer cortex (22.5%) and the inner cortex (18.6%). In group I, PSAA was found in 20(23.2%)

maxillary sinues. In group II, PSAA was found in 23(26.7%) maxillary sinues while in group III it was found in 26(30.2%) and group IV 17(19.7%). As the P value 0.94 >0.05 there was no statistical significant difference according to age group. A pie diagram showing location of PSAA in different sites.A graphical visualization showing location of PSAA according to age groups in different sites (Graph 1a and 1b)

Table 1.A. Distribution of location of PSAA in male patients

Table 1 A shows distribution of location of PSAA in male patients.Out of 86, PSAA was found in 57(66.28%) of cases in which 16(19.2%) were located in inner cortex. 48(50.81%) located in intraosseous while 22(29.8%) located in outer cortex. P-value(0.013<0.05) which indicates statistical significant difference in location of PSAA among male patients. So, in male patients PSAA was located maximum in intraosseous as compared to inner cortex and outer cortex. A graphical visualization of percentage of location of PSAA in male patients. (Graph 1 A)

Table 1.B. Distribution of location of PSAA in female patients

Table 1 B shows distribution of location of PSAA in female patients. Out of 86,29(33.7%) females had PSAA located at different sites of Maxillary sinus. 16(17.24%) females had PSAA located in inner cortex, 48(65.5%) females in intraosseous and 22(17.24%) females in outer cortex. So, in female patients PSAA was located maximum in intraosseous as compared to inner cortex and outer cortex. As the P-value(0.014<0.05), it indicates significant difference in location of PSAA for female patients. A graphical visualization of number of patients having PSAA at different locations in female patients. (Graph 1 B)

Table 1.C. Distribution of location of PSAA on right side of MS in male patients

Table 1 C shows distribution of location of PSAA on right side of maxillary sinus in male patients.Male patients had PSAA located in inner cortex was less as compared to intraosseous and outer cortex. 29(60.7%) male patients had PSAA located in intraosseous . 11(17.8%)males patients had PSAA in inner cortex and 17(21.4%) males had PSAA in outer cortex. Overall 28(49%) males had PSAA on right side of MS. As p-value was 0.029<0.05, which indicates statistical significant difference in location of PSAA among male patients. P value for age groups (0.935>0.05), which indicates statistical insignificant difference in location of PSAA for age groups for right side of male patients. A graphical visualization showing distribution of location of PSAA on right side of MS in male patients (Graph 1 C).

Table 1.D. Distribution of location of PSAA on left side of MS in male patients

Table 1 D shows distribution of location of PSAA on left side of maxillary sinus in male patients.In 29(41.37%) male patients PSAA was located in intraosseous which was more as compared to outer cortex 17(37.93%) and inner cortex 11(21%). Maximum number of male patients had PSAA located in intraosseous. As p-value for location was 0.044<0.05, thus locations were statistically significant for left site of Maxillary sinus. There was statistical significant difference among age and location of PSAA,p-value(0.047<0.05). A graphical visualization showing Distribution of location of PSAA on left side of MS in male patients (Graph 1 D).

Table 1.E. Distribution of location of PSAA on right side of MS in female patients

Table 1 E providesdistribution of location of PSAA on right side of maxillary sinus infemale patients.15(51.72%) females had PSAA on right site of MS.5(13.33%) females had PSAA located in inner cortex, 19(73.33%) in intraosseous and 5(13.33%) in outer cortex on right side of MS. As p-value was 0.034<0.05, which indicates statistical insignificant difference in location of PSAA among female patients. P-value 0.58>0.05, which indicates that there was statistical insignificance difference for location of PSAA among different age groups. A graphical visualization showing distribution of location of PSAA on right side of MS in female patients (Graph 1 E).

Table 1.F. Distribution of location of PSAA on left side of MS in female patients

Table 1 F describes distribution of location of PSAA on left side of maxillary sinus infemale patients.Total 14(48.27%) females had PSAA on left side of MS. 5(21.4%) females had PSAA located in inner cortex, 19(57.14%) in intraosseous and 5(21.4%) in outer cortex. As p-value was (0.38<0.05), which indicates statistical insignificant difference for different location of PSAA among female patients. P-value (0.007<0.05) indicates significant difference on location from age. A graphical visualization showing Distribution of location of PSAA on left side of MS in female patients (Graph 1 F).

Table 2. Distance of PSAA from medial wall and floor of MS.

Table 2 describes the average distance of PSAA from medial wall and floor of Maxillary sinus. The average distance of PSAA from medial wall was 13.34±4.5mm while the distance of PSAA to floor was 13±7.06mm. As p-value(0.99>0.05), there

was no significant difference between distance of PSAA of medial wall among age groups.As p-value(0.074>0.05), there was no significant difference between distance of PSAA of floor wall among age groups.A graphical visualization showing average distance of PSAA from medial wall and floor of Maxillary sinus (Graph 2)

Table 2.A. Distance of PSAA from medial wall and floor of MS in male patients.

Table 2 A describes average distance of PSAA from medial wall and floor of MS in male patients. The average distance of PSAA from medial wall was 15.34±4.5mm while the distance of PSAA to floor was 13±7.06mm. As p-value(0.08>0.05), there was no significant difference between distance of PSAA from medial wall among age groups. As p-value(0.07>0.05), there was no significant difference between distance of PSAA from floor among age groups. A graphical visualization showing average distance of PSAA from medial wall and floor of MS in male patients (graph 2A)

Table 2.B. Distance of PSAA from medial wall and floor of MS in female patients.

Table 2 B shows average distance of PSAA from medial wall and floor of MS in female patients. The average distance of PSAA from medial wall was 12.26± 3.2mm while the distance of PSAA to floor was 10.35±2.56mm. As p-value(0.059>0.05), there was no significant difference between distance of PSAA of medial wall among age groups. As p-value(0.10>0.05), there was no significant difference between distance of PSAA of floor among age groups. A graphical visualization showing average distance of PSAA from medial wall and floor of MS in female patients (Graph 2B)

Table 2.C. Distance of PSAA from medial wall and floor of MS in male patients according to side.

Table 2 C describes average distance of PSAA from medial wall and floor of MS in male patients according to side. The average distance of PSAA from medial wall was 14.35±3.43mm while the distance of PSAA to floor was 13.38±7.73mm on right side.The average distance of PSAA from medial wall was 15.106±4.09mm while the distance of PSAA to floor was 14.6±7.72mm on left side.As p-value(0.35>0.05) on right side and (0.07>0.05)on left side, there was no significant difference between distance of PSAA to medial wall according to side. As p-value(0.062>0.05) on right side and (0.06>0.05) on left side, there was no significant difference between distance of PSAA to floor according to side.A graphical visualization showing average distance of PSAA from medial wall and floor of MS in male patients according to side(Graph 2C)

Table 2.D. Distance of PSAA from medial wall and floor of MS in female patients according to side

Table 2 D describes average distance of PSAA from medial wall and floor wall of MS in female patientsaccording to side.The average distance of PSAA from medial wall was 13.2±1.2mmwhile the distance of PSAA to floor was 7.2±3.3mm on right side. The average distance of PSAA from medial wall was 13.5±0.12mmwhile the distance of PSAA to floor was 13.59±3.5mm on left side.As p-value(0.058>0.05) on right side and (0.13>0.05)on left side, there was no significant difference between distance of PSAA to medial wall according to side. As p-value(0.024<0.05) on right side and (0.013<0.05) on left side, there was significant difference between distance of PSAA to floor according to side.A graphical visualization showing average

distance of PSAA from medial wall and floor of MS in female patients according to side. (Graph 2D)

Table 3. Variation in diameters(in mm) of PSAA according to age groups

Table 3 shows variations of diameters of PSAA according to age groups. The mean diameter was1.460±0.27mm. In group I, there was significant difference as p-value(0.021<0.05) in mean variation of diameters <1mm, diameter 1-2mm and diameter >2mm. In group II, p-value(0.013<0.05) there was significant difference in diameter. In group III p-value(0.139>0.05), so there was no significant difference among different range of diameters, as there was not much difference in (1.2±0.43) and (1.51±1.23). In group IV p-value(0.26>0.05), so there was no significant difference among different different range of diameters. A graphical visualization showing diameters(in mm) of PSAA according to age groups. (Graph 3)

Table 3.A. Overall frequency and percentage of diameter of psaa

Table 3 A describes overall frequency and percentage of diameterof PSAA.Overall 7(8.13%)number of patients had PSAA with diameter < 1mm and 69(80.23%) number of patients had PSAA with diameter 1-2mm. 10(11.62%) number of patients had PSAA with diameter >2mm. Pie diagram showing overall percentage of diameter of PSAA.(Graph 3A)

Table 3.B. Variation in diameter of PSAA in male patients

Table 3 B describes variation of PSAA in male patients. In male patients for group I, p-value (0.005<0.05), which indicates significant difference between diameter. In group II sufficient observation was not available, so it was not possible to compute p-value.only we can say that mean diameter was1.68 ± 0.24mm. In group

III, p-value(0.68>0.05),which shows no significant difference between diamters of male patients.In group IV,p-value was (0.18>0.05) not significant for diameters of male patients.Overall in male patients, diameters were found to be significant (p value 0.0003).A graphical visualization showing variation in diameter of PSAA in male patients. (Graph 3 B)

Table 3.C. Variation in diameter of PSAA in female patients.

Table 3 C describes variation of PSAA in female patients. In group I, there was significant difference as p-value(0.002<0.05) in mean variation of diameters <1mm, diameter 1-2mm and diameter >2mm . In Group II,p-value(0.0001<0.05), there was significant difference between diameter of PSAA. In group III p-value(0.21>0.05), so there was no significant difference among different range of diameters, as there was no much difference in (1.53 ± 0.30)mm and (1.87 ± 0.26)mm. In Group IV,p-value(0.21>0.05), there was no significant difference between diameter of PSAA. In female ,p-value(0.02<0.05), there was significant difference between diameter of PSAA. A graphical visualization showing variation in diameter of PSAA in female patients. (Graph 3 C)

Table 3.D. Variation in diameter of PSAA in male patients on right side of MS

Table 3 D describes variation of diameter of PSAA in male patients on right side. For group I, p-value (0.005<0.05),which indicates significant difference between diameter. In group II sufficient observation was not available,so it was not possible to compute p-value,only we can say that mean diameter is 1.68 ± 0.24mm.Group III, p-value(0.68>0.05), showed no significant difference between diameters of male patients.In group IV, p-value was (0.18>0.05) not significant for diameters of male

patients.Overall in male patients, diameters were found to be significant(p value 0.0003).A graphical visualization showing variation in diameter of PSAA in male patients on right side. (Graph 3 D)

Table 3.E. Variation in diameter of PSAA in male patients on left side of MS

Table 3 E describes variation of diameter of PSAA in male patients on left side.In group I, group II and group IV data is not available.In group III, p-value (0.98>0.05),which showed no significant difference between diamters of male patients on left side of MS. A graphical visualization showing variation in diameter of PSAA in male patients on left side. (Graph 3 E)

Table 3.F. Variation in diameter of PSAA in female patients on right side of MS

Table 3 F describes variation of diameter of PSAA in female patients on right side. In group I, there was significant difference as p-value(0.001<0.05) in mean variation of diameters <1mm, diameter 1-2mm and diameter >2mm . In Group II,p-value(0.059>0.05), there was insignificant difference between diameter of PSAA. In group III p-value(0.025<.05), so there was significant difference among different range of diameters. In Group IV,sufficient observation was not available,so it was not possible to compute p-value,only we can say that mean diameter is 1.35 ± 0.4mm. On right site of female,p-value(0.019<0.05), there was significant difference between diameter of PSAA. A graphical visualization showing variation in diameter of PSAA in female patients on right side. (Graph 3 F)

Table 3.G. Variation in diameter of PSAA in female patients on left side of MS

Table 3 G describes variation of diameter of PSAA in female patients on left side.For group I, group III and group IV theobservation was not available . In Group

II,p-value(0.04<0.05), there was significant difference between diameter of PSAA. A graphical visualization showing variation in diameter of PSAA in female patients on left side. (Graph 3 G)

Table 3.H. Correlation of diameter of PSAA with age and gender.

Table 3 H describescorrelation of diameter of PSAA with age and gender; as the patient gets older diameter of PSAA also increases. As female patients gets older diameter decreases. As male patients gets older diameter increases. A line diagram showing correlation of diameter of PSAAwith ageand gender (females and males) (Graph 3 H, 3I, 3J)

Table 4. Variation of area and volume of MS according to age

Table 4 describes the variation of area and volume of MS according to age. Over all mean area and volume was 666.3 ± 235.81mm^2 and 11966.5 ± 5188.34mm^3 respectively. In group 1 area was 645.89 ± 191.15mm^2 while volume was 11653.03 ± 5206.9mm^3, in group II area was 778.23 ± 285.06mm^2 and volume was 14533.65 ± 6885.131mm^3. In group III and group IV area were 776.38 ± 227.78mm^2 and 657.78 ± 1 91.33mm^2 respectively while volume were 13763.71 ± 4684.68mm^3 and 15428.62 ± 5671.622mm^3 respectively. P-value (0.92>0.05), there was no significant difference between area of PSAA for different age groups. P-value (0.34>0.05), there was no significant difference between volume of PSAA for different age groups. A graphical visualization showing variation of area and volume of MS according to age. (Graph 4)

Table 4.A. Mean area of MS according to gender.

Table 4 A describes the mean area of MS according to gender. In group I p value <0.025, there wassignificant difference between male and female in area. Similarly in group II, III and group IV p value was<0.05 which suggest that there was significant difference between male and female in area. A graphical visualization showing mean area of MS according to gender. (Graph 4 A)

Table 4.B. Mean volume of MS according to gender.

Table 4 B describes mean volume of MS according to gender.In age group I and II, since p-value<0.05, then there was significant difference in volume of MS according to gender. In age group III and IV, since p-value>0.05, then there was no significant difference in volume of MS according to gender. A graphical visualization showing mean volume of MS according to gender. (Graph 4 B)

Table 4.C. Mean area of MS for right and left sides in male patients.

Table 4 C shows mean area of MS for right and left in male patients. In group I P-value(0.04<0.05) , there was statistically significant difference between right and left area of MS. In group II,III and IV, p-value >0.05, there was no significant difference between right and left area of MS. A graphical visualization showing mean area of MS for right and left sides in male patients (Graph 4 C)

Table 4.D. Mean volume of MS for right and left sides in male patients

Table 4 D shows mean volume of MS for right and left in male patients. In group I, p-value (0.014<0.05) there was statistically significant difference between right and left volume of MS. Likewise group II, III and IV p-value <0.05,there was

significant difference between volume of left and right MS. A graphical visualization showing mean volume of MS for right and left sides in male patients (figure 4 D)

Table 4.E. Mean area of MS for right and left sides in female patients

Table 4 E shows mean area of MS for right and left in female patient. In all age groups I, II, III there is insignificant difference between right and left area of MS for female. In age group IV,p-value 0.042<0.05,there was significant difference between area left and area right of MS. A graphical visualization showing mean area of MS for right and left sides in female patients (Graph 4 E)

Table 4.F. Mean volume of MS for left and right sides in female patients

Table 4 F describes mean volume of MS for right and left sides in female patients. In group II p-value 0.019<0.05 ,there was significant difference between right and left volume of MS. In group I,III,IV (p- value>0.05), indicates statistically insignificant difference between left and right volume of MS. A graphical visualization showing mean volumeof MS for right and left sides in female patients (Graph 4 F)

Table 5. Percentage of septa present on right and left side of maxillary sinus according to age groups

Table 5 shows total percentage of septa present on right and left sideof MS according to age groups. Out of 400 maxillary sinus, 190(47.5%) maxillary sinus had septa. 93(48.95%) septas were present on right side, and 97(51.05%) septas were present on left side. In group I and III, total septas present were 48. In group II total septas present were 49 while in group IV it were 45. As p-value (0.07>0.05),(0.058>0.05) therefore right and left septas are insignificant of age groups.A graphical visualization

showing total percentage of septa present on right and left side of MS according to age groups.(Graph 5)

Table 5.A. Percentage of presence of septa in male patients according to side

Table 5 A describes percentage of presence of septas in male patients according to side.93(46.5%) maxillary sinus had septa in male patients. 53(56.9%) septas were present on right side and 40(43%) on left side in males. On right side, group IV had 15 septas , followed by group I (14) and group II and III as (12) each. On left side, groupIII had 14 septas, followed by group II (12), group I (8) and group IV (6). A graphical visualization showingpercentage of presence of septa in male patients according to side. (Graph 5 A)

Table 5.B. Percentage of presence of septa in female patients according to side

Table 5 B describes percentage of presence of septas in female patients according to side**.** Around 97(48.5%) septas were present in female patients. 40(41.2%) septas were present on right side and 57(58.7%) on left side in females. On right side, all groups had 10 septas. On left side, group I had 16 septas followed by group II (15), then group IV (14) and group III (12). A graphical visualization showingpercentage of presence of septas in female patients according to side. (Graph 5 B)

Table.6. Overall pathologies present according to age group.

Table 6 describes overall pathology present according to age group. Out of 400 maxillary sinus, pathologies were seen in 159(39.75%) maxillary sinus. In group III 55, maximum pathologies were present. In group I 31 pathologies were present, in group II and group IV 35 and 38 pathologies were present respectively. 101(63 %) mucositis were present in total number. Polyp 22(13.83%)were fewer as compared to

mucositis and sinusitis 36(22.64%). Here p-value(0.06>0.05) which showedno significant difference between all the pathologies according to age. A graphical visualization showing overall pathology present according to age group. (Graph 6)

Table 6.A. Over all pathologies present in male patients.

Table 6 A shows overall pathology present in male patients.In group III, maximum pathologies 29 were present followed by group IV 26, group I 22 and group II 21. Around 70(70.7%) of mucositis were found in male patient, 20(20.2%) of sinusitis and 9(9.09%) of polyp were present in males. p-value is (0.0006), there was significant difference between different pathologies in male. A graphical visualization showing overall pathology present in male patients. (Graph 6 A)

Table 6.B. Overall pathologies present in female patients

Table 6 B describes overall pathology present in female patients. Group III had maximum pathologies(25) followed by group II(14), group IV (12) and group I(9). 31(51.66%) of mucositis were present, 16(26.66%) sinusitis and 13(21.66%) of polyp. P-value 0.002, which shows significant difference between pathologies in female patients. A graphical visualization showing overall pathology present in female patients. (Graph 6 B)

Table 6.C. Overall pathologies present on right side of MS in male patients.

Table 6 C describes overall pathology present on right side of maxillary sinus in male patients. On right side, 37(75.5 %)mucositis had found whereas sinusitis were 10(20.40%) and polyp were only2(4%.).P-value(0.0013<0.05), there was significant difference between the pathologies on right side of male patients. A graphical

visualization showing overall pathology present on right side in male patients. (Graph 6 C)

Table 6.D. Overall pathologies present on left side of MS in male patients.

Table 6 D Describes overall pathology present on left side in male patients. 33(66%)mucositis were present maximally as compared to sinusitis 10(20%) and Polyp 7(14%). P-value(0.002<0.05), there was significant difference between the pathologies on left side of male patients. A graphical visualization showing overall pathology present on left side in male patients. (Graph 6 D)

Table 6.E. Overall pathologies present on right side of MS in female patients

Table 6 E Describes overall pathology present on right side in female patients. On right side, mucositis were present in 13(48.14%) and other two pathologies which were polyp and sinusitis are found to be lesser i.e. 7(25.9%).As p-value(0.002<0.05), thus there was statistical significance between different pathologies for right side of female patients. A graphical visualization showing overall pathology present on right side in female patients. (Graph 6 E)

Table 6.F. Overall pathologies present on left side of MS in female patients

Table 6 F Describes overall pathology present on left side in female patients. As p-value(0.025<0.05), thus there was statistical significance between different pathologies for left site of female patients. On left side, mucositis were found to be 18(54.5%), 9(27.2%) were sinusitis and 6(18.18%) were polyp. A graphical visualization showing overall pathology present on left side in female patients. (Graph 6 F)

DISCUSSION

Maxillary sinus is the largest of all the air sinuses and grows very rapidly as the permanent teeth erupt until 15 to 20 years of age. After this age the size of the maxillary sinus usually remains static. But if the posterior teeth are extracted due to any reason there is inferior expansion of the maxillary sinus causing increase in the area and volume of maxillary sinus[17]. Inadequate bone volume due to alveolar bone resorption in association with pneumatization of the maxillary sinus often causes difficulty while implant placement for replacement of teeth[70]. To increase the bone volume, sinus lift surgeries are performed using lateral approach and by alveolar ridge approach. Recently, maxillary sinus bone graft using the alveolar ridge approach has been increasingly used with the development of equipment, but it is hard to secure a clear view and if the amount of residual bone is insufficient, the survival rate ofthis approach is low. Therefore, the lateral approach has been widely used as a much stabler and predictable maxillary sinus bone graft[5].

The blood supply of the maxillary sinus is by three arteries namely, infraorbital artery (IOA), posterior superior alveolar artery (PSAA) and anterior superior alveolar artery. They are the branches of the maxillary artery that run into the lateral wall of the maxilla and supply the maxillary sinus and the Schneiderian membrane[59]. The introsseous branch of PSAA supplies the maxillary molar and maxillary sinus[19]. Since the maxillary sinus has a complex location and a rich blood supply it is very crucial to investigate it to avoid complications during and after surgeries which are discussed as under.

During the sinus lift surgery if PSAA gets traumatized accidentally, it may cause mild to severe bleeding, obscuring the vision of the operator and may also lead to perforation of the maxillary sinus membrane[6]. As the posterior superior alveolar nerve lies in close proximity to the PSAA, there is a high risk of pain, inflammation or ischemia during or after the treatment[12].

While performing Le Fort I osteotomy, the osteotomy line is generally placed at the higher level that is 4 to 5mm above the root apex of maxillary molar. In such situation also there can be a possibility of risk of injury to PSAA during osteotomy leading to nasal bleeding[12,19].

The artery may also be damaged during procedures like orthognathic surgeries, removal of pathologic lesions and infections of the maxillary sinus, post operative membrane perforations, bone necrosis, Lefort I fracture treatment and Caldwell-Luc surgeries[12,60,65]. While giving PSA nerve block, due to incorrect injection technique there may be a hematoma formation which makes assessment of PSAA and PSAN vital [12].

Since these surgeries are routinely carried out these days, it is very important for the oral surgeons to take precautions not to damage the extensive blood supply of maxillary sinus specially the PSAA.

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 the diagnosis and treatment. With the advent of newer imaging modalities like Computed Tomography(CT) and Cone Beam Computed Tomography(CBCT) it has been possible to obtain both two dimensional and three dimensional images. The following study was done using CT scan as larger field of view is available, therefore maxillary sinus evaluation can be done and bilateral comparison is possible.

The CT scan images of patients who had undergone CT imaging for any reason were included in the study. The study sample comprised of CT scan images of 200 subjects (100 males and 100 females) which were divided into following groups : group 1: 20-29 yrs , group 2: 30-39 yrs, group 3: 40-49 yrs and group 4: 50-59 yrs. Each group included 25 males and 25 females.

In this study, when CT images of 400 maxillary sinuses were evaluated the PSAA could be visualized in 86 maxillary sinus that is in 21.5% of cases. The images were evaluated in coronal sections at 1.0mm slice thickness. Previous studies done on CT imaging have found success rate of identification to be 54% to 74%[1,2,5,10]. Whereas in studies done on CBCT a higher success rate can be seen[4,59,64,70].**(Table 1)**

The difference in the prevalence and location of PSAA may be due to the differences in the sample size or the methodology of the other studies. According to solar et al, in their study they demonstrated that there is anastomosis between PSAA and IOA which was found in 100% of cadaveric specimen. This suggests that not detecting PSAA on CT scans does not necessarily mean that the artery is missing or absent. It may be due to its small diameter that goes unnoticed. Another reason could be that the studies conducted on CBCT could better identify PSAA's because of their high resolution images.

The location of PSAA was evaluated at three sites, inner cortex, intraosseous and outer cortex. In the present study,of all the PSAA's identified, intraosseous location (55.8%) was the most commonly found followed by outer cortex (25.5%) and the inner cortex (18.6%).Similarly intraosseus location of PSAA was predominantly found by many authors [1,3,4,10,12,64]. Whereas the inner cortex location of PSAA was found only in two studies by **Khojastehpour et al**[59] (49.8%) and **Haghanifer et al**[65] (49.7%) which is in contrast with the present study. **(Table 1, Graph 1a)**

This artery could be located predominantly in males(66.28%) as compared to females (33.72%) which was highly significant. **Kurt et al**[50]**,Park et al**[5]**, Khojastehpour et al**[59] had similar findings in their studies, where this artery was located in 83%, 66.7% and 54.3% of males respectively. In contrast to our findings a study conducted by **Shahidi et al**[64] showed more incidence of PSAA in females(65.7%). When the location of PSAA in males and females were compared, 50.8% of males showed intraosseous location as compared to only 33.72% of females. In 29.82% of males and 17.24% of females the location of PSAA was outer cortex

and 19.29% of males and 17.24% of females showed inner cortex as their location. It can be inferred that intraosseous location is most commonly seen in males and there is significant correlation between location and gender. **(Table 1A, 1B)**

Ilguy et al[4] found that 74.4% of females and 66.4% of males showed intraosseous location. Also 10% of males and 1.9% of females showed outer cortex as their location. In the study conducted by **Khojastehpour et al**[59] they found that inner cortex was the maximally found location for both males and females, 54.3% and 44.2% respectively. The difference of incidence of PSAA among male and female may be due to the difference in the male to female ratio and also the racial differences in the study population.

In the present study we found no correlation between the location of PSAA and the age groups (p value 0.94>0.05) hence it can be inferred that location does not change with age **(Table 1, Graph 1b).**On comparing right and left sides, it was found that PSAA's were found equally on both right and left. This was in accordance with the results of several authors who found PSAA equally on right and left sides[3,50,65]. **(Table 1C - 1F)**

If the approximate distance of the PSAA from the floor and the medial wall is known, surgeries in this region can be planned in such a way that it does not get traumatized. The PSA artery was detected at a mean distance of 13.34±4.5mm from the medial wall of maxillary sinus. According to **Guncu et al**[1] the mean distance of PSAA from the medial wall was 11±3.8mm in their study. The difference in the mean could be due to different sample size by different authors. **(Table 2)**

Mean distance of PSAA from floor was 13±7.06mm which is almost similar to the findings of **Kurt et al**[50] (13.2mm). **Haghanifer et al**[65] reported the distance of artery to the floor and medial wall increased from first premolar to third molar teeth, ranging from 5.64mm to 9.75mm and 4.3mm to 9.55mm respectively while **Hur et al**[19] reported distance of PSAA to floor for dental areas were 9.4,9.7,10.3,9.6 and 9.5mm for first premolar to third molar teeth.This difference could be due to measuring the distance at five dental areas in the course of the artery. The results would possibly also change, if they are compared in dentate and edentulous patients. Studies have also measured the distance from PSAA to alveolar crest, but this distance will vary due to the crestal bone loss, presence or absence of teeth and periodontal pathologic condition[12,19].**(Table 2)**

In the present study, there was statistically insignificant difference between the distance of PSAA to medial wall and floor of maxillary sinus with age. According to **Haghanifer et al**[65] and **Ilguy et al**[4] as the age increases distance of artery to medial wall decreases which is in contrast with the present study. These differences could be explained by the anatomic variation in thepositions of arteries as they have examined the location of PSAA in different locations from first premolar to third molar. Other reason could be due to the small number of cases evaluated by these authors. **(Table 2, Graph 2)**

There was statistically insignificant difference between distance of PSAA to medial wall and floor among right and left side. **(Table 2C, 2D; Graph 2C, 2D)**When compared among males and females, the distance of artery to medial wall and floor of maxillary sinus was significantly higher in males than in females. The

mean distance of PSAA to medial wall and floor were 15.34±4.5mmm and 13±7.06mm respectively for males, for females it was 11±3.2mm and 10.2±3.5mm respectively. Similar results were found by **Khojastehpour et al[59], Ilguy et al[4]**and **Haghanifer et al[65]**, however no statistical significant difference was found between the male and female by **Kurt et al[50]** and **Panjnoush et al[6]**. The difference between males and females as regards to the distance could be due to the basic difference in the area and volume of maxillary sinuses as the sinuses are usually larger in males. **(Table 2A,2B ; Graph 2A, 2B)**

Damage to the bony canal can cause bleeding at the site of operation which may obscure the vision causing membrane perforation which prolongs the operation and assessment of the sinus membrane reflextion[4]. The incidence of intense bleeding during sinus augmentation procedures, osteotomy and pathologies in maxilla is low when the diameter of PSAA is small[4]. The possibility of having surgical complications is more in larger canals and it should be taken into account before performing surgeries[3].

The mean diameter of the PSAA was found to be 1.460±0.27mm. out of 86 arteries located, 8.13% of the arteries were <1mm, 11.62% of the arteries were >2mm and 80.23% of the arteries were 1-2mm. In the study conducted by **Guncu et al[1]** and **Kim et al[41]** the mean diameter was 1.3±0.5mm and 1.52±0.47mm respectively which is almost similar to the present study. However **Ibrahim et al[10]**, **Ilguy et al[4]** and **Haghanifer et al[65]** reported mean diameter to be less as compared to the present study (1.15±0.38mm, 0.94±0.26mm and 0.91±0.31mm respectively). Similarly studies conducted by **Guncu et al[1]** and **Tehranchi et al[70]**found that 51.4% and 74.8%

of arteries measured between 1-2mm. Whereas in the studies conducted by **Hayek et al**[3], **Ilguy et al**[4]and **Haghanifer et al**[65]diameter less than 1mm found in 68.1%, 68.9% and 69.81% respectively. **(Table 3, 3A; Graph 3, 3A)**

These differences in the diameter in different studies can be attributed to the use of CBCT which has high resolution and hence has the ability to detect even very small diameters of blood vessels(0.3mm)[65]. Another reason may be attributed to racial differences in the study population.

It was seen that as the age of the subject increased the diameter of PSAA also increased. When the diameters among the males and the females in the study were compared, it was observed that the males predominantly had the larger diameter of PSAA.In males it was observed that as the age of the subjects increased, the diameter of PSAA also increased. Whereas in females it was sesn that as age advanced the diameter of PSAA decreases**.** Similar results were obtained in the study conducted by **Khojastehpour et al**[59] and **Ilguy et al**[4]. However in the studies conducted by **Guncu et al**[1]and **Ibrahim et al**[10] there is no correlation of diameter of PSAA with age and gender. **Mardinger et al**[2] could not find any difference between males and females but found that the diameter was more in older patients. **(Graph 3H-3J)**

This marked relationship between gender and diameter of PSAA could be due to the ability of CT scan which can only detect larger canals[10]. Another reason may be an osteoporotic bone in which the artery is highly detectable, which is primarily seen in elderly patients[59].

Area was measured in coronal section by taking the maximum value of craniocaudal and transverse distance and calculated by multiplying craniocaudal distance and transverse distancewhile volume was measured in coronal and axial section by taking the maximum value of craniocaudal, transverse and anteroposterior distance and calculated by multiplying craniocaudal, transverse and anteroposterior distance and 0.5[69].

In the present study, total average area of the maxillary sinus was 6.66 ± 2.35cm^2 and the volume was 11.96 ± 5.18 cm ^{3}. In the studies conducted by **Kanthem et al[9] , Ariji et al[23],Ariji et al[24] , Attia et al[43], Azhar et al[55], Bangi et al[69]**and where they found larger area (8.5 to 10.2cm^2) and volume(14cm^3 to 31cm^3) of maxillary sinus. This discrepancy may be due to different geographical population used sample size collection and different methods of calculating the dimensions. The data which was automatically computed were14-17% higher than the manually calculated volume[38]. **(Table 4)**

There is no significant difference between area and volume of maxillary sinus in different age groups.(P-value 0.92>0.05, P-value 0.34>0.05). However according to **Ariji et al[24]**and **Ozdikici et al[72]** there was statistically significant difference among age groups, in which as age increased size of the maxillary sinus decreased. After birth, the maxillary sinus continues to pneumatize into the developing alveolar ridge as the permanent teeth erupt. At the age of 20 years with the completion of the eruption of third molars , pneumatization of sinus ends. The change in adult maxillary sinus volume with age isthought to be related to the presence or absence ofposterior maxillary teeth[68]. **(Table 4, Graph 4)**. There was no significant difference observed

between the area and volume of right and the left MS. **Ariji et al[24],Sahlstrand-Johnson et al[38]** and **Attia et al[43]**; also found results similar to present study.**(Table 4C - 4F)**

The area of the maxillary sinus was significantly more in males as compared to females. This was in accordance with the studies conducted by several Indian authors[9,48,70]. Whereas no significant difference was seen between males and females in the studies conducted by **Ariji et al[24], Kawarai et al[28], Attia et al[43]**and **Ozdikici et al[72].** This could be due to population variation as our study was carried out in Indian population.**(Table 4A,4B; Graph 4A, 4B)**

Other complications that may interfere while performing surgeries are the anatomical variations of maxillary sinus which includes septas. The septae are composed of cortical bone and may be either complete or partial[7]. Septae can be seen in many patterns like complete horizontal, partial horizontal, complete perpendicular, partial perpendicular, single or multiple(2 or 3)[14]. Due to presence of septa, during the maxillary sinsus surgeries it can obstruct the proper visualization of the maxillary cavity so there are chances of membrane perforation[8].

In the present study, out of 400 maxillary sinus,190(47.5%)sinuses showedseptas. Whereas in the studies conducted by **Bornstein et al[67], Sigaroudi et al[14] , Orhan et al[45]** septas were found in the range of 55% to 69%. This difference could be due to the thickness of the imaging slice, septae may be missed if the slice thickness is more. **(Table 5)**

Overall maxillary sinuses of 97 (48.5%) females and 93(46.5%) males had septa which is almost equal for both the genders. Similar results were found by **Orhan et al**[45]**, Bornstein et al**[67]**, Kannaperuman et al**[58] 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**[7] (54.5% males, 45.4% females) and female predilection were seen in the study conducted by **Sigaroudi et al**[14] (61.2% females, 38.8% males). This variation may be due to the different methodology used and variations in sample size and population.**(Table 5A, 5B; Graph 5A,5B)**

In the present study, the number of maxillary sinus having septas were independent of the age group similar results were obtained by **Orhan et al**[45]. When compared among right and left, 93 septas (48.95%) were on right side while 97 septas (51.05 %) were on left side. This is in accordance with other studies who also did not find any significant difference between right and left[7,35,45,67,71].**(Table 5, Graph 5)**

While viewing the maxillary sinuses one should look for other incidental findings like mucosal thickening, opacification, polypoid mass, neoplasms, etc should be viewed in the imaging field.For dental implant siteassessment in the maxilla, the configuration and status of themaxillary sinus is important to assess the available amount ofbone. If a sinus lift is indicated, the visualization is useful,because the success rate of sinus lift procedures is cruciallydependent on the configuration and status of the maxillarysinus.Hence, in order to avoid unnecessary treatment orprovide appropriate treatment planning and follow-up, the significanceof incidental pathologic findings should be clarified[73,74].

Although in the present study, out of all the 400 maxillary sinsuses, such incidental pathologies were seen in 159(39.75%), previous studies have only reported an occurrence of such pathologies in only 14% to 58%[44,53,57,73,74,75].**(Table 6)**

Such difference may be due to the difference in the sample size in different studies and differences in the population. Other reason could be due to use of different imaging modalities for detection of maxillary sinus pathologies.

The pathologies in the maxillary sinus like mucosal thickening(mucositis), polyps, opacification(sinusitis) were evaluated. Mucosal thickening is the thickening of more than 1 mm in any wall of the maxilla. Polypoid lesions are the homogenous round opacities with distinct demarcating boundaries at the base of the maxillary sinus. Complete opacification is the completely opacified maxilla in all axial and coronal slices suggestive of maxillary sinusitis[44]. Out of all the pathologies,mucositis was the most commonly seen 101(63.52%) followed by sinusitis 36(22.64%) and polyp 22(13.83%). These results were in accordance with the studies conducted by several authors where mucositis were found maximally[73,74,75]. The variation in the results may be due the slice thickness of 1 mm which was used in our study, this could also have influenced the high occurrence of mucosal thickening in our study. **(Table 6, Graph 6)**

Maxillary sinus pathologies did not show predilection for any particular age group (P value is 0.06>0.05). The studies conducted by **Limet al[44], Raghav et al[74] , Drumond et al[75]** also had the similar results. No significance of age could be due to the fact that the patients varied in age from 20 to 59 years of age and did not include patients under 12-years of age. The formation of their MS is still incomplete and

certain abnormalities such as mucosal thickening and opacification are common findings in early childhood[76].**(Table 6,Graph 6)**

Total 76 pathologies were present on the right side while 83 were present on left side. There was significant difference between the pathologies on the right and the left sides. On right side mucositis(50) was maximally seen followed by sinusitis (17) and polyp(9). On left side mucositis (51) was maximally seen followed by sinusitis (19) and polyp(13). These results were in contrast with the studies conducted by **Ritter et al[73], Raghav et al[74]** where they found no difference of occurrence between the right and the left side. **(Table 6C- 6F)**

There is significant difference between males and females among different pathologies in maxillary sinus. Mucositis was seen in 70.7% of males and 51.66% of females. Sinusitis was seen in 20.2% of males and 26.66% of females, polyps were seen in 9.09% of males and 21.66% of females. On the contrary no significant difference in the occurrence of pathologies between males and females was observed by **Malik et al[78]**. The reason could be due to the difference in male and female sample size.**(Table 6A, 6B; Graph 6A, 6B)**

Although PSAA is the most important artery supplying the maxillary sinus, but in CT images only 21.5% could be identified. This suggest that PSAA could have lot of variations and other methods such as CBCT or contrast studies may be useful.

CONCLUSION

The present study was a hospital based observational study carried out in the Department of Oral Medicine and Radiology and Department of Radiodiagnosis.

Preoperative imaging of the maxillary sinus is helpful for the assessment of location of PSAA, its distance from the medial and floor of maxillary sinus, morphology of maxillary sinus and anatomical variations. These may be used to adjust the surgical treatment plan to yield more successful treatments and avoid possible complications.

A total of 200 subjects were selected who were referred to radiology department for CT imaging of the brain for various reasons. The location, diameter of PSAA and anatomical variations of the maxillary sinus were assessed. The subjects were divided into four groups consisting of 25 males and 25 females in each group.

From the results of the present study it can be inferred that:

1. In this study, when 400 maxillary sinuses were evaluated the PSAAcould be located in only 21.5% of cases.

2. The intraosseous location (55.8%) was the most common followed by outer cortex (25.5%) and the inner cortex (18.6%).

3. There was significant correlation between location and gender with intraosseous location being most common in males.(P value 0.05)

4. In the present study no correlation was found between the location of PSAA and age. (p value 0.94>0.05)

5. The mean distance of PSAA from the floor of maxillary sinus was found to be 13±7.06mm.

6. The mean distance of PSAAfrom the medial wall of maxillary sinus was found to be 13.34±4.5mm.

7. There was statistically insignificant difference between distance of PSAA to medial wall and floor among age and gender.

8. There was statistically insignificant difference between distance of PSAA to medial wall and floor among right and left side.

9. The mean diameter of the PSAA was 1.460±0.27mm. It was observed that the males predominantlyhad larger diameter of PSAA.

10. There was statisticallysignificant difference between age and diameter of PSAA. As the age of the subject increased the diameter of PSAA also increased.

11. In the present study, total average area of the maxillary sinus was 6.66 ± 2.35cm^2 and the volume was 11.96 ± 5.18 mm^3

12. There is no significant difference between area and volume of maxillary sinus in different age groups.(P-value 0.92>0.05, P-value 0.34>0.05)

13. There was no significant difference observed between the area and volume of right and the left MS.

14. The area of the maxillary sinus was more in males as compared to females and this was statistically significant.

15. In the present study, out of 400 maxillary sinuses,190 (47.5%) maxillary sinus showed septa. Overall 48.5% females and 46.5% of males had septa.

16. The maxillary sinuses having septa were independent of the age group.

17. When compared among right and left side of MS, 93(48.95%) MS had septas on right side while 97(51.05%) MS had septas on left side and found to be almost similar.

18. There was statistically insignificant difference between the presence of septa among right and left side of maxillary sinus.

19. More number of pathologies in maxillary sinus were detected in males as compared to females.

20. Maxillary sinus pathologies did not show predilection for any particular age group. There was significant difference between the pathologies on the right and the left sides in males and females.

LIMITATIONS

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

2. Studies have shown that, when compared between the results of manually and automatically calculated volume, the data calculated from the automatically calculated volume were more accurate than manually calculated volume.

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. The use of recently developed CBCT scan is recommended as a routine examination as a diagnostic tool in dentistry. It could better identify the location and diameter of PSAA, even very small diameters of PSAA can be measured. Also it has a shorter scan time(<30sec), higher resolution, good spatial resolution and lower radiation exposure than CT.

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TABLES AND GRAPHS

Table 1. Overall distribution of location of PSAA according to age groups in different sites.

Location	Group I	Group II	Group III	Group IV	Total Frequency	Percentage	p-value
Inner cortex	4	2	4	6	16	18%	*0.94(NS)
Intraosseous	12	13	16	7	48	55.6%	
Outer cortex	4	8	6	4	22	25.5%	
Total present	20	23	26	17	86	21.5%	
Percentage	23.2%	26.7%	30.2%	19.7%			

*p value obtained using one way ANOVA test. NS- not significant at 5% level of significance.

Table 1.A. Distribution of location of PSAA in male patients.

	Inner cortex	Intraosseous	Outer cortex	Total	P-value
Total present	11	29	17	57(66.28%)	*0.013(S)
Not present	5	19	5	29	
Total	16	48	22	86	
Percentage	19.29	50.8	29.82		

*p-value is obtained using one way ANOVA test. S –significant at 5% level of significance.

Table 1.B. Distribution of location of PSAA in female patients

	Inner cortex	Intraosseous	Outer cortex	Total	P-value
Total	5	19	5	29(33.72%)	*0.01499(S)
Not present	11	29	17	57	
Total	16	48	22	86	
Percentage	17.24	65.5	17.24		

*p-value is obtained using one way ANOVA test. S – significant at 5% level of significance.

Table 1.C. Distribution of location of PSAA on right side of MS in male patients

Age groups	Inner cortex	Intraosseous	Outer cortex	Total	p- value for location	P value for age groups
I	1	5	1		*0.029(S)	*0.935(NS)
II	1	3	3			
III	1	6	1			
IV	2	3	1			
Total	5	17	6	28(49%)		
Not Present	6	12	11	29		
Total	11	29	17	57		
Percentage	17.8	60.7	21.4			

*p-value is obtained using two way ANOVA test. S – significantand NS- not significant at 5% level of significance.

Table 1.D. Distribution of location of PSAA on left side of MS in male patients

Age groups	Inner cortex	Intraosseous	Outer cortex	Total	P- value Location	P value for group
I	3	4	3		*0.044(S)	*0.047 (S)
II	1	2	2			
III	1	4	4			
IV	1	2	2			
Total	6	12	11	29(50.8%)		
Not present	5	17	6	28		
Total	11	29	17	57		
Percentage	20.68	41.37	37.93			

*are obtained using two way ANOVA test, S-significant at 5% level of significance

Table 1.E. Distribution of location of PSAA on right side of MS in female patients

Age groups	Inner cortex	Intraosseous	Outer cortex	Total	P- value for location	P value for groups
I	0	3	0		*0.034(S)	*0.58(NS)
II	0	3	2			
III	1	4	0			
IV	1	1	0			
Total	2	11	2	15(51.72%)		
Not present	3	8	3	14		
Total	5	19	5	29		
Percentage	13.33	73.33	13.33			

*p-value is obtained using two way ANOVA test. S – significant and NS- not significant at 5% level of significance.

Table 1.F. Distribution of location of PSAA on left side of MS in female patients

Age groups	Inner cortex	Intraosseous	Outer cortex	Total	P- value for location	P-value for group
I	0	0	0		*0.38 (NS)	*0.007(NS)
II	0	5	1			
III	1	2	1			
IV	2	1	1			
Total	3	8	3	14(48.27 %)		
not present	2	11	2	15		
Total	5	19	5	29		
percentage	21.4	57.14	21.4			

*p-value is obtained using twoway ANOVA test. NS- not significant at 5% level of significance.

Table 2. Distance(in mm) of PSAA from medial wall and floor of MS.

Distance (age groups)	Medial wall	Floor
I	15.34±4.525	13.428±7.061
II	13.685±4.8703	14.75±8.281
III	14.68±2.9665	14.102±8.307
IV	14.8±2.407	12.422±3.638
Overall	13.34±4.5	13±7.06
P-value	*0.992(NS)	*0.074(NS)

*p-values obtained using one way CHI SQUARE test at 5% level of significance NS-not significant.

Table 2.A. **Distance of PSAA from medial wall and floor of MS in male patients.**

Age groups	Medial wall	Floor
I	16.1±3.8	13.6±8.3
II	11.9±5.03	10.1±7.9
III	14.5±3.07	15.3±8.9
IV	14.6±2.1	13.8±3.1
overall	15.34±4.5	13±7.06
p-value	*0.08(NS)	*0.07(NS)

*p-values obtained using one way CHI SQUARE test at 5% level os significance, NS-not significant.

Table 2.B.Distance of PSAA from medial wall and floor of MS in female patients.

	Female	
Age groups	**Medial wall**	**Floor wall**
I	13.6±8.3	13.2±5.4
II	10.17±7.9	16.05±8.0
III	15.3±8.9	12.9±7.4
IV	13.8±3.1	10.2±3.5
Overall	12.26± 3.2	10.35±2.56
p-value	*0.059(NS)	*0.10(NS)

*p-values obtained using one way CHI SQUARE test at 5% level of significance, S-significant.

Table 2.C. Distance of PSAA from medial wall and floor of MS in male patients according to side.

Age group	Male patients			
	Medial wall		Floor	
	Right	Left	Right	Left
I	15.5±4.2	13.51±3.5	13.7±8.6	13.5±8.5
II	14±8.3	15.4±4.2	7.2±8.4	13.7±8.6
III	13.23±0.74	9.8±6.1	13.1±3.8	13.1±9.1
IV	14.7±3.1	14.6±2.8	14.9±3.9	13.6±2.3
Overall	14.35±3.43	15.106±4.09	13.38±7.73	14.60±7.72
P-value	*0.35(NS)	*0.07(NS)	*0.062(NS)	*0.056(NS)

*p-values obtained using one way CHI SQUARE test at 5% level of significance NS-not significant.

Table 2.D. Distance of PSAA from medial wall and floor of MS in female patients according to side.

Age group	Female patients			
	Medial wall		Floor	
	Right	Left	Right	Left
I	13.4±5.7	NA	13.2±5.4	NA
II	15.7±3.35	17.1±3.38	12.97±3.93	17.3±9.2
III	15.97±1.8	13.7±2.56	11.6±8.73	14.26±6.8
IV	13.5±1.3	14.2±0.91	8.2±3.93	11.01±4.35
Overall	13.2±1.2	13.5±0.12	7.2±3.3	13.59±3.5
P-value	*0.058(NS)	*0.13(NS)	*0.024(S)	*0.013(S)

*p-values obtained using one way CHI SQUARE test at 5% level of significance, S-significant, NS- not significant

Table 3. Variation of diameters(in mm) of PSAA according to age groups.

Age groups	Diameter<1mm	Diameter 1-2mm	Diameter >2mm	*p-value
I	1.09±0.41	1.61±0.28	2.125±0.125	0.021(S)
II	0.75±0.07	1.55±0.29	2.466±0.288	0.013(S)
III	1.2±0.43	1.51±1.23	NA	0.139(NS)
IV	NA	1.55±0.28	1.86±0.263	0.26(NS)
Total mean	1.460±0.27mm			

*Obtained using one way ANOVA test at 5% level of significance.S-significant, NS-not significant. NA- not available

Table 3.A. Overall frequency and percentage of diameter of PSAA

	Diameter <1mm	Diameter 1-2mm	Diameter >2mm
Frequency	7	69	10
Percentage	8.13	80.23	11.62

Table 3.B. Variation in diameter of PSAA in male patients.

Age groups	Diameter<1mm	Diameter1-2mm	Diameter>2mm	*p-value
I	1.3 ± 0.45	1.59 ± 0.3	2.1 ± 0.077	0.005(S)
II	NA	1.68 ± 0.24	NA	NA
III	1.4 ± 0.44	1.56 ± 0.27	NA	0.68(NS)
Iv	NA	1.52 ± 0.22	1.8 ± 0.23	0.18(NS)
Total	1.24 ± 0.45	1.5 ± 0.28	1.33 ± 0.23	0.0003(S)

*Obtained using one way ANOVA test at 5% level of significance.S-significant, NS-not significant. NA- not available

Table 3.C. Variation in diameter of PSAA in female patients.

Age groups	Diameter <1mm	Diameter 1-2mm	Diameter >2mm	*p-value
I	0.9 ± 0.0	1.8 ± 0.0	2.4 ± 0.0	0.002(S)
II	0.7 ± 0.0	1.4 ± 0.29	2.4 ± 0.25	0.0001(S)
III	0.85 ± 0.07	1.48 ± 0.39	NA	0.21(NS)
IV	NA	1.53 ± 0.30	1.87 ± 0.26	0.211(NS)
Total	0.69 ± 0.03	1.45 ± 0.31	1.9 ± 0.21	0.02(S)

*Obtained using one way ANOVA test at 5% level of significance.N-not significant,S-significant. NA- not available

Table 3.D. Variation in diameter of PSAA in male patients on right side of MS

Age groups	Diameter<1mm	Diameter1-2mm	Diameter>2mm	*p-value
I	1.3 ± 0.45	1.59 ± 0.3	2.1 ± 0.077	0.005(S)
II	NA	1.68 ± 0.24	NA	NA
III	1.4 ± 0.44	1.56 ± 0.27	NA	0.68(NS)
IV	NA	1.52 ± 0.22	1.8 ± 0.23	0.18(NS)
Total	1.24 ± 0.45	1.5 ± 0.28	1.33 ± 0.23	0.0003(S)

*Obtained using one way ANOVA test at 5% level of significance.S-significant, NS-not significant. NA- not available

Table 3.E. Variation in diameter of PSAA in male patients on left side of MS

	Diameter<1mm	Diameter1-2mm	Diameter>2mm	*p-value
III	1.5± 0.52	1.5 ± 0.34	NA	0.98(NS)

*Obtained using one way ANOVA test at 5% level of significance. S-significant, NS-not significant. NA- not available

Table 3.F. Variation in diameter of PSAA in female patients on right side of MS

Age group	Diameter <1mm	Diameter 1-2mm	Diameter >2mm	*pvalue
I	0.9 ± 0.0	1.8 ± 0.0	2.3 ± 0.0	0.001(s)
II	0.7±0.0	1.52 ± 2.15	2.55 ± 0.35	0.059(ns)
III	0.85 ± 0.07	1.63 ± 0.35	NA	0.025(S)
IV	NA	1.35 ± 0.49	NA	NA
Overall	0.86 ± 0.054	1.54 ± 0.298	2.47 ± 0.288	0.019(S)

*Obtained using one way ANOVA test at 5% level of significance.. S-significant, NS-not significant .NA- not available

Table 3.G. Variation in diameter of PSAA in female patients on left side of MS

Age group	Diamter<1mm	Diameter 1-2mm	Diameter >2mm	*p-value
II	NA	1.24 ± 0.33	2.3 ± 0.0	0.04(S)

*Obtained using one way ANOVA testat 5% level of significance,S-significant.NA-not available

Table 3 H. Correlation of diameter of PSAA with age and gender

	Age	Females	Males
Pearson's correlation	0.0499	0.1757	0.1695
P-value	0.042	0.0011	0.0016

P value is calculated with 5 % level of significance

Table 4. Variation of area(in mm^2) and volume(in mm^3) of MS according to age

Age group	Area	Volume
I	645.89 ± 191.15	11653.03 ± 5206.9
II	778.23 ± 285.06	14533.65 ± 6885.131
III	776.38 ± 227.78	13763.71 ± 4684.68
IV	657.78 ±1 91.33	15428.62 ± 5671.622
Total	666.3 ± 235.81	11966.5 ± 5188.34
P-value*	0.92(NS)	0.34(NS)

*Obtained by one way ANOVA test at 5% level of significance. NS- not significant

Table 4.A. Mean area of MS according to gender.

Age group	Male	Female	*P-value
I	1123.20 + 2318.03	708.03 + 203.40	0.025(S)
II	792.14 + 239.10	718.28 + 214.76	0.013(S)
III	777.19 + 271.44	687.57 + 218.29	0.039(S)
IV	687.85 + 274.72	649.07 + 189.31	0.021(S)

*obtained using CHI SQUARE test at 5 % level of significance.S-significant.

Table 4 B. Mean volume of MS according to gender.

Age group	Male	Female	*P-value
I	15165.94 + 6141.53	12850.82 + 4400.01	0.034(S)
II	14828.36 + 5388	12812.47 + 4633.09	0.024(S)
III	13853.2 + 6878.14	12089.57 + 4049.11	0.16(NS)
IV	12340.74 + 6176.5	11678.9 + 3979.85	0.42(NS)

*is obtained using CHI SQUARE test at 5% level of significance. S- significant, NS- not significant

Table 4.C. Mean area of MS for right and left sides in male patients

Age group	Left	Right	*P-value
I	814.14 + 258.38	1432.27 + 3271.80	0.04(S)
II	807.9 + 253.6	776.39 + 227.8	0.12(NS)
III	778.23 + 285.06	776.12 + 263.01	0.057(NS)
IV	657.78 + 237.11	717.92 + 309.82	0.063(NS)

*obtained using CHI SQUARE test at 5% level of significance.S- significant, NS- not significant

Table 4.D. Mean volume of MS for right and left sides in male patients

Age groups	Left	Right	*P-value
I	14307.08 + 7196.14	14811.52 + 6352.07	0.014(S)
II	15178.60 + 5676.02	14478.11 + 5176.67	0.022(S)
III	14533.05 + 6885.13	13173.34 + 6944.13	0.029(S)
IV	11653.03 + 5206.92	13028.45 + 7056.23	0.018(S)

*obtained using CHI SQUARE test at 5% level of significance. S- significant

Table 4.E. Mean area of MS for right and left sides in female patients

Age groups	Left	Right	*P-value
I	711.68 + 204.8	704.38 + 206.15	0.33(NS)
II	758.75 + 228.82	677.80 + 195.93	0.27(NS)
III	713.77 + 247.55	661.37 + 185.95	0.06(NS)
IV	652.24 + 191.34	645.89 + 191.16	0.032(S)

*obtained using CHI SQUARE test at 5% level of significance.S- significant, NS- not significant

Table4.F. Mean volume of MS for left and right sides in female patients

Age groups	Left	Right	*P-value
I	12836.74 + 4504.15	12864.9 + 4386.25	0.067(NS)
II	13507.09 + 4772.9	12117.85 + 4472.75	0.019(S)
III	12197.27 + 3945.56	11981.86 + 4228.73	0.102(NS)
IV	11698.72 + 4118.16	11659.08 + 3921.53	0.23(NS)

*obtained using CHI SQUARE test at 5% level of significance.S- significant, NS- not significant

Table 5. Percentage of septa present on right and left side of maxillary sinus according to age group.

	Septa		
Age groups	**Right**	**Left**	**Total**
I	24	24	48
II	22	27	49
III	22	26	48
Iv	25	20	45
Total	93	97	190
Percentage	48.95	51.05	47.5
***p-value**	0.07(NS)	0.058(NS)	

*Obtained using CHI SQUARE test, at 5% level of significance. NS- not significant

Table5.A. Percentage of presence of septa in male patients according to side.

Age groups	Right	Left	Total	Percentage
I	14	8	22	23.6
II	12	12	24	25.8
III	12	14	26	27.9
IV	15	6	21	22.5
Total	53(56.9%)	40(43%)	93(46.5%)	

Table 5.B. Percentage of presence of septa in female patients according to side.

Age groups	Right	Left	Total	Percentage
I	10	16	26	26.8
II	10	15	25	25.7
III	10	12	22	22.6
IV	10	14	24	24.7
Total	40(41.2%)	57(58.7%)	97(48.5%)	

Table 6. Overall pathologies present according to group.

Age groups	Mocositis	Sinusitis	Polyp	Total
I	15	13	3	31
II	22	4	9	35
III	41	9	5	55
IV	23	10	5	38
Total	101	36	22	159(39.75%)
Percentage	63.52	22.64	13.83	*pvalue=0.06(NS)

*obtained using one way ANOVA at 5% level of significance. NS- significant

Table 6.A. Overall pathologies present in male patients.

Age groups	Mocositis	Sinusitis	Polyp	Total
I	11	8	3	22
II	16	2	3	21
III	25	3	1	29
IV	18	7	1	26
Total	70	20	9	99
Percentage	70.7	20.2	9.09	*p-value=0.0006 (S)

*obtained using one way ANOVA at 1 % level of significance.S- significant

Table 6.B. Overall pathologies present in female patients

Age groups	Mocositis	Sinusitis	Polyp	Total
I	4	5	0	9
II	6	2	6	14
III	16	6	3	25
IV	5	3	4	12
Total	31	16	13	60
Percentage	51.66	26.66	21.66	*pvalue=0.002(S)

*obtained using one way ANOVA at 1 % level of significance, S- significant

Table 6.C.Overall pathologies present on right side of MS in male patients.

Age groups	Mocositis	Sinusitis	Polyp	Total
I	7	5	1	13
II	6	1	1	8
III	14	1	0	15
IV	10	3	0	13
Total	37	10	2	49
Percentage	75.5	20.40	4.081	*p-value=0.0013(S)

*is obtained using one way ANOVA test at 5% level of significance.S-significant.

Table 6.D. Overall pathologies present on left side of MS in male patients.

Age groups	Mocositis	Sinusitis	Polyp	Total
I	4	3	2	9
II	10	1	2	13
III	11	2	2	15
IV	8	4	1	13
Total	33	10	7	50
Percentage	66	20	14	*p-value=0.002 (S)

*P-value is obtained using one way ANOVA at 5% level of significance. S- significant

Table 6.E. Overall pathologies present on right side of MS in female patients

Age groups	Mocositis	Sinusitis	Polyp	Total
I	2	1	0	3
II	3	2	3	8
III	6	3	2	11
IV	2	1	2	5
Total	13	7	7	27
Percentage	48.14	25.92	25.92	*p-value=0.002 (S)

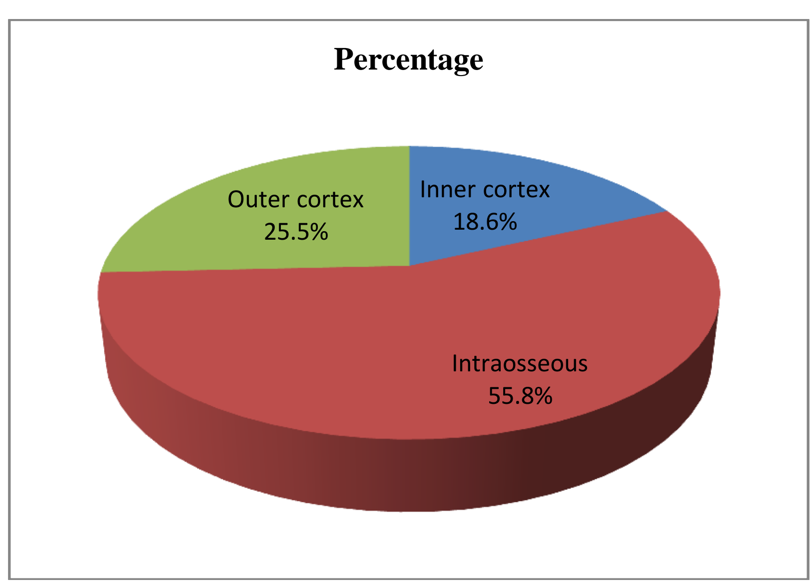
*Obtained using one way ANOVA test at 5% level of significance.S- significant

Table 6.F. Overall pathologies present on left side of MS in female patients

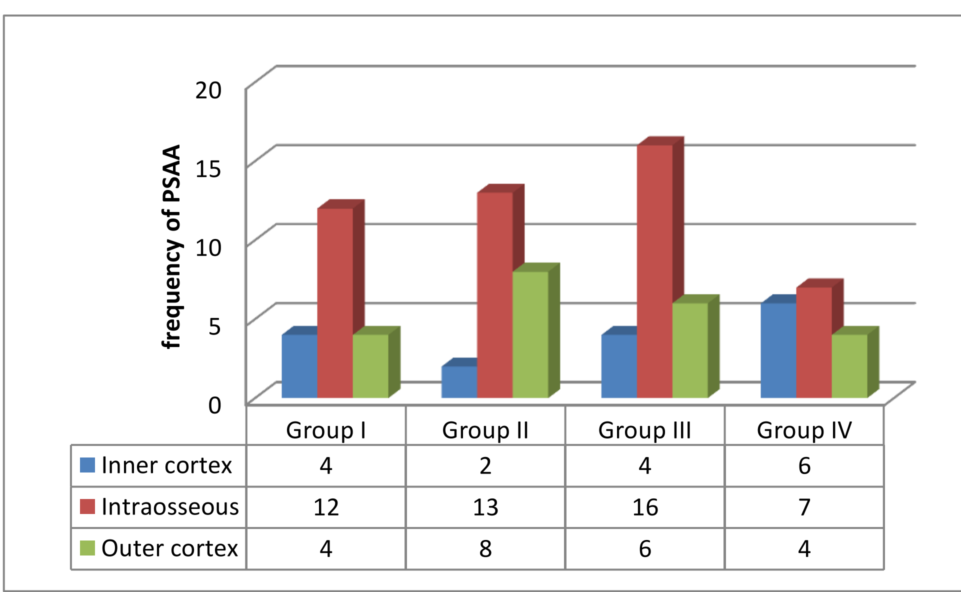
Age groups	Mocositis	Sinusitis	Polyp	Total
I	2	4	0	6
II	3	0	3	6
III	10	3	1	14
IV	3	2	2	7
Total	18	9	6	33
Percentage	54.5	27.2	18.18	*p-value=0.025(S)

*obtained usingb one way ANOVA test at 5% level of significance. S- significant

GRAPHS

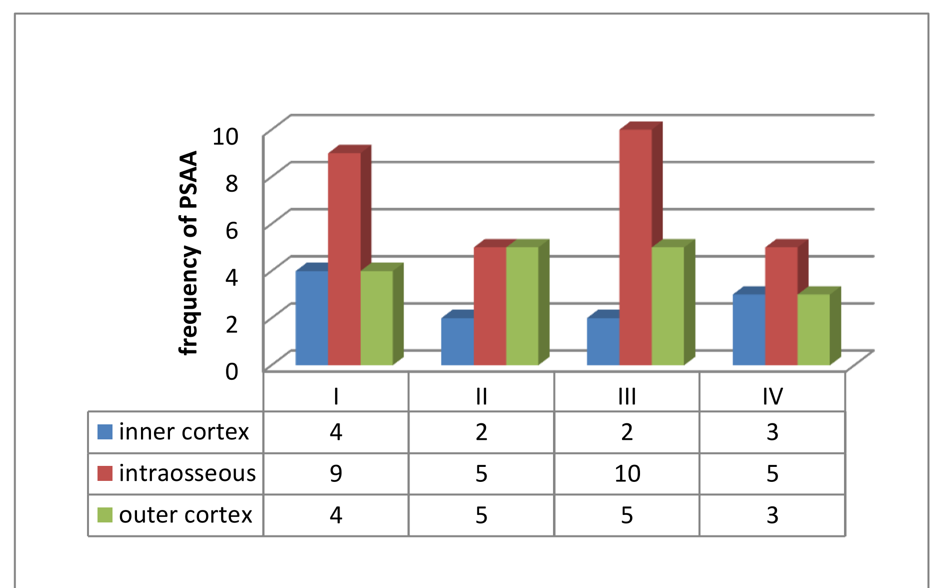


Graph 1a-Pie diagram showing overall distribution of location of PSAA among different sites.

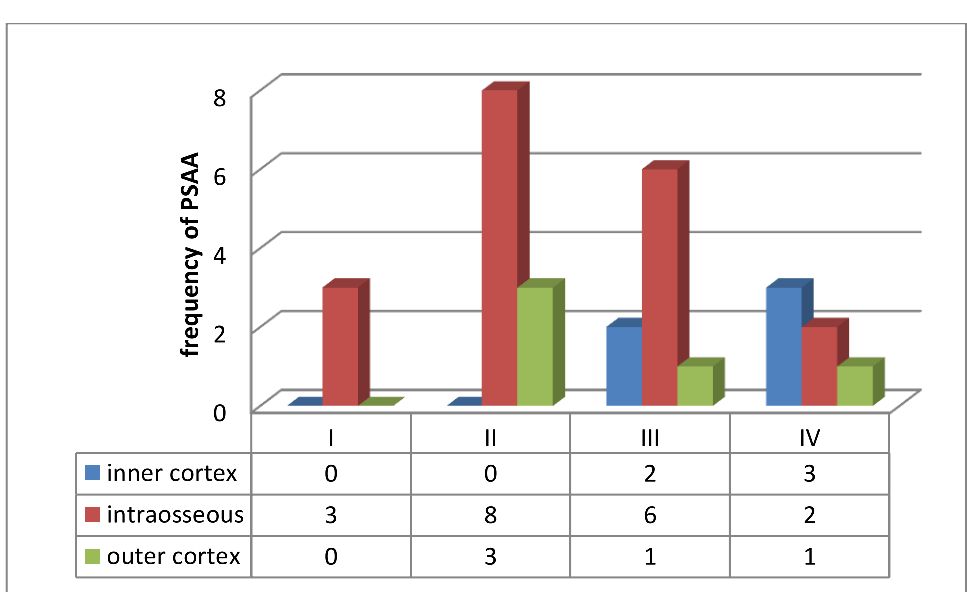


	Group I	Group II	Group III	Group IV
Inner cortex	4	2	4	6
Intraosseous	12	13	16	7
Outer cortex	4	8	6	4

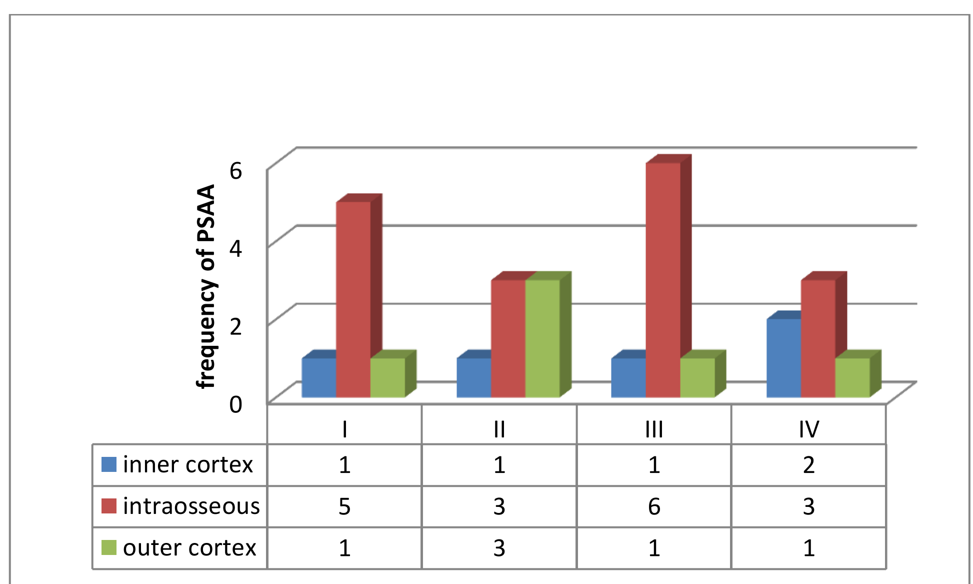
Graph 1b- Bar diagram showing distribution of location of PSAA according to age groups in different sites.



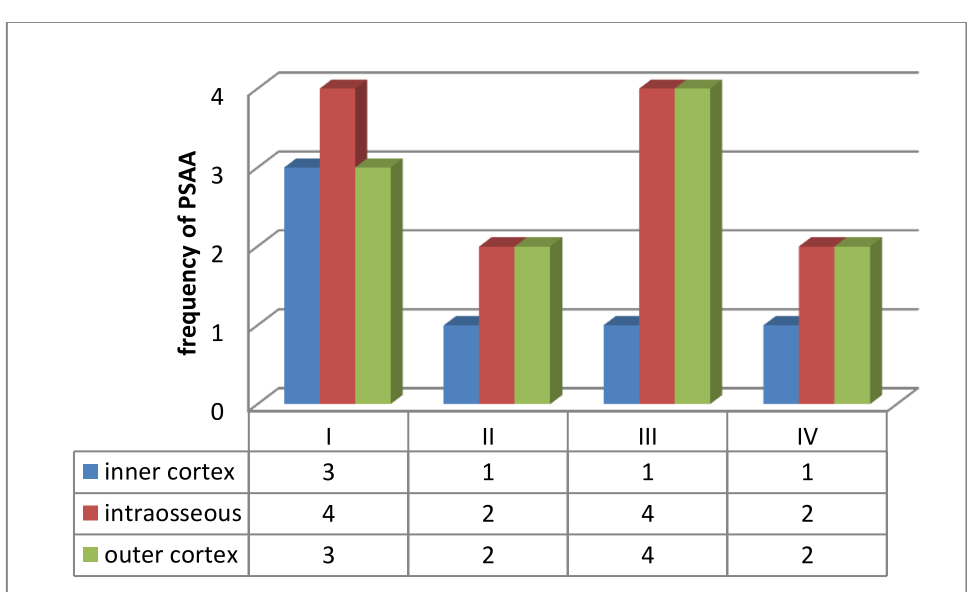
Graph 1 A- Bar diagram showing distribution of location of PSAA in male patients



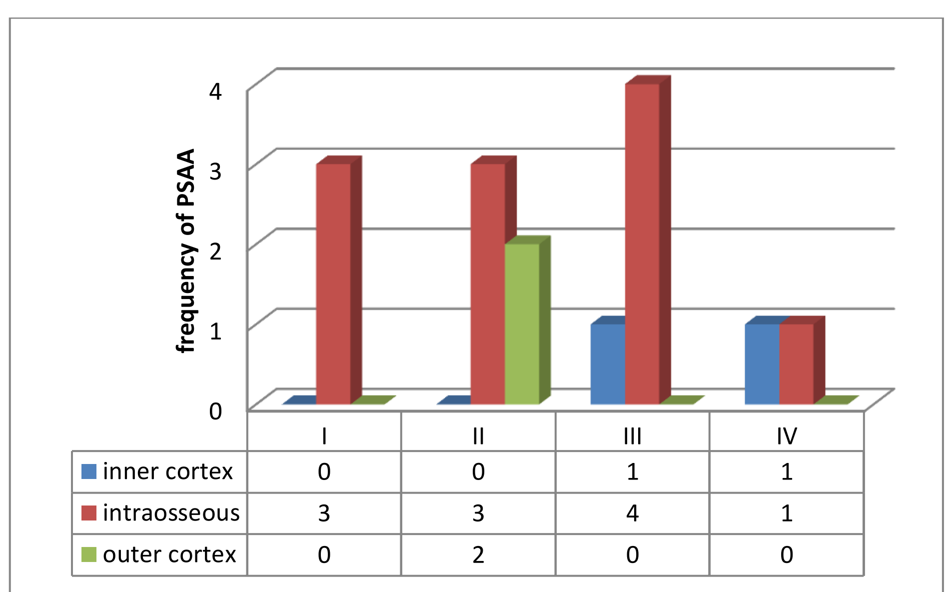
Graph 1 B-Bar diagram showing distribution of location of PSAA in female patients



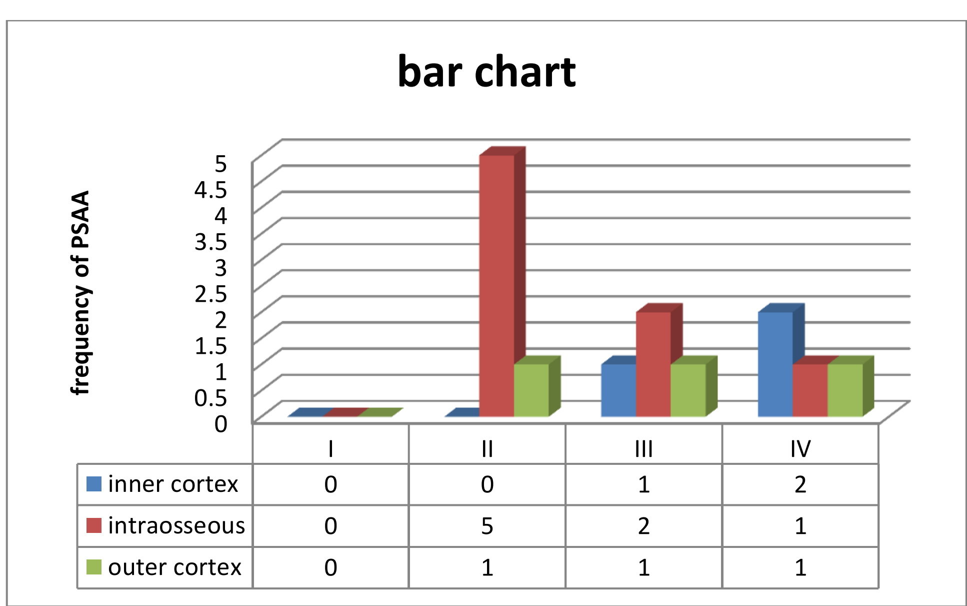
Graph 1C- Bar diagram showing distribution of location of PSAA on right side of MS in male patients



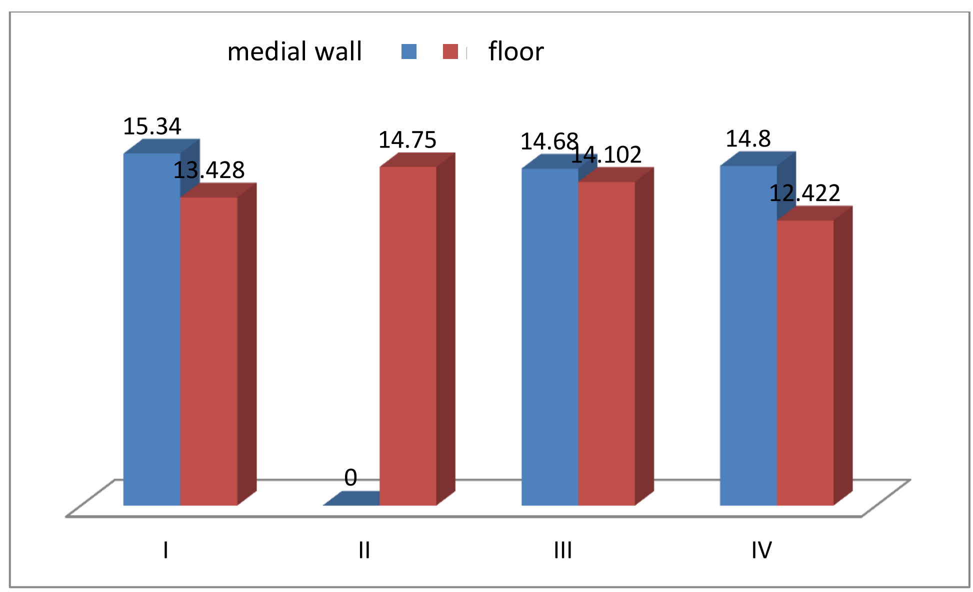
Graph 1 D- Bar diagram showing distribution of location of PSAA on left side of MS in male patients



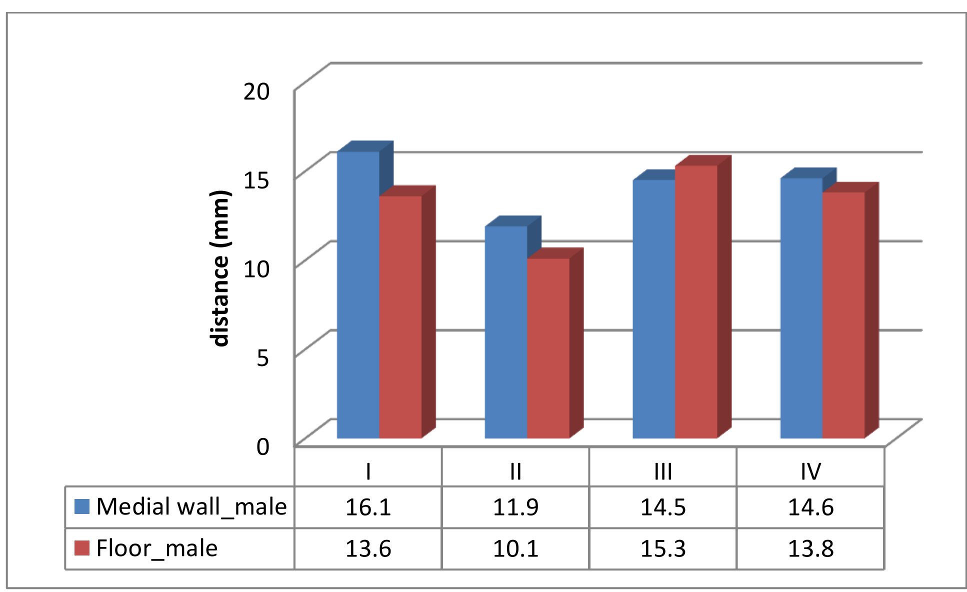
Graph 1E- Bar diagram showing distribution of location of PSAA on right side of MS in female patients



Graph 1 F -Bar diagram showing distribution of location of PSAA on left side of MS in female patients

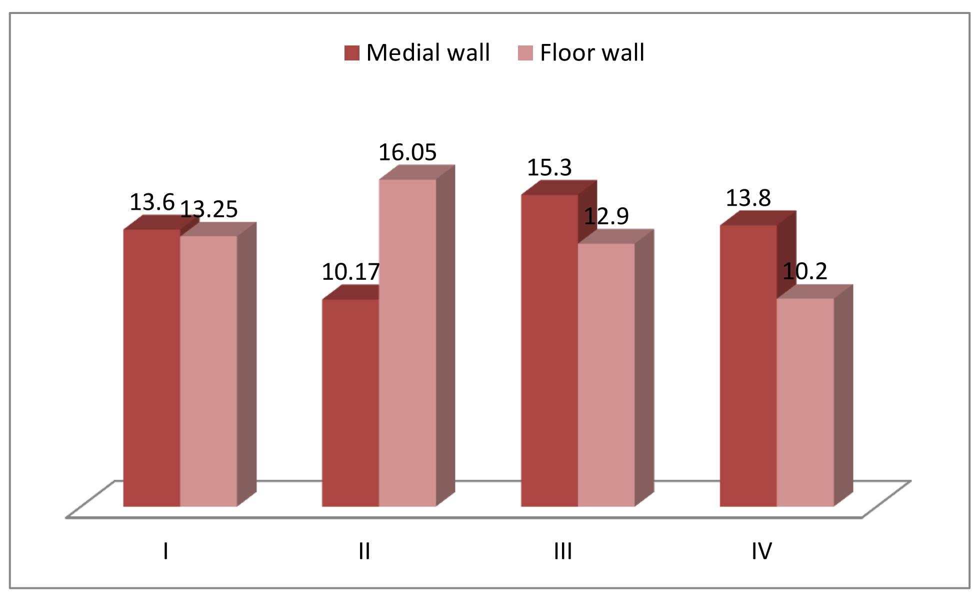


Graph 2- Bar diagram showing distance of PSAA from medial wall and floor of MS.

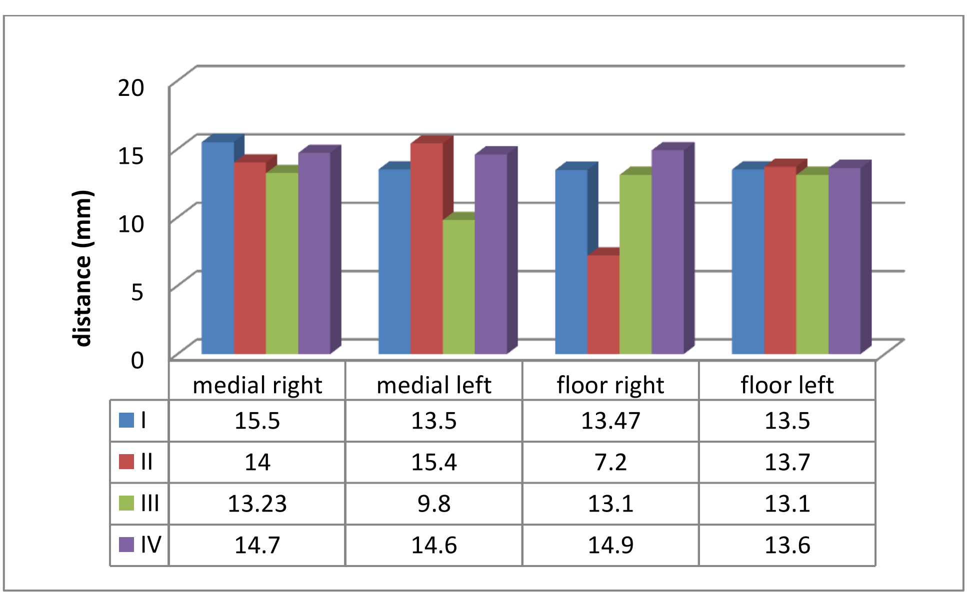


	I	II	III	IV
Medial wall_male	16.1	11.9	14.5	14.6
Floor_male	13.6	10.1	15.3	13.8

Graph 2 A- Bar diagram showing distance of PSAA from medial wall and floor of MS in male patients

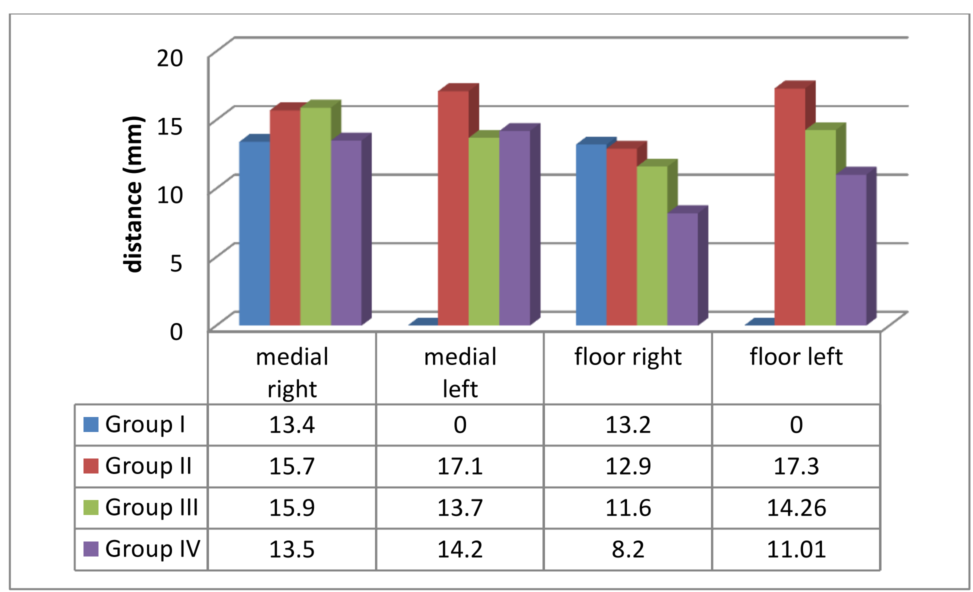


Graph 2 B-Bar diagram showing distance of PSAA from medial wall and floor of MS in female patients.



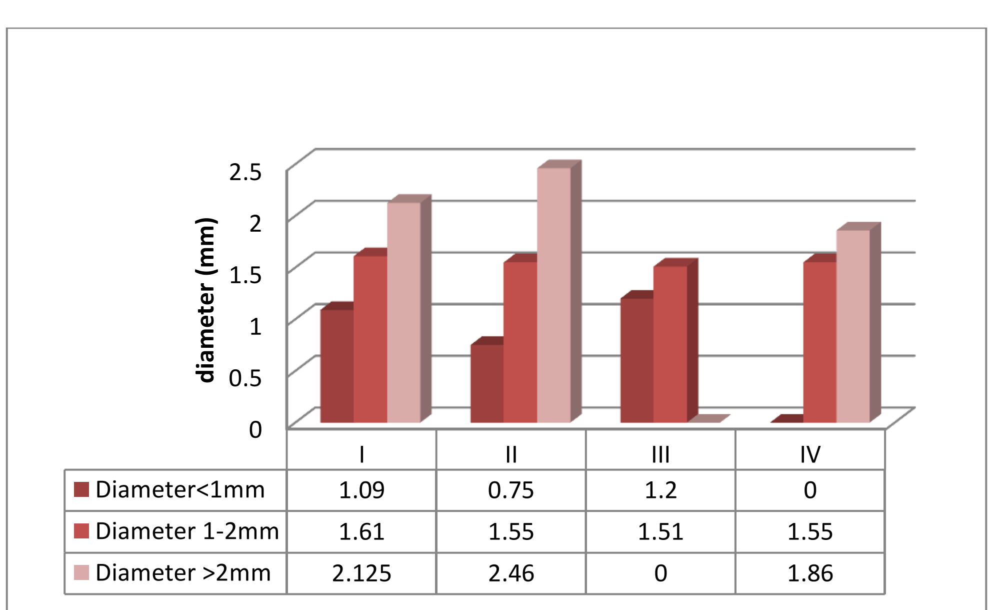
	medial right	medial left	floor right	floor left
I	15.5	13.5	13.47	13.5
II	14	15.4	7.2	13.7
III	13.23	9.8	13.1	13.1
IV	14.7	14.6	14.9	13.6

Graph 2 C- Bar diagram showing distance of PSAA from medial wall and floor of MS in male patients according to side.



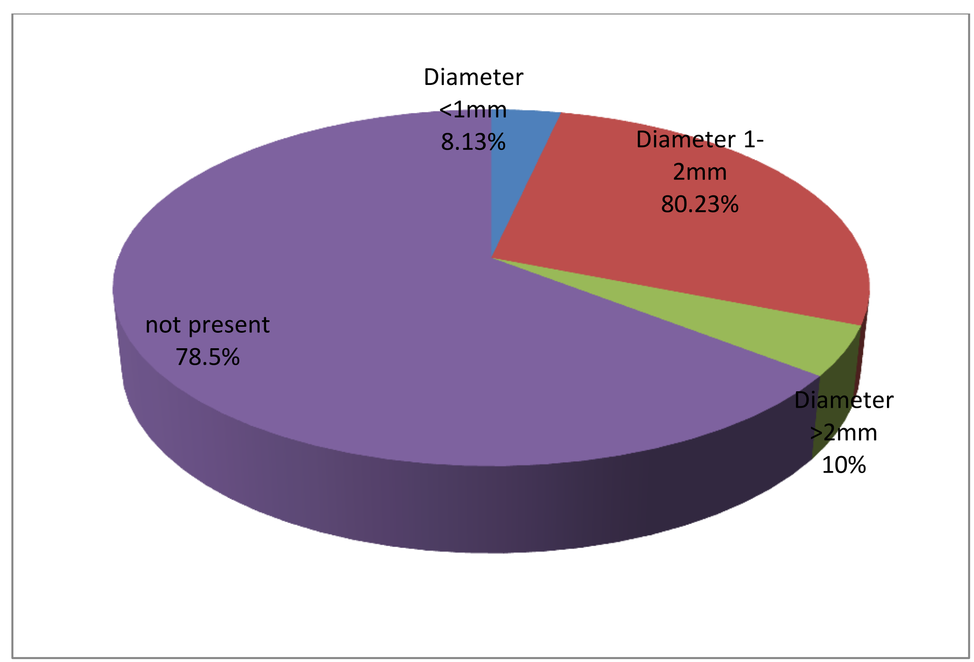
	medial right	medial left	floor right	floor left
Group I	13.4	0	13.2	0
Group II	15.7	17.1	12.9	17.3
Group III	15.9	13.7	11.6	14.26
Group IV	13.5	14.2	8.2	11.01

Graph 2 D- Bar diagram showing average distance of PSAA from medial wall and floorof MS in female patients according to side.

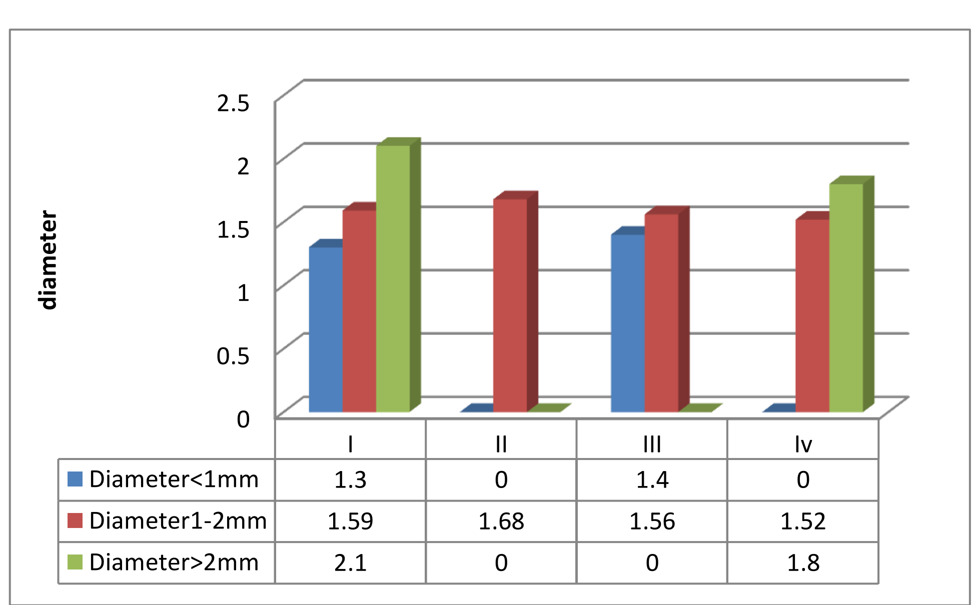


	I	II	III	IV
Diameter<1mm	1.09	0.75	1.2	0
Diameter 1-2mm	1.61	1.55	1.51	1.55
Diameter >2mm	2.125	2.46	0	1.86

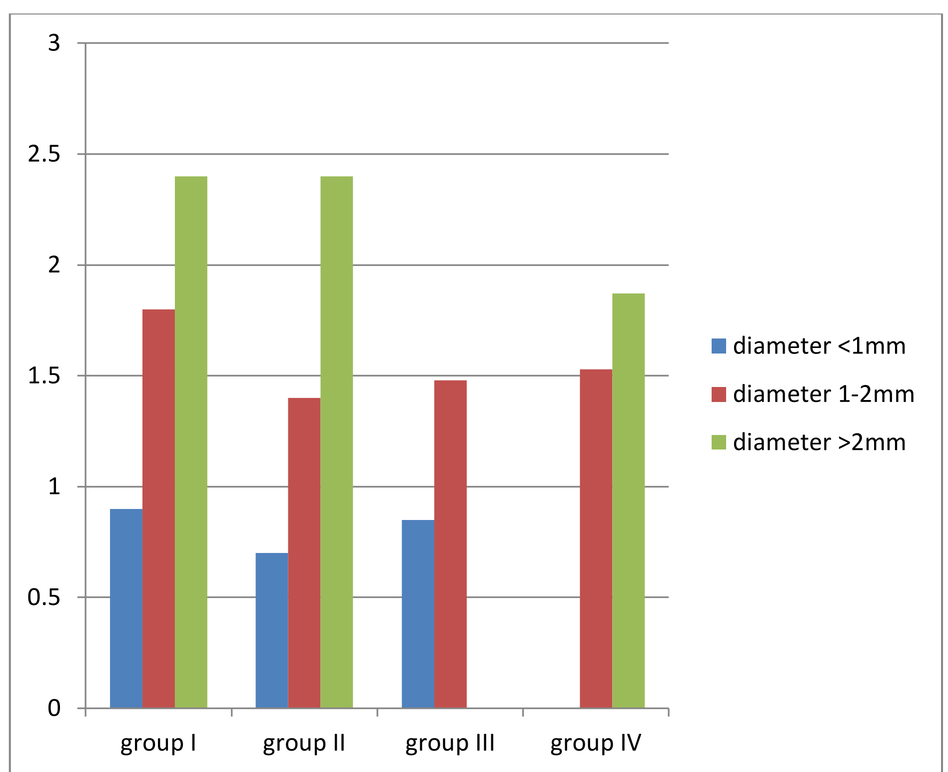
Graph 3-Bar diagram showing variation in diameters(in mm) of PSAA according to age groups



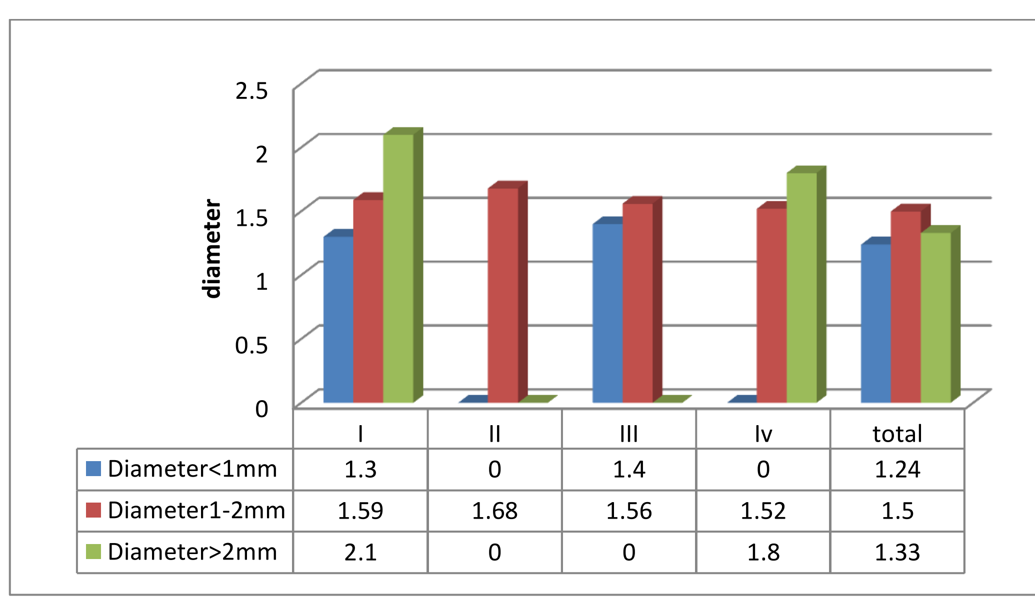
Graph 3 A-Pie diagram showing overall frequency and percentage of diameter of PSAA



Graph 3B-Bar diagram showing variation in diameter of PSAA in male patients

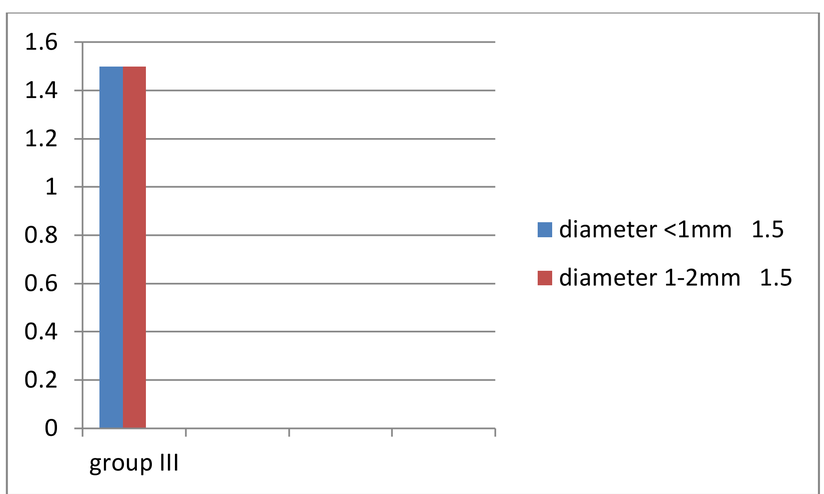


Graph 3 C-Bar diagram showing variation in diameter of PSAA in female patients

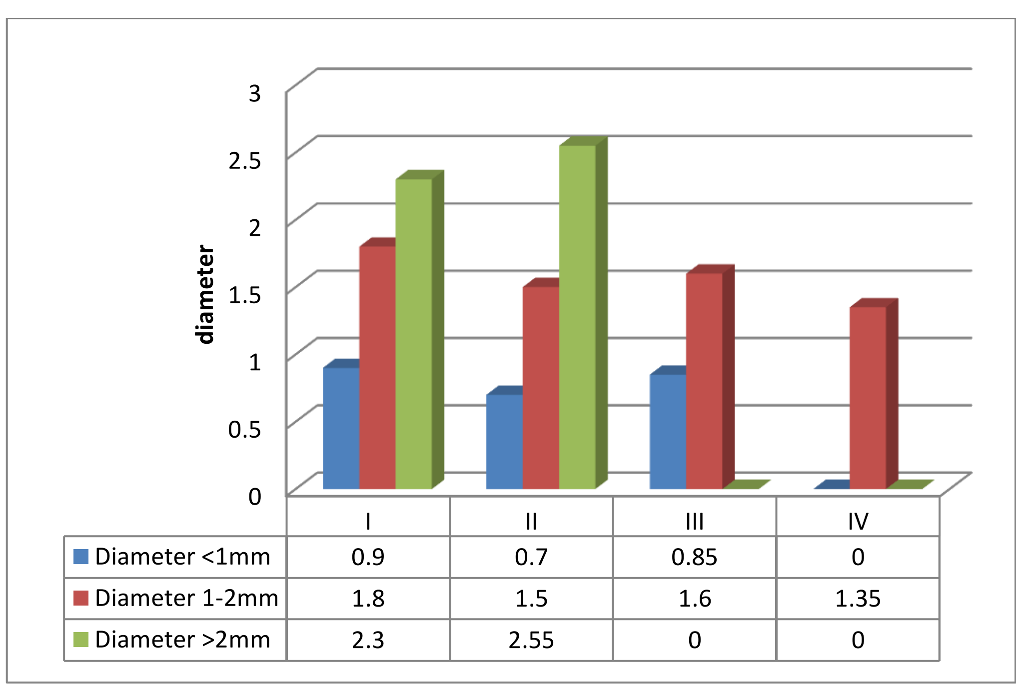


	I	II	III	Iv	total
Diameter<1mm	1.3	0	1.4	0	1.24
Diameter1-2mm	1.59	1.68	1.56	1.52	1.5
Diameter>2mm	2.1	0	0	1.8	1.33

Graph 3 D-Bar diagram showing variation in diameter of PSAA in male patients on right side of MS.

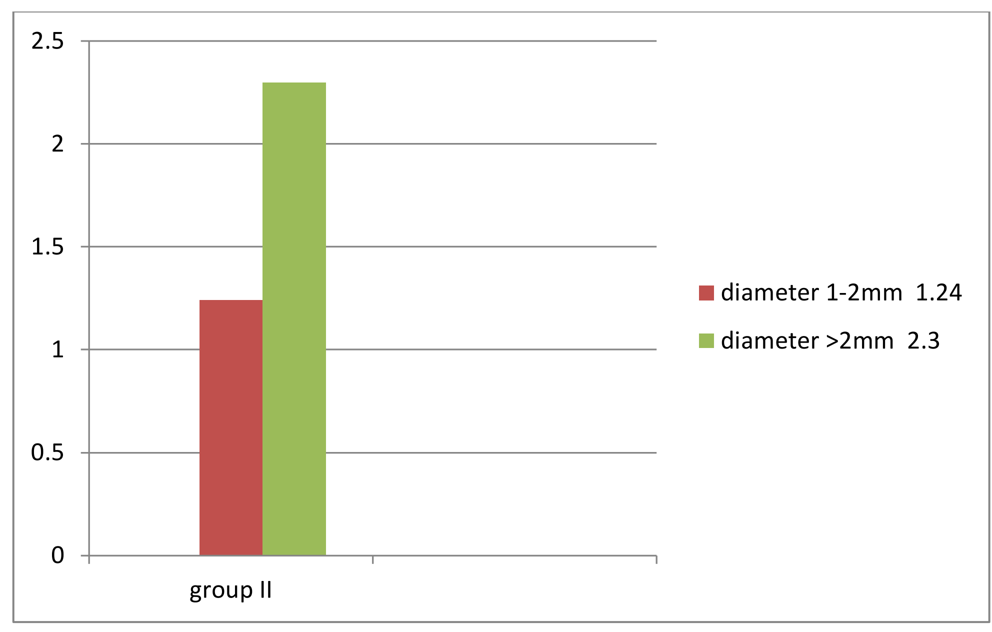


Graph 3 E- Bar diagram showing variation in diameter of PSAA in male patients on left side of MS

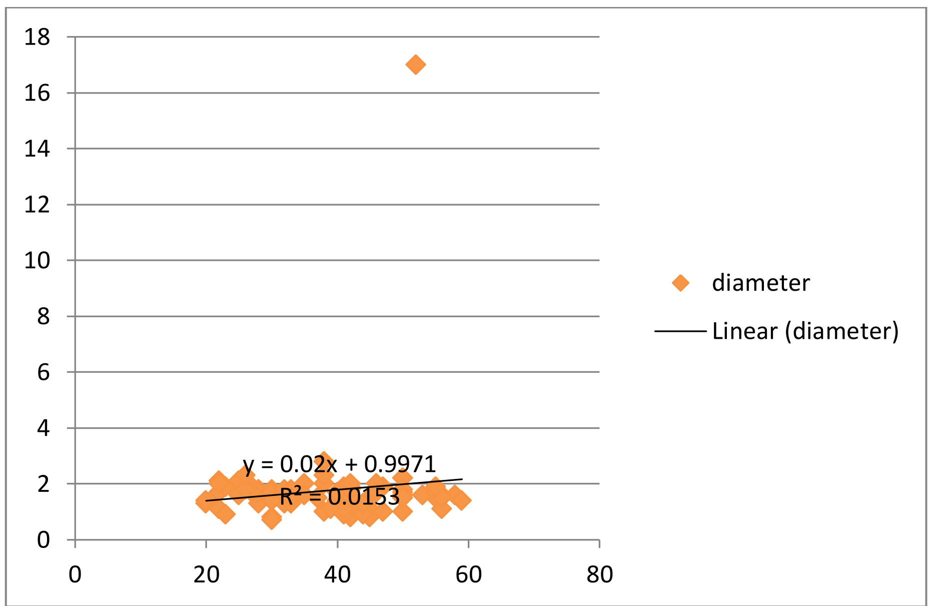


	I	II	III	IV
Diameter <1mm	0.9	0.7	0.85	0
Diameter 1-2mm	1.8	1.5	1.6	1.35
Diameter >2mm	2.3	2.55	0	0

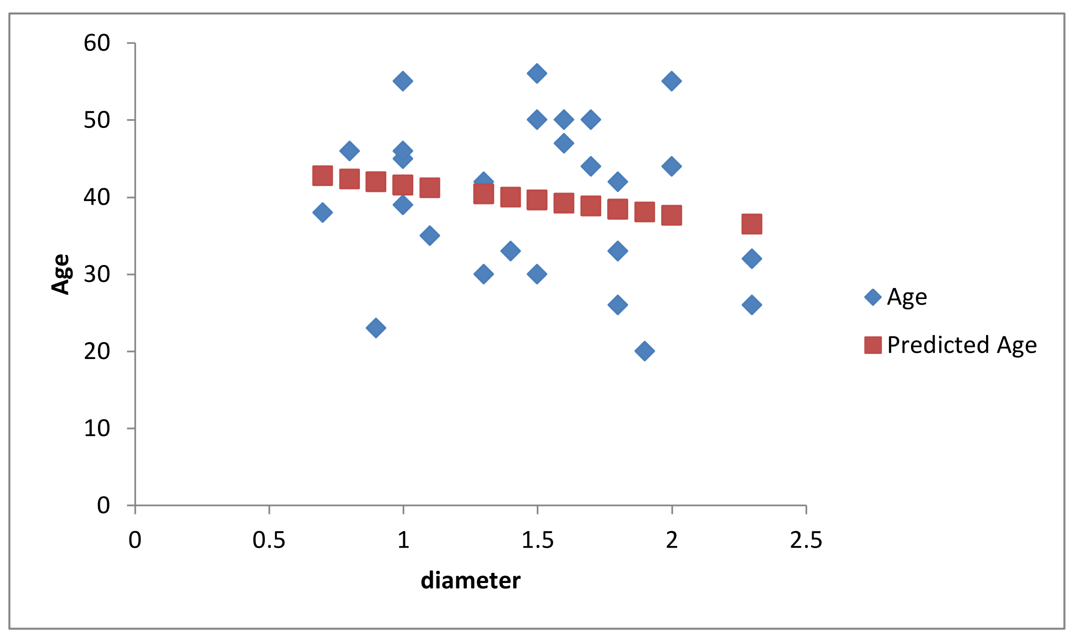
Graph 3 F-Bar diagram showing variation in diameter of PSAA in female patients on right side of MS



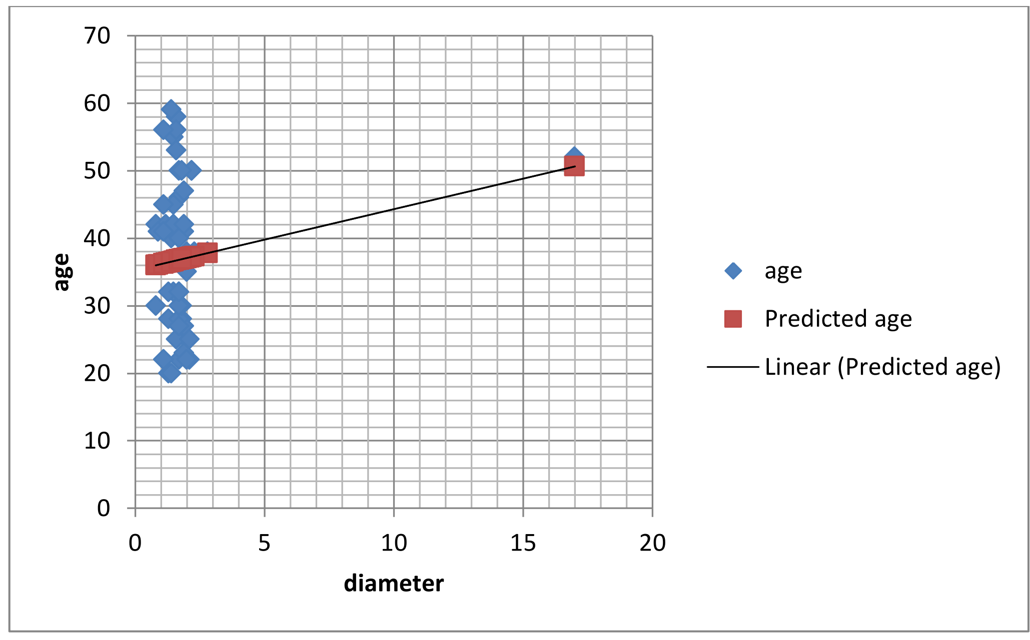
Graph 3 G- Bar diagram showing variation in diameter of PSAA in female patients on left side of MS



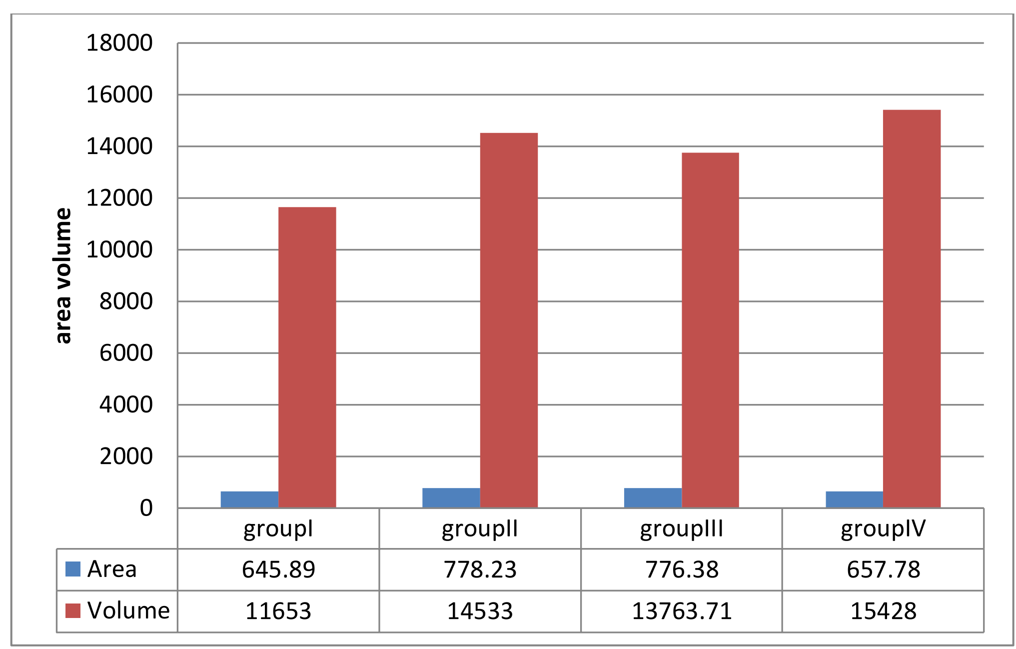
Graph 3 H- Line diagram showing correlation of diameter of PSAA with age



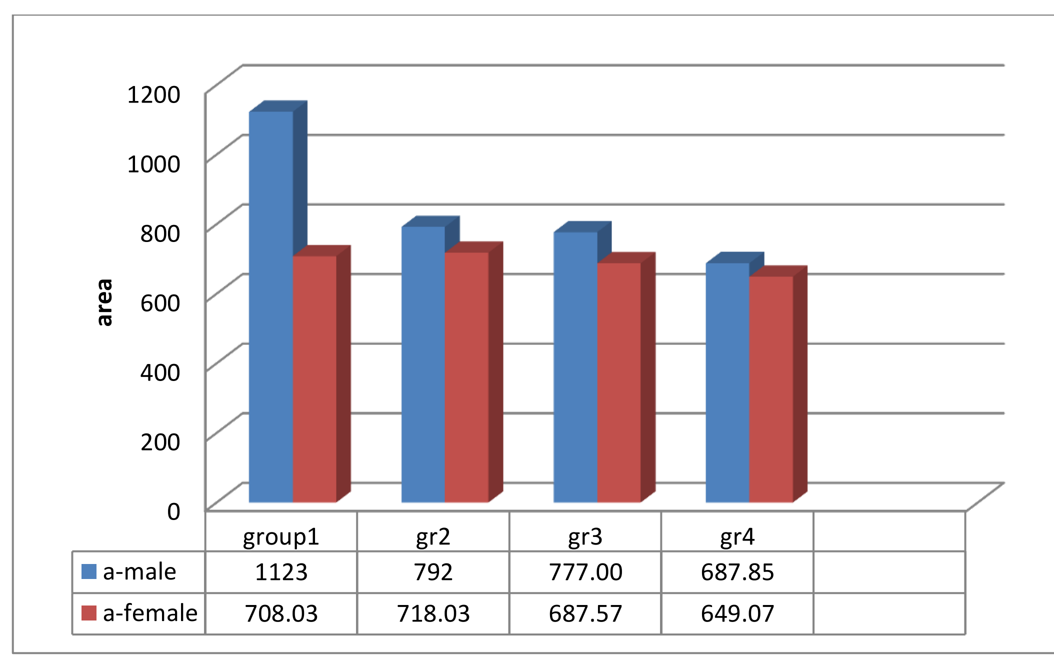
Graph 3 I- Line diagram showing correlation of diameter of PSAAwith females



Graph 3J- Line diagram showing correlation of diameter of PSAA with males

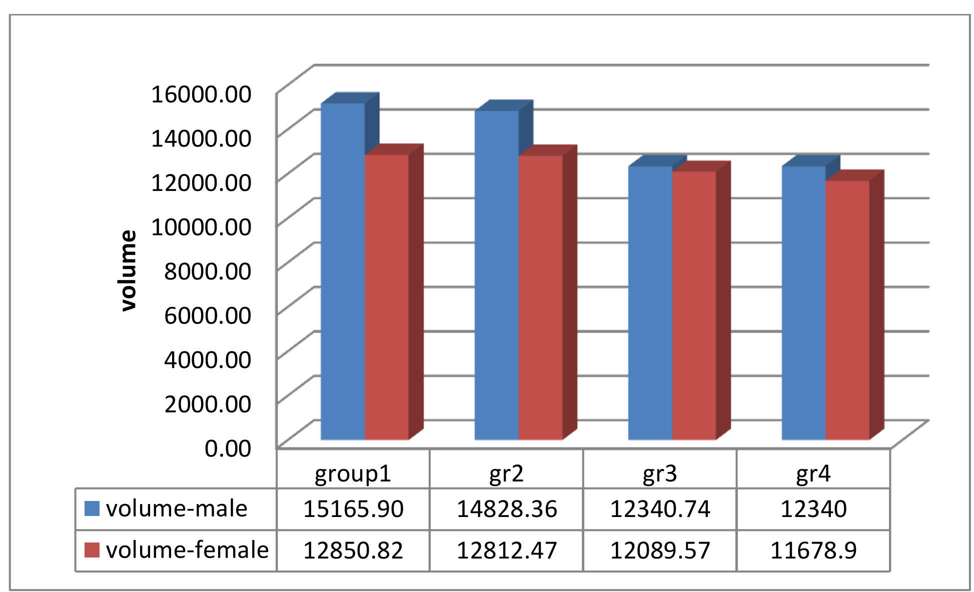


Graph 4- Bar diagram showing variation of area and volume of MS according to age

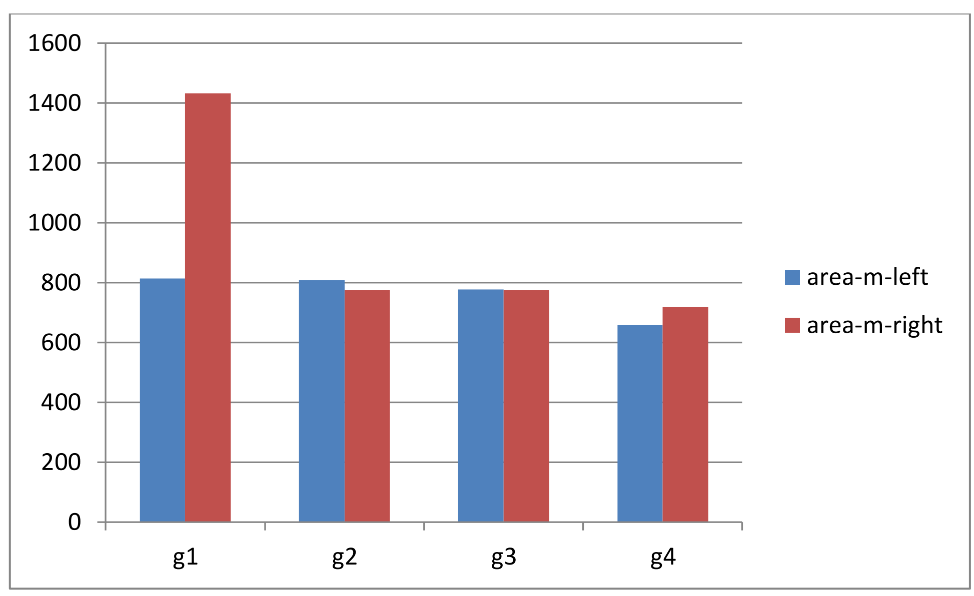


Graph 4 A-Bar diagram showing the mean area of MS according to gender.

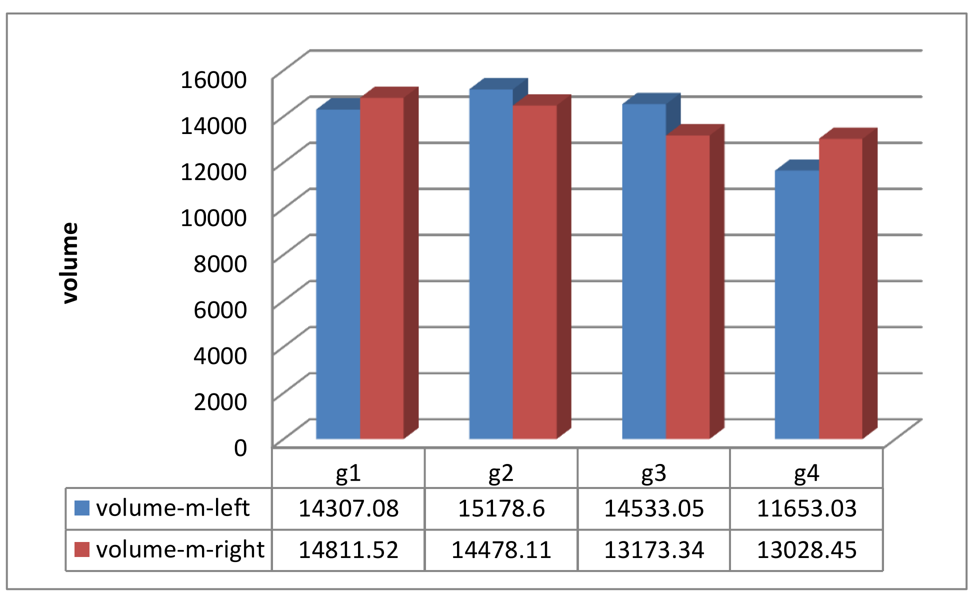
(a- area, gr- group)



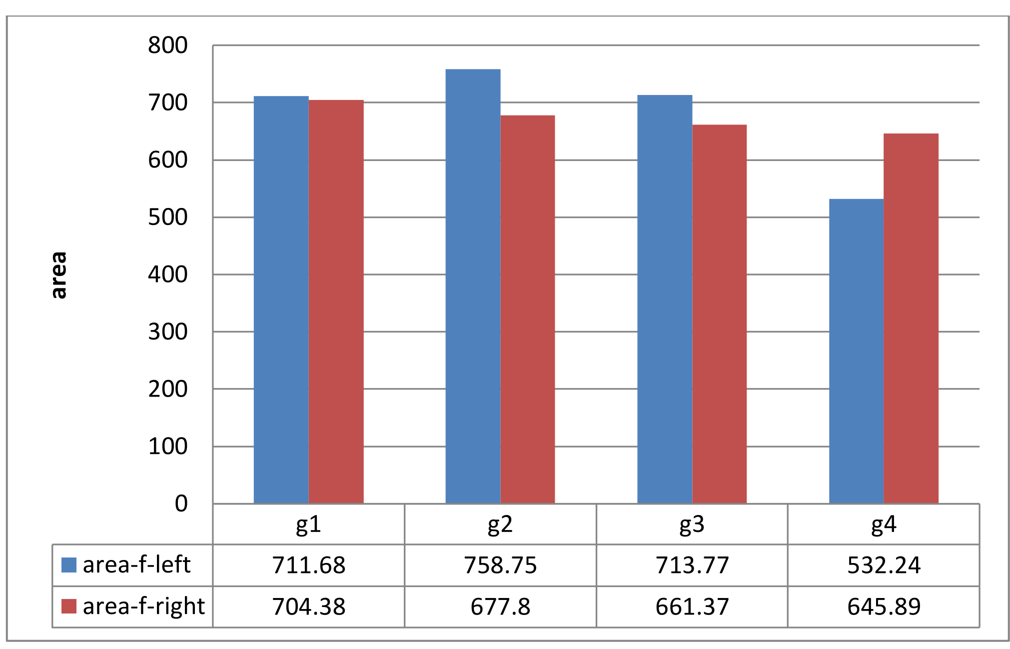
Graph 4 B-Bar diagram showing the mean volume of MS according to gender.



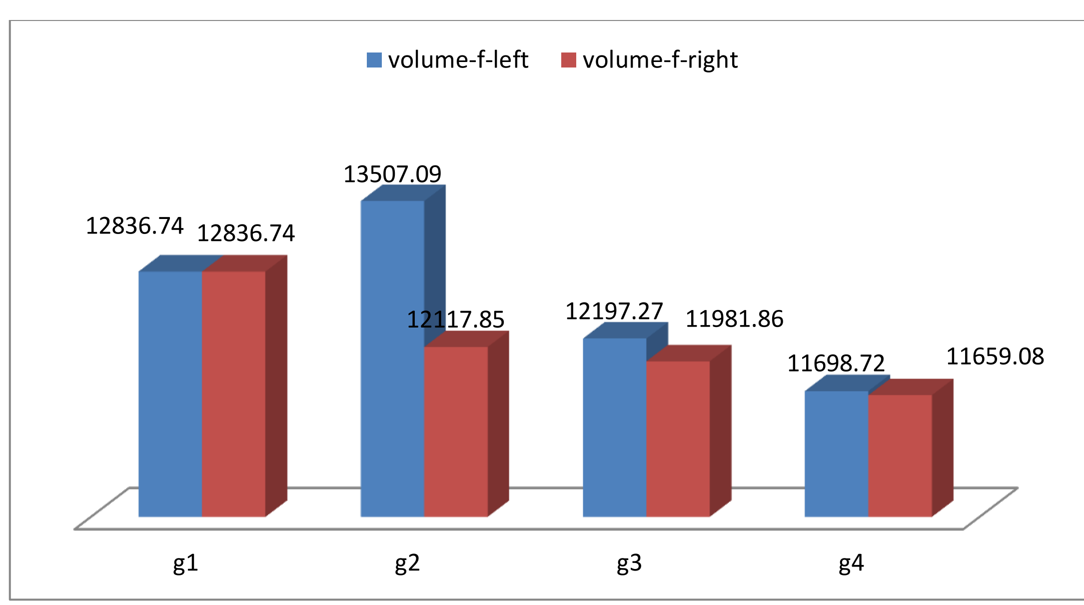
Graph 4 C-Bar diagram showing mean area of MS for right and left sides in male patients.(m- male, g- group)



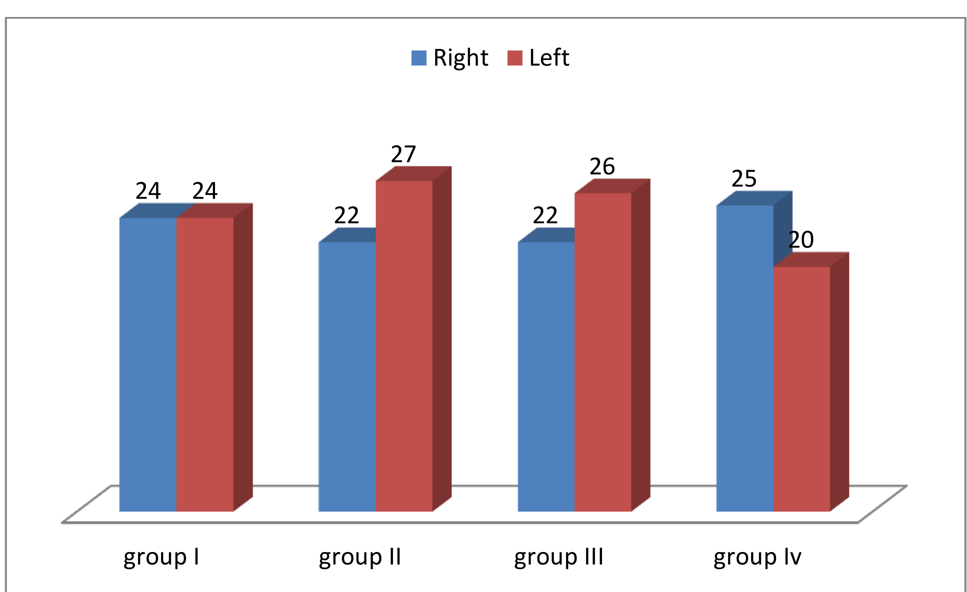
Graph 4 D-Bar diagram showing mean volumeof MS for right and left sides in male patients.(m- male, g- group)



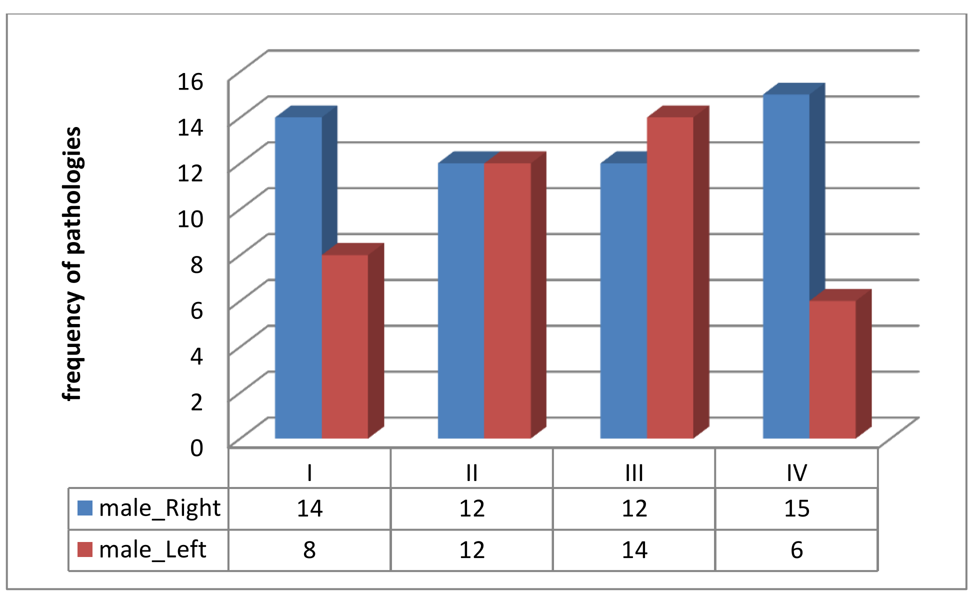
Graph 4 E- Bar diagram showing mean area of MS for right and left sidesin female patients(f-female, g- group)



Graph 4 F-Bar diagram showing the mean volume of MS on left and right sidesin female patients(f- female,g-group)

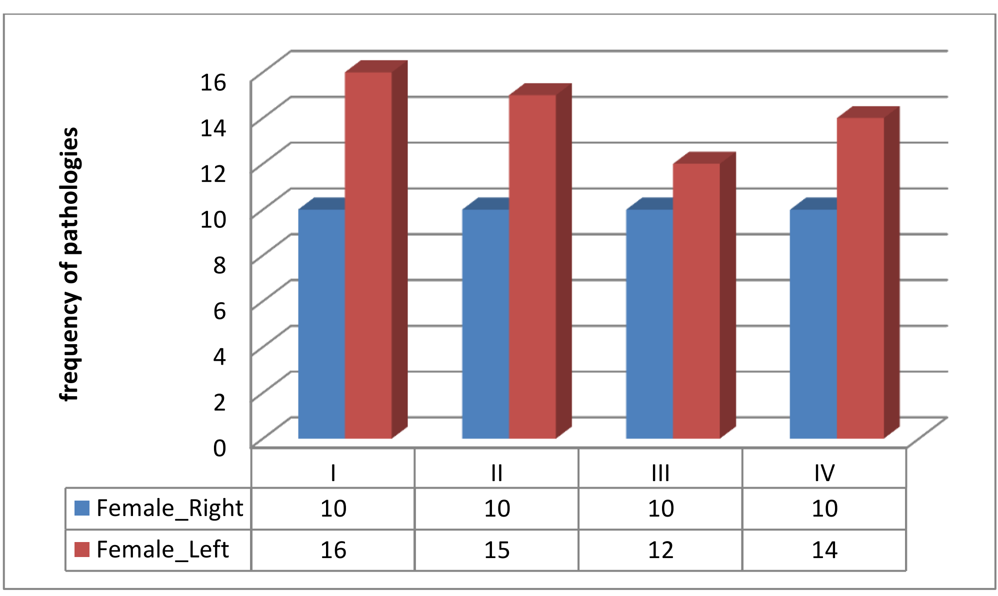


Graph 5-Bar diagram showing the percentage of septa present on right and left sides of maxillary sinus according to age groups.



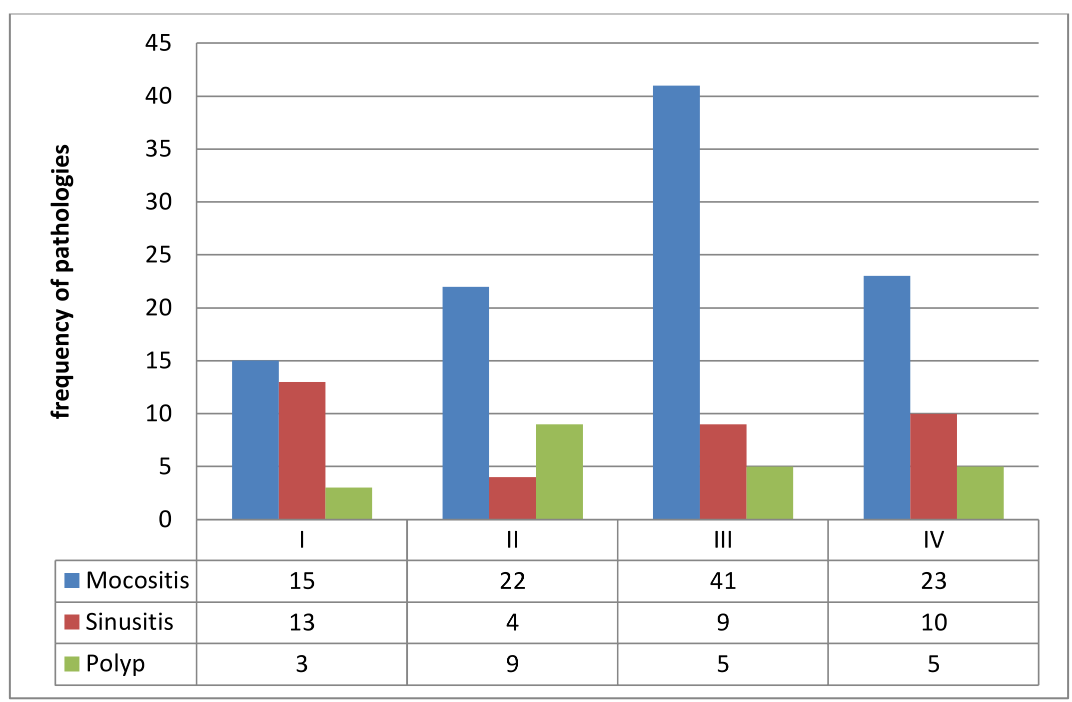
	I	II	III	IV
male_Right	14	12	12	15
male_Left	8	12	14	6

Graph 5 A-Bar diagram showing percentage of presence of septa in male patients according to side



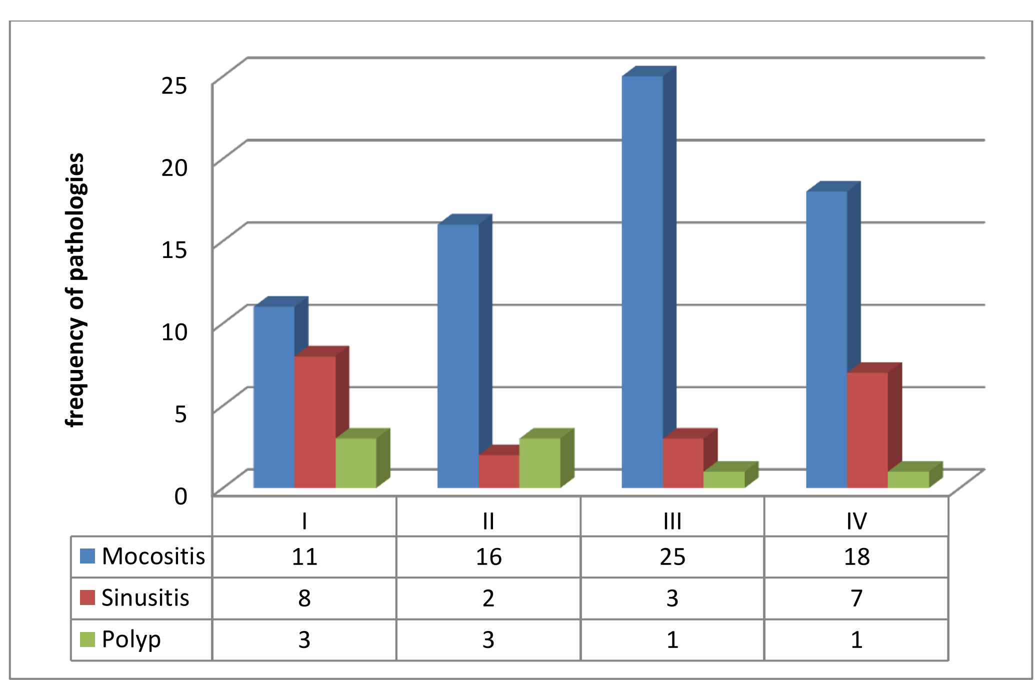
	I	II	III	IV
Female_Right	10	10	10	10
Female_Left	16	15	12	14

Graph 5 B- Bar diagram showing percentage of presence of septa in female patients according to side



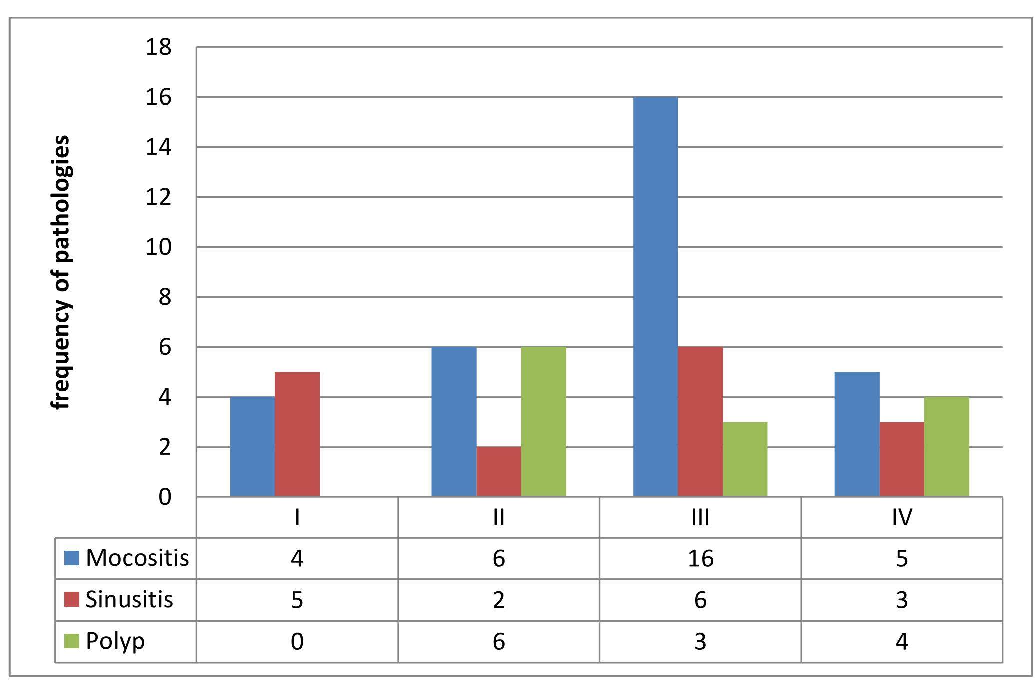
	I	II	III	IV
Mocositis	15	22	41	23
Sinusitis	13	4	9	10
Polyp	3	9	5	5

Graph 6-Bar diagram showing overall pathologies present according to age group.

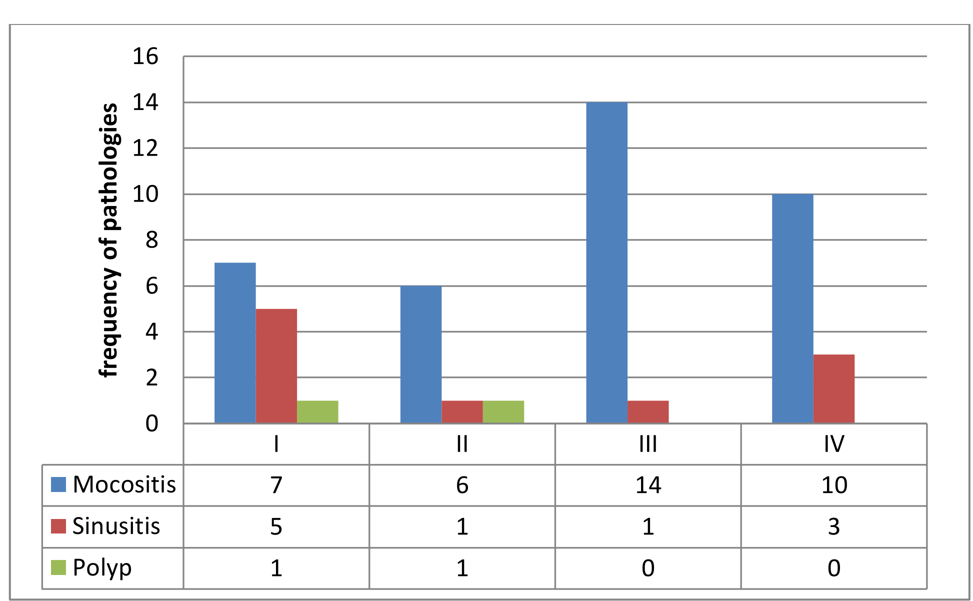


	I	II	III	IV
Mocositis	11	16	25	18
Sinusitis	8	2	3	7
Polyp	3	3	1	1

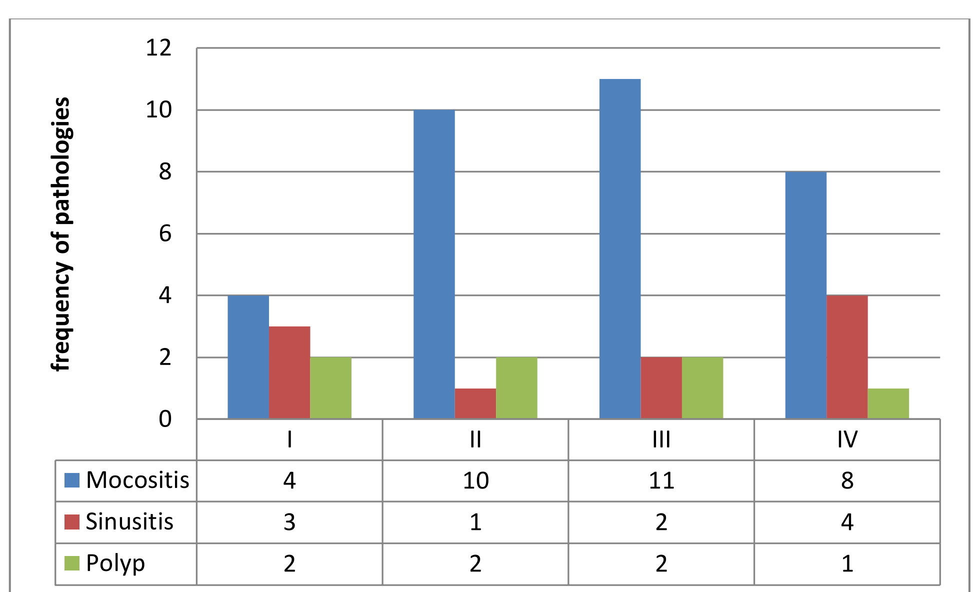
Graph 6 A-Bar diagram showing the overall pathologies present in male patients.



Graph 6 B-Bar diagram showing overall pathologies present in female patients

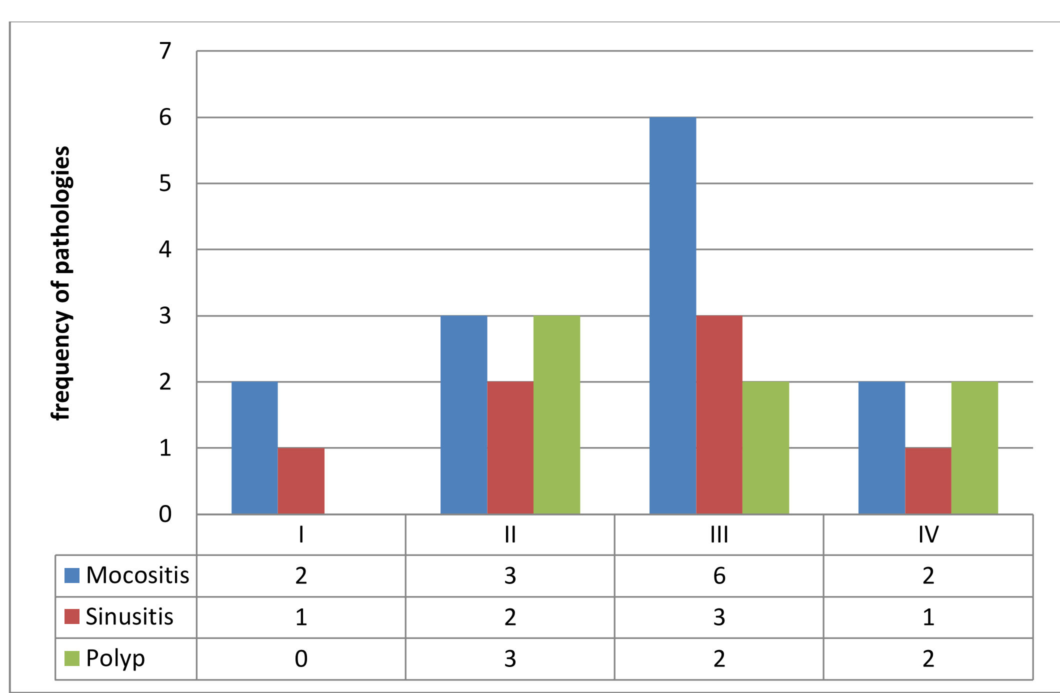


Graph 6 C-Bar diagram showing overall pathologies present in right side of MS in male patients.



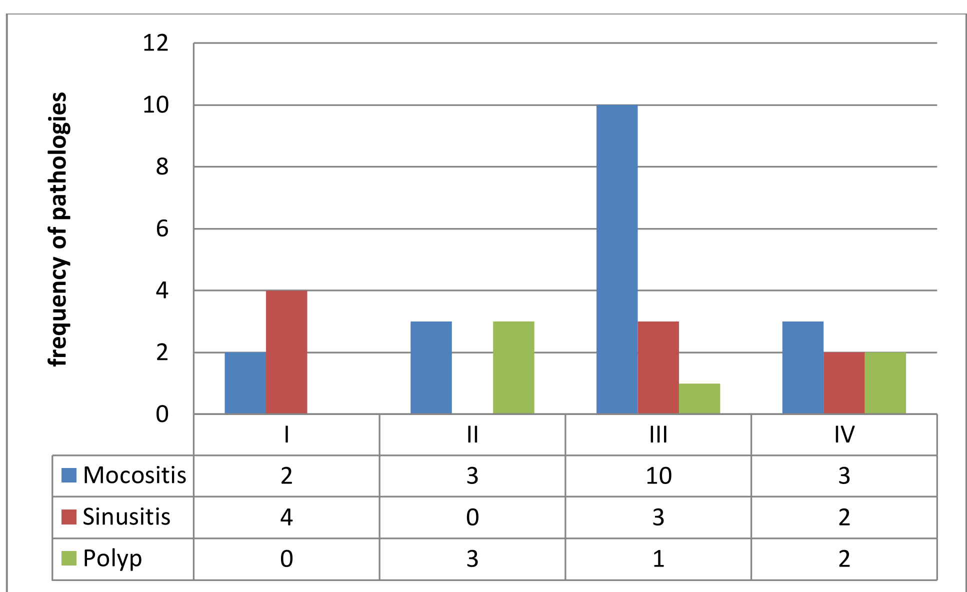
	I	II	III	IV
Mocositis	4	10	11	8
Sinusitis	3	1	2	4
Polyp	2	2	2	1

Graph 6 D-Bar diagram showing overall pathologies present in left side of MS in male patients.



	I	II	III	IV
Mocositis	2	3	6	2
Sinusitis	1	2	3	1
Polyp	0	3	2	2

Graph 6 E-Bar diagram showing overall pathologies present on right side of MS in female patients



	I	II	III	IV
Mocositis	2	3	10	3
Sinusitis	4	0	3	2
Polyp	0	3	1	2

Graph 6 F- Bar diagram showing overall pathologies present on left side of MS in female patients

ANNEXURE I

CASE PROFORMA

BIODATA OF PATIENT -:

Name -

Age - Date -

Sex -

1. **LOCATION OF POSTERIOR SUPERIOR ALVEOLAR ARTERY ON LATERAL WALL OF MAXILLARY SINUS :**

	INNER CORTEX	INTRAOSSEOUS	OUTER CORTEX
A) RIGHT			
B) LEFT			

2.RELATIONSHIP OF PSAA WITH MEDIAL WALL AND FLOOR OF MAXILLARY SINUS

	RIGHT	LEFT
A) DISTANCE BETWEEN PSAA AND MEDIAL WALL OF MAXILLARY SINUS -		
B) DISTANCE BETWEEN PSAA AND FLOOR OF MAXILLARY SINUS -		

3 . DIAMETER OF PSAA

	< 1mm	1-2mm	>2mm
A) RIGHT			
B) LEFT			

4.ANATOMICAL VARIATIONS OF MAXILLARY SINUS

	RIGHT	LEFT
Area of maxillary sinus - (l x b)		
Volume (t x cc x ap x 0.5 cm^3) Transverse dimension (t)		
Craniocaudal dimension (cc)		
Antero-posterior dimension (ap)		
Septa (present / absent)		
Thickness of mucosal Lining		

PATHOLOGIES OF MAXILLARY SINUS

ANNEXURE II

INFORMED CONSENT FORM

(Confidential)

Evaluation of Anatomical variations of Posterior superior alveolar artery and maxillary sinus using Computed Tomography

I, Mr./Master/Mrs./Miss.____

Resident of: _________________________________ aged _____ years, exercising my free will/choice, without any pressure/lure of incentive in any form, hereby give my consent/consent for the project to be conducted.

I acknowledge that doctor has informed me about this research project suitably and sufficiently to my satisfaction. I agree to let my X-rays, photographs, impressions and other investigations to be taken as required. I agree to take part in this project and will not mix any other projects during the period of this trial. I shall report to the dental hospital or other place where called on given appointment dates and time. I shall inform the doctor on any adverse effects or unusual symptoms noticed by me. I shall co-operate with the doctors and paramedical staff, in all respects. I permit to publishing the results of my participation in this study. I shall not be given any reimbursement or compensation. I have been informed of my right to opt out of this research project at any time without giving any reason for doing so.

I hereby record my consent for participation in the said trial.

____________________	______________	__________	__________
Patient's name	Signature/thumbprint	Date	Time
____________________	______________	__________	__________
Investigator's name	Signature	Date	Time

KEY TO MASTER CHART

S. NO	ABBREVATIONS	FULL FORM
1	f	Female
2	m	Male
3	mm	Millimeter
4	cm	Centimeter
5	MS	Maxillary Sinus
6	PSAA	Posterior Superior Alveolar Artery
7	p	Present
8	a	Absent

MASTER CHART

Sr.No.	Age	Sex	1. Location of PSAA on Lateral Wall of MS :				2. Relationship of PSAA with Medial wall and floor of MS			3. Diameter of PSAA				4. Area of MS			5. Volume of MS			7. thickness of mucosal lining						8. septae			9. Pathology of MS			
				Inner Cortex	Intrao sseous	Outer Cortex		Distance Between PSAA & Medial wall of MS	Distance Between PSAA & Floor of MS		< 1mm	1-2 mm	> 2 mm		mm^2	cm^2		mm^3	cm^3		Roof	Floor	Lateral wall	Medial wall	complete		Present	Absent		Polyp	Sinusitis	mucositis
GROUP I (25 f, 25 m)																																
1	22	f	Right				Right			Right				Right	620	6.2	Right	12896	12.89	Right						Right	P		Right			
			Left				Left			Left				Left	764.9	7.64	Left	15911.9	15.91	Left						Left	P		Left			
2	26	f	Right				Right			Right				Right	749.92	7.49	Right	12741	12.74	Right						Right	P		Right			
			Left				Left			Left				Left	686.34	6.86	Left	12148	12.14	Left						Left	P		Left			
3	23	f	Right				Right			Right				Right	702.46	7.02	Right	11941.8	11.94	Right						Right	P		Right			
			Left				Left			Left				Left	799.47	7.99	Left	14310.5	14.31	Left						Left	P		Left			
4	24	f	Right				Right			Right				Right	621	6.21	Right	11550.6	11.55	Right						Right	P		Right			
			Left				Left			Left				Left	747	7.47	Left	13819.5	13.81	Left						Left	P		Left			
5	20	f	Right				Right			Right				Right	1012.1	10.12	Right	17610	17.61	Right						Right	P		Right			
			Left				Left			Left				Left	1059.6	10.59	Left	18438	18.43	Left						Left	P		Left			
6	23	f	Right		✓		Right	18.3 mm = 1.83 cm	11.0mm= 1.1cm	Right	0.9mm= 0.09cm			Right	1179.12	11.79	Right	24230	24.23	Right						Right	P		Right			
			Left				Left			Left				Left	972	9.72	Left	18856	18.85	Left						Left	P		Left			
7	21	f	Right				Right			Right				Right	744.6	7.44	Right	15152	15.15	Right						Right		a	Right			
			Left				Left			Left				Left	862.4	8.62	Left	17981	17.98	Left						Left		a	Left			
8	26	f	Right				Right			Right				Right	739.32	7.39	Right	13196.8	13.19	Right						Right	P		Right			
			Left				Left			Left				Left	943.19	9.43	Left	16930	16.93	Left						Left	P		Left			
9	26	f	Right		✓		Right	14.8mm= 1.4cm	10.9mm=1.09cm	Right		1.8mm=0.18cm		Right	978.69	9.78	Right	18056	18.05	Right		floor				Right	P		Right			mucositis
			Left				Left			Left				Left	687.3	6.87	Left	12783	12.78	Left		floor				Left	P		Left			mucositis
10	28	f	Right				Right			Right				Right	232.88	2.32	Right	3458.26	34.58	Right						Right	P		Right			
			Left				Left			Left				Left	270.18	2.7	Left	4417.44	44.17	Left						Left	P		Left			
11	23	f	Right				Right			Right				Right	630.36	6.3	Right	12228.9	12.22	Right						Right		a	Right			
			Left				Left			Left				Left	634.74	6.34	Left	11457	11.45	Left						Left		a	Left			
12	21	f	Right				Right			Right				Right	587.52	5.87	Right	9605.9	9.6	Right						Right		a	Right			
			Left				Left			Left				Left	754.8	7.54	Left	11774.8	11.77	Left						Left		a	Left			
13	27	f	Right				Right			Right				Right	615.23	6.15	Right	11012.6	11.01	Right						Right		a	Right			
			Left				Left			Left				Left	525.47	5.25	Left	8775.3	8.77	Left						Left		a	Left			
14	25	f	Right				Right			Right				Right	462.69	4.62	Right	8374.6	8.37	Right						Right		a	Right			
			Left				Left			Left				Left	363.56	3.63	Left	6416.8	6.41	Left						Left		a	Left			
15	27	f	Right				Right			Right				Right	872.37	8.72	Right	15004.7	15	Right		floor				Right	P		Right			mucositis
			Left				Left			Left				Left	809.19	8.09	Left	15536.4	15.53	Left					complete	Left	P		Left		sinusitis	
16	20	f	Right				Right			Right				Right	239.32	2.39	Right	2812.o1	2.81	Right						Right	P		Right			
			Left				Left			Left				Left	336.72	3.36	Left	4427.86	4.42	Left						Left	P		Left			
17	26	f	Right		✓		Right	11.4mm=1.14cm	12.1mm=1.21cm	Right			2.3mm=0.23cm	Right	701.73	7.01	Right	12666	12.66	Right						Right		a	Right			
			Left				Left			Left				Left	763	7.63	Left	13772	13.77	Left		floor				Left	P		Left			mucositis
18	28	f	Right				Right			Right				Right	647.28	6.47	Right	12654.32	12.65	Right						Right		a	Right		sinusitis	
			Left				Left			Left				Left	626.46	6.26	Left	11213.6	11.21	Left		floor	lateral wall	medial wall		Left		a	Left		sinusitis	
19	24	f	Right				Right			Right				Right	799.47	7.99	Right	14230.56	14.23	Right						Right		a	Right			
			Left				Left			Left				Left	880	8.8	Left	15503.1	15.5o	Left						Left		a	Left			
20	26	f	Right				Right			Right				Right	879.32	8.79	Right	18289	18.28	Right						Right		a	Right			
			Left				Left			Left				Left	830.72	8.3	Left	16780	16.78	Left						Left		a	Left			
21	29	f	Right				Right			Right				Right	721.52	7.21	Right	13564	13.56	Right						Right		a	Right			
			Left				Left			Left				Left	672.75	6.72	Left	12244	12.24	Left		floor	lateral wall	medial wall		Left		a	Left		sinusitis	
22	28	f	Right				Right			Right				Right	663.92	6.63	Right	11021	11.02	Right						Right	p		Right			
			Left				Left			Left				Left	594.66	5.94	Left	8354.9	8.35	Left						Left	p		Left			
23	20	f	Right				Right			Right				Right	676.4	6.76	Right	10450.38	10.45	Right						Right		a	Right			
			Left				Left			Left				Left	521.16	5.21	Left	7348.35	7.34	Left						Left	p		Left			
24	20	f	Right				Right			Right				Right	771.12	7.71	Right	13995	13.99	Right						Right	p		Right			
			Left				Left			Left				Left	641.58	6.41	Left	10457	10.45	Left						Left	p		Left			
25	23	f	Right				Right			Right				Right	761.2	7.61	Right	14881	14.88	Right						Right	p		Right			
			Left				Left			Left				Left	1044.8	10.44	Left	21262	21.26	Left						Left	p		Left			
26	28	m	Right			✓	Right	16.5mm=1.65cm	9.8mm=0.98	Right		1.8mm=0.18cm		Right	707.25	7.07	Right	13791.3	13.79	Right					complete	Right		a	Right		sinusitis	
			Left	✓			Left	11.6mm=1.16cm	9.5mm=0.95cm	Left		1.8mm=0.18cm		Left	990.08	9.9	Left	19306	19.3	Left		floor	lateral wall	medial wall		Left		a	Left		sinusitis	
27	25	m	Right				Right			Right				Right	1134.54	11.34	Right	19060.2	19	Right	roof	floor	lateral wall			Right	P		Right			mucositis
			Left		✓		Left	16.3mm=1.63cm	11.9mm=1.19cm	Left			2mm=0.2cm	Left	832.76	8.32	Left	13990	13.9	Left						Left		a	Left			mucositis
28	27	m	Right	✓			Right	15.1mm=1.5cm	6.3mm=0.63cm	Right		1.9mm=0.19cm		Right	679.14	6.79	Right	13650	13.65	Right	roof	floor	lateral wall			Right	P		Right		sinusitis	
			Left	✓			Left	15.7mm=1.5cm	7.9mm=0.79cm	Left		1.7mm=0.17cm		Left	762.96	7.62	Left	14534.3	14.53	Left		floor	lateral wall	medial wall		Left	P		Left		sinusitis	
29	22	m	Right				Right			Right				Right	752.96	7.52	Right	14419.18	14.41	Right						Right		a	Right			
			Left			✓	Left	21.0=2.1cm	29.6mm=2.96cm	Left		1.7mm=0.17cm		Left	895.39	8.95	Left	17594	17.59	Left						Left		a	Left			

30	22	m	Right				Right			Right				Right	601.65	6.01	Right	10787.5	10.78	Right						Right		a	Right			
			Left		✓		Left	17.1mm=1.71cm	7mm=0.7cm	Left			2.1mm=0.21cm	Left	475.2	4.75	Left	8886.24	8.88	Left						Left		a	Left			
31	20	m	Right				Right			Right				Right	939.12	9.39	Right	15166	15.16	Right						Right	P		Right			
			Left			✓	Left	20.2mm=2.02cm	24.8mm=2.48cm	Left		1.3mm=0.13cm		Left	860.7	8.6	Left	14072	14.07	Left						Left	P		Left			
32	24	m	Right				Right			Right				Right	17114.5	17.11	Right	35834	35.83	Right						Right		a	Right			
			Left				Left			Left				Left	1510.88	15.1	Left	32483	32.48	Left						Left		a	Left			
33	23	m	Right		✓		Right	16.5mm=1.65cm	13.1= 1.31cm	Right		1.9mm=0.19cm		Right	628.32	6.28	Right	12157	12.15	Right		floor	lateral wall	medial wall		Right		a	Right			
			Left				Left			Left				Left	628.32	6.28	Left	12377	12.37	Left					complete	Left		a	Left			
34	20	m	Right		✓		Right	15.9mm=1.59cm	6.4mm=0.64cm	Right		1.4mm=0.14cm		Right	871.56	8.71	Right	16951.8	16.95	Right		floor	lateral wall	medial wall		Right	P		Right			mucositis
			Left				Left			Left				Left	732.9	7.32	Left	13888	13.88	Left						Left		a	Left	polyp		
35	22	m	Right				Right			Right				Right	869.6	8.69	Right	16262	16.26	Right					complete	Right		a	Right		sinusitis	
			Left				Left			Left				Left	935.6	9.35	Left	18198	18.19	Left						Left		a	Left			
36	28	m	Right				Right			Right				Right	749.42	7.49	Right	14463	14.46	Right						Right		a	Right			
			Left				Left			Left				Left	555.9	5.55	Left	9589.7	9.58	Left			lateral wall			Left		a	Left			mucositis
37	20	m	Right				Right			Right				Right	854.36	8.54	Right	17087.2	17.08	Right						Right		a	Right			
			Left				Left			Left				Left	772.87	7.72	Left	15573.3	15.57	Left						Left		a	Left			
38	22	m	Right				Right			Right				Right	990.64	9.9	Right	17930.58	17.93	Right		floor		medial wall		Right		a	Right			mucositis
			Left		✓		Left	19.5mm=1.95cm	18.4mm=1.84cm	Left		2mm=0.2cm		Left	1210.02	12.1	Left	21477	21.47	Left						Left	P		Left			
39	28	m	Right				Right			Right				Right	716.31	7.16	Right	12499	12.49	Right						Right	P		Right			
			Left				Left			Left				Left	877.23	8.77	Left	877.23	8.77	Left						Left	P		Left			
40	28	m	Right				Right			Right				Right	796.39	7.96	Right	15250	15.25	Right						Right	P		Right			
			Left				Left			Left				Left	825.92	8.25	Left	14907	14.9	Left						Left	P		Left			
41	20	m	Right				Right			Right				Right	583.1	5.83	Right	10466.6	10.46	Right						Right	P		Right			
			Left				Left			Left				Left	552.8	5.5	Left	10310.4	10.31	Left						Left		a	Left			
42	28	m	Right		✓		Right	10.7mm=1.07cm	7.1mm=0.71cm	Right		1.3mm=0.13cm		Right	453.15	4.53	Right	6004.2	6	Right		floor				Right	P		Right			mucositis
			Left				Left			Left				Left	502.25	5.02	Left	7106.8	7.1	Left						Left		a	Left			
43	22	m	Right		✓		Right	8.5mm=0.85cm	14.3mm=1.43cm	Right		1.1mm=0.11cm		Right	379.44	3.79	Right	6052	6.05	Right					complete	Right		a	Right		sinusitis	
			Left	✓			Left	11.3mm=1.13cm	6.9mm=0.69cm	Left		1.1mm=0.11cm		Left	355	3.55	Left	5626.7	5.62	Left					complete	Left		a	Left		sinusitis	
44	20	m	Right				Right			Right				Right	821.28	8.21	Right	16179	16.17	Right						Right		a	Right			
			Left				Left			Left				Left	855.91	8.55	Left	17203.7	17.2	Left						Left		a	Left			
45	28	m	Right				Right			Right				Right	833.86	8.33	Right	15593.1	15.59	Right						Right	P		Right	polyp		
			Left				Left			Left				Left	521.24	5.21	Left	8678.6	8.67	Left						Left	P		Left			
46	25	m	Right				Right			Right				Right	708.84	7.08	Right	14850.1	14.85	Right					complete	Right		a	Right		sinusitis	
			Left				Left			Left				Left	909.44	9.09	Left	18825	18.82	Left		floor	lateral wall	medial wall		Left		a	Left			mucositis
47	24	m	Right				Right			Right				Right	732.28	7.32	Right	15925.24	15.92	Right						Right	P		Right			
			Left				Left			Left				Left	1226.96	12.26	Left	25520.7	25.52	Left		floor				Left	P		Left			
48	25	m	Right			✓	Right	20.7mm=2.07cm	22.5mm=2.25cm	Right		1.6mm=0.16cm		Right	1065.9	10.65	Right	21691	21.69	Right		floor	lateral wall	medial wall		Right	P		Right			mucositis
			Left			✓	Left	21.4mm=2.14cm	32.4mm=3.24cm	Left			2.1mm=0.21cm	Left	976	9.76	Left	20008	20	Left						Left	P		Left	polyp		
49	28	m	Right		✓		Right	20.2mm=2.02cm	30.4mm=3.0cm	Right		1.7mm=0.17cm		Right	961.4	9.61	Right	18218	18.21	Right		floor	lateral wall	medial wall		Right		a	Right			mucositis
			Left		✓		Left	14.0mm=1.4cm	15.9mm=1.59cm	Left		1.7mm=0.17cm		Left	836.4	8.36	Left	16644.3	16.64	Left		floor	lateral wall			Left		a	Left			
50	27	m	Right				Right			Right				Right	861.63	8.61	Right	16801	16.8	Right	roof	floor	lateral wall	medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	750.72	7.5	Left	16590	16.59	Left						Left		a	Left			

GROUP II (25 f, 25 m)

51	34	f	Right				Right			Right				Right	571.78	5.71	Right	9948.9	9.94	Right						Right	p		Right			
			Left				Left			Left				Left	650	6.5	Left	11407	11.4	Left						Left	p		Left			
52	35	f	Right				Right			Right				Right	608.36	6.08	Right	10524	10.52	Right					complete	Right	p		Right		sinusitis	
			Left				Left			Left				Left	826.63	8.26	Left	14466	14.46	Left						Left	p		Left			
53	35	f	Right				Right			Right				Right	537.46	5.37	Right	7954.48	7.95	Right		floor	lateral wall	medial wall		Right		a	Right	polyp		
			Left				Left			Left				Left	524.38	5.24	Left	7079.13	7.07	Left					complete	Left		a	Left		sinusitis	
54	32	f	Right				Right			Right				Right	900.72	9	Right	16122	16.1	Right						Right		a	Right			
			Left				Left			Left				Left	1017.3	10.17	Left	19533	19.5	Left						Left		a	Left			
55	32	f	Right				Right			Right				Right	534.52	5.34	Right	8124.7	8.12	Right						Right	p		Right			mucositis
			Left			✓	Left	17.8mm=1.78cm	26.2mm=2.62cm	Left			2.3mm=0.23cm	Left	551.04	5.51	Left	8954.4	8.9	Left				medial wall		Left	p		Left			
56	30	f	Right				Right			Right				Right	642.2	6.42	Right	11045	11.04	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	665.72	6.65	Left	10651	10.65	Left						Left		a	Left			
57	34	f	Right				Right			Right				Right	693.77	6.93	Right	13251	13.25	Right						Right	p		Right			
			Left				Left			Left				Left	700.97	7	Left	12582	12.58	Left						Left	p		Left			
58	33	f	Right		✓		Right	11.0mm=1.1cm	8.0mm=0.8cm	Right		1.8mm=0.18cm		Right	540.8	5.4	Right	9382.8	9.38	Right						Right		a	Right			
			Left		✓		Left	15.7mm=1.57cm	8.6mm=0.86cm	Left		1.8mm=0.18cm		Left	540.8	5.4	Left	8869.1	8.86	Left						Left	p		Left			
59	32	f	Right				Right			Right				Right	540.96	5.4	Right	8303.7	8.3	Right						Right		a	Right			
			Left				Left			Left				Left	873.84	8.7	Left	14199	14.19	Left		floor		medial wall		Left		a	Left	polyp		
60	32	f	Right				Right			Right				Right	454.41	4.54	Right	6157.2	6.15	Right	roof	floor		medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	670.8	6.7	Left	9827.2	9.82	Left						Left		a	Left			
61	30	f	Right		✓		Right	14mm=1.4cm	15.3mm=1.53cm	Right		1.3mm=0.13cm		Right	563.5	5.63	Right	9607.6	9.6	Right						Right	p		Right			
			Left		✓		Left	9.1mm=0.91cm	9.7mm=0.97cm	Left		1.3mm=0.13cm		Left	604.8	6.04	Left	9344.16	9.34	Left				medial wall		Left	p		Left			mucositis
62	34	f	Right				Right			Right				Right	833.48	8.33	Right	15085	15.08	Right						Right	p		Right			
			Left				Left			Left				Left	633.15	6.33	Left	11649	11.64	Left						Left	p		Left			
63	33	f	Right		✓		Right	15.9mm=1.59cm	16.3mm=1.63cm	Right		1.4mm=0.14cm		Right	885.78	8.85	Right	17582	17.58	Right		floor				Right	p		Right	polyp		
			Left				Left			Left				Left	898.64	8.98	Left	16984	16.98	Left		floor		medial wall		Left	p		Left			mucositis
64	35	f	Right				Right			Right				Right	653.4	6.53	Right	11630.5	11.63	Right						Right	p		Right			
			Left				Left			Left				Left	947.13	9.47	Left	18469	18.46	Left						Left	p		Left			
65	38	f	Right				Right			Right				Right	861.25	8.61	Right	16665	16.66	Right						Right		a	Right			
			Left				Left			Left				Left	991.1	9.9	Left	20267.9	20.26	Left						Left		a	Left			
66	30	f	Right			✓	Right	16.7mm=1.67cm	12.8mm=1.28cm	Right		1.5mm=0.15cm		Right	651.24	6.51	Right	10843.1	10.83	Right						Right		a	Right			
			Left				Left			Left				Left	1204.28	12.04	Left	17522.2	17.52	Left						Left		a	Left			
67	38	f	Right				Right			Right				Right	951.15	9.51	Right	15884	15.88	Right						Right		a	Right			
			Left		✓		Left	21.7mm=2.17cm	29.0mm=2.9cm	Left	0.7mm=0.07cm			Left	1176.14	11.76	Left	22346	22.34	Left						Left		a	Left			
68	35	f	Right				Right			Right				Right	929.74	9.29	Right	17897	17.89	Right						Right		a	Right			
			Left				Left			Left				Left	889.14	8.89	Left	17871	17.87	Left				medial wall		Left		a	Left	polyp		
69	39	f	Right				Right			Right				Right	755.89	7.55	Right	16024	16.02	Right		floor	lateral wall			Right	p		Right	polyp		
			Left		✓		Left	17.5mm=1.75cm	26.1mm=2.61cm	Left		1mm=0.1cm		Left	867.36	8.67	Left	17000.2	17	Left		floor				Left	p		Left			mucositis
70	32	f	Right				Right			Right				Right	1005.41	10.05	Right	19102	19.1	Right						Right	p		Right			
			Left				Left			Left				Left	762.75	7.62	Left	14110	14.11	Left						Left	p		Left			
71	32	f	Right				Right			Right				Right	191.4	1.91	Right	1866.15	18.66	Right					complete	Right	p		Right		sinusitis	
			Left				Left			Left				Left	250.2	2.5	Left	3352.6	3.35	Left				medial wall		Left		a	Left	polyp		
72	35	f	Right				Right			Right				Right	696.96	6.96	Right	11848	11.84	Right						Right	p		Right			
			Left				Left			Left				Left	489.6	4.89	Left	8616.9	8.61	Left						Left	p		Left			
73	35	f	Right				Right			Right				Right	890.9	8.9	Right	17016	17.01	Right						Right	p		Right			
			Left		✓		Left	13.9mm=1.39cm	4.4mm=0.44cm	Left		1.1mm=0.11cm		Left	836.16	8.36	Left	16305	16.3	Left						Left	p		Left			
74	32	f	Right			✓	Right	15.9mm=1.59cm	7.5mm=0.75	Right			2.3mm=0.23cm	Right	648	6.48	Right	11566	11.56	Right						Right	p		Right			
			Left				Left			Left				Left	922.5	9.22	Left	16097	16.09	Left						Left	p		Left			
75	34	f	Right				Right			Right				Right	402	4.02	Right	4833	4.83	Right						Right	p		Right			
			Left				Left			Left				Left	474.36	4.74	Left	7091.68	7.09	Left						Left	p		Left			
76	38	m	Right		✓		Right	17.2mm=1.72cm	5.9mm=0.59	Right		2mm=0.2cm		Right	782.34	7.82	Right	13417	13.41	Right						Right		a	Right			
			Left				Left			Left				Left	1230.8	12.3	Left	23939	23.93	Left					complete	Left		a	Left		sinusitis	
77	32	m	Right		✓		Right	9.8mm=0.98cm	9.5mm=0.95cm	Right		1.5mm=0.15cm		Right	617.1	6.17	Right	10490.7	10.49	Right		floor				Right	p		Right			mucositis
			Left				Left			Left				Left	619.04	6.19	Left	10987.9	10.98	Left		floor				Left	p		Left			mucositis
78	30	m	Right			✓	Right	15.4mm=1.54cm	7.6mm=0.76cm	Right		1.8mm=0.18cm		Right	674.1	6.74	Right	14054	14.05	Right						Right		a	Right			
			Left		✓		Left	14.9mm=1.49cm	11.4mm=1.14cm	Left	0.8mm=0.08cm			Left	739.26	7.39	Left	12271	12.27	Left		floor				Left		a	Left			mucositis
79	32	m	Right	✓			Right	21.2mm=2.12cm	19.3mm=1.93cm	Right		1.3mm=0.13cm		Right	737.1	7.37	Right	13562	13.56	Right			lateral wall			Right		a	Right			mucositis
			Left				Left			Left				Left	880.46	8.8	Left	15672	15.67	Left	roof					Left		a	Left			mucositis
80	32	m	Right				Right			Right				Right	606.72	6.06	Right	9859.2	9.85	Right						Right		a	Right			
			Left				Left			Left				Left	607.7	6.07	Left	11515	11.51	Left	roof					Left		a	Left			mucositis
81	35	m	Right				Right			Right				Right	697.6	6.97	Right	10952	10.95	Right						Right	p		Right			
			Left				Left			Left				Left	670.41	6.7	Left	10827	10.82	Left						Left	p		Left			
82	32	m	Right				Right			Right				Right	528	5.28	Right	8550.8	8.55	Right						Right		a	Right			
			Left	✓			Left	13.4mm=1.34cm	6.7mm=0.67cm	Left		1.7mm=0.17cm		Left	483	4.83	Left	7776.3	7.77	Left						Left		a	Left			
83	30	m	Right				Right			Right				Right	564.3	5.64	Right	10016	10.01	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	598.5	5.98	Left	10264	10.26	Left				medial wall		Left		a	Left			mucositis
84	35	m	Right				Right			Right				Right	861.84	8.61	Right	16978	16.97	Right						Right	p		Right			
			Left				Left			Left				Left	840.16	8.4	Left	17055	17.05	Left						Left	p		Left			
85	35	m	Right				Right			Right				Right	926.1	9.26	Right	18151	18.15	Right		floor				Right		a	Right	polyp		

			Left				Left			Left				Left	1065.3	10.65	Left	22385	22.38	Left		floor				Left		a	Left	polyp		
86	30	m	Right				Right			Right				Right	766.36	7.66	Right	16515	16.51	Right						Right	p		Right			
			Left			✓	Left	13.8mm=1.38cm	19.6mm=1.96cm	Left		1.7mm=0.17cm		Left	703.08	7.03	Left	15502	15.5	Left					complete	Left		a	Left		sinusitis	
87	39	m	Right				Right			Right				Right	760.43	7.6	Right	14105	14.1	Right						Right		a	Right			
			Left				Left			Left				Left	951.39	9.51	Left	16744	16.74	Left					complete	Left		a	Left		sinusitis	
88	31	m	Right				Right			Right				Right	846.3	8.46	Right	16968	16.96	Right		floor	lateral wall			Right		a	Right			mucositis
			Left				Left			Left				Left	912.9	9.12	Left	19490	19.49	Left		floor		medial wall		Left		a	Left			mucositis
89	38	m	Right				Right			Right				Right	1091.34	10.91	Right	21390	21.39	Right		floor				Right	p		Right			mucositis
			Left				Left			Left				Left	1301.92	13.01	Left	26884	26.88	Left						Left	p		Left			
90	35	m	Right				Right			Right				Right	1069.12	10.69	Right	22184	22.18	Right						Right	p		Right			
			Left				Left			Left				Left	694.2	6.94	Left	14300	14.3	Left	roof	floor	lateral wall	medial wall		Left	p		Left			mucositis
91	36	m	Right				Right			Right				Right	829.92	8.29	Right	15809	15.8	Right						Right		a	Right			
			Left				Left			Left				Left	843.2	8.43	Left	16779	16.77	Left						Left		a	Left			
92	32	m	Right				Right			Right				Right	341.25	3.41	Right	4999.3	4.99	Right						Right		a	Right			
			Left				Left			Left				Left	296	2.96	Left	4247.6	4.24	Left						Left	p		Left			
93	37	m	Right		✓		Right	17.2mm=1.72cm	13.2mm=1.32cm	Right		1.5mm=0.15cm		Right	943.2	9.43	Right	17967	17.96	Right						Right	p		Right			
			Left				Left			Left				Left	943.2	9.43	Left	19099	19.09	Left						Left		a	Left			
94	38	m	Right				Right			Right				Right	840.16	8.4	Right	13778	13.77	Right						Right	p		Right			
			Left				Left			Left				Left	910.89	9.1	Left	14255	14.25	Left						Left	p		Left			
95	34	m	Right				Right			Right				Right	1124.8	11.24	Right	20640	20.64	Right						Right	p		Right			
			Left				Left			Left				Left	1165.8	11.65	Left	20809	20.8	Left						Left	p		Left			
96	30	m	Right				Right			Right				Right	729.88	7.29	Right	13716	13.71	Right		floor				Right	p		Right			mucositis
			Left				Left			Left				Left	971.46	9.71	Left	18992	18.99	Left		floor				Left	p		Left			mucositis
97	32	m	Right				Right			Right				Right	1071.77	10.71	Right	21006	21	Right						Right	p		Right			
			Left			✓	Left	15.0mm=1.5cm	11.2mm=1.12cm	Left		1.7mm=0.17cm		Left	1056.02	10.56	Left	20856	20.85	Left				medial wall		Left	p		Left			mucositis
98	35	m	Right				Right			Right				Right	524.16	5.24	Right	9356.25	9.35	Right						Right	p		Right			
			Left				Left			Left				Left	504.45	5.04	Left	8550.42	8.55	Left		floor				Left	p		Left	polyp		
99	33	m	Right			✓	Right	10.5mm=1.05cm	9.7mm=0.97cm	Right		2mm=0.2cm		Right	322.56	3.22	Right	4096.51	4.09	Right						Right		a	Right			
			Left				Left			Left				Left	430.92	4.3	Left	6075.9	6.07	Left						Left		a	Left			
100	38	m	Right			✓	Right	15.4mm=1.54cm	13.6mm=1.36cm	Right			2.8mm=0.28cm	Right	1153.19	11.53	Right	23392	23.39	Right					complete	Right	p		Right		sinusitis	
			Left		✓		Left	9.1mm=0.91cm	17.7mm=1.77cm	Left			2.3mm=0.23cm	Left	777.48	7.77	Left	14189	14.18	Left					complete	Left	p		Left		sinusitis	

GROUP III (25 f, 25 m)

101	45	f	Right				Right			Right				Right	754.8	7.54	Right	13586	13.58	Right						Right		a	Right			
			Left	✓			Left	18.7mm=1.87cm	10.7mm=1.07cm	Left		1mm=0.1cm		Left	715.56	7.15	Left	11126	11.12	Left					complete	Left		a	Left		sinusitis	
102	48	f	Right				Right			Right				Right	742.96	7.42	Right	14413	14.41	Right						Right	p		Right			
			Left				Left			Left				Left	709.29	7.09	Left	12767	12.76	Left						Left	p		Left			
103	42	f	Right				Right			Right				Right	988.14	9.88	Right	17144	17.14	Right	roof	floor	lateral wall	medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	987	9.87	Left	17321	17.32	Left	roof	floor	lateral wall	medial wall		Left		a	Left			mucositis
104	42	f	Right				Right			Right				Right	322.66	3.22	Right	5259.3	5.25	Right						Right	p		Right			
			Left				Left			Left				Left	414.15	4.14	Left	6170.83	6.17	Left						Left		a	Left			
105	40	f	Right				Right			Right				Right	540.54	540	Right	9567.5	9.56	Right					complete	Right	p		Right		sinusitis	
			Left				Left			Left				Left	653.91	6.53	Left	10952	10.95	Left					complete	Left	p		Left		sinusitis	
106	47	f	Right		✓		Right	10.4mm=1.04cm	6.6mm=0.66cm	Right		1.6mm=0.16cm		Right	793.5	7.93	Right	15076	15.07	Right			lateral wall			Right	p		Right	polyp		
			Left				Left			Left				Left	613.8	6.13	Left	11263.23	11.26	Left		floor				Left	p		Left			mucositis
107	46	f	Right				Right			Right				Right	641.55	6.41	Right	11002.5	11	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	650.76	6.5	Left	10867	10.86	Left		floor				Left		a	Left			mucositis
108	45	f	Right				Right			Right				Right	469.56	4.69	Right	8264.2	8.26	Right			lateral wall			Right		a	Right	polyp		
			Left				Left			Left				Left	424.84	4.24	Left	7477.18	7.47	Left		floor				Left		a	Left			mucositis
109	42	f	Right				Right			Right				Right	309.52	3.09	Right	4178.52	4.17	Right						Right	p		Right			
			Left				Left			Left				Left	309.52	3.09	Left	4457.08	4.45	Left						Left	p		Left			
110	43	f	Right				Right			Right				Right	685.69	6.85	Right	12719	12.71	Right						Right		a	Right			
			Left				Left			Left				Left	1504.48	15.04	Left	19537	19.53	Left						Left		a	Left			
111	46	f	Right		✓		Right	16.7mm=1.67cm	25mm=0.25cm	Right	0.8mm=0.08cm			Right	641.48	6.41	Right	10488	10.48	Right						Right		a	Right			
			Left		✓		Left	14.4mm=1.44cm	25.6mm=2.56cm	Left		1mm=0.1cm		Left	768	7.68	Left	13900	13.9	Left						Left		a	Left			
112	48	f	Right				Right			Right				Right	648.89	6.48	Right	11647	11.64	Right						Right	p		Right			
			Left				Left			Left				Left	713.37	7.13	Left	12983	12.98	Left						Left	p		Left			
113	40	f	Right				Right			Right				Right	711.89	7.11	Right	13525	13.52	Right						Right	p		Right			
			Left				Left			Left				Left	829.92	8.29	Left	15478	15.47	Left						Left	p		Left			
114	45	f	Right				Right			Right				Right	701.1	7.01	Right	11953.75	11.95	Right					complete	Right	p		Right		sinusitis	
			Left				Left			Left				Left	786.48	7.86	Left	13763	13.76	Left		floor		medial wall		Left	p		Left			mucositis
115	46	f	Right				Right			Right				Right	623.82	6.23	Right	9045.39	9.04	Right						Right	p		Right			
			Left				Left			Left				Left	623.82	6.23	Left	7267.5	7.26	Left						Left	p		Left			
116	45	f	Right				Right			Right				Right	623.2	6.23	Right	11155	11.15	Right					complete	Right		a	Right		sinusitis	
			Left				Left			Left				Left	482.31	4.82	Left	8633.3	8.63	Left					complete	Left		a	Left		sinusitis	
117	42	f	Right				Right			Right				Right	438.9	4.38	Right	6868.78	6.86	Right						Right		a	Right			
			Left				Left			Left				Left	441.32	4.41	Left	7370.04	7.37	Left		floor				Left		a	Left			mocositis
118	45	f	Right				Right			Right				Right	429.94	4.29	Right	7760.41	7.76	Right						Right	p		Right			
			Left				Left			Left				Left	486.88	4.86	Left	8982.9	8.98	Left						Left	p		Left			
119	44	f	Right		✓		Right	13.5mm=1.35cm	17.6mm=1.76cm	Right		2mm=0.2cm		Right	631.56	6.31	Right	11241	11.24	Right		floor				Right	p		Right			mucositis
			Left			✓	Left	10.9mm=1.09cm	13.9mm=1.39cm	Left		1.7mm=0.17cm		Left	591.68	5.91	Left	11094	11.09	Left		floor		medial wall		Left	p		Left			mucositis
120	46	f	Right				Right			Right				Right	722.88	7.22	Right	14674	14.67	Right	roof					Right	p		Right			mucositis
			Left				Left			Left				Left	777.75	7.77	Left	14855	14.85	Left		floor				Left	p		Left			mucositis
121	42	f	Right	✓			Right	18mm=1.8cm	5mm=0.5cm	Right	0.9mm=0.09cm			Right	988.14	9.88	Right	17144.2	17.14	Right	roof	floor	lateral wall	medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	987	9.87	Left	17321.8	17.32	Left	roof	floor	lateral wall	medial wall		Left		a	Left			mucositis
122	48	f	Right				Right			Right				Right	675	6.75	Right	12960	12.96	Right		floor				Right	p		Right			
			Left				Left			Left				Left	816.93	8.16	Left	16011	16.01	Left		floor				Left	p		Left	polyp		
123	42	f	Right		✓		Right	15.7mm=1.57cm	9.2mm=0.92cm	Right		1.3mm=0.13cm		Right	988	9.88	Right	17144	17.14	Right		floor	lateral wall	medial wall		Right		a	Right			mucositis
			Left		✓		Left	15.9mm=1.59	8.5mm=0.85cm	Left		1.8mm=0.18cm		Left	987	9.87	Left	17321	17.32	Left		floor				Left		a	Left			mucositis
124	48	f	Right				Right			Right				Right	555.8	5.55	Right	9337.9	9.33	Right						Right	p		Right			
			Left				Left			Left				Left	687.8	6.87	Left	13824	13.82	Left						Left	p		Left			
125	45	f	Right				Right			Right				Right	904.84	9.04	Right	18615	18.61	Right						Right	p		Right			
			Left				Left			Left				Left	880.8	8.8	Left	16735	16.73	Left						Left	p		Left			
126	40	m	Right				Right			Right				Right	875.14	8.75	Right	17327	17.32	Right		floor				Right	p		Right			mucositis
			Left		✓		Left	12.7mm=1.27cm	13.9mm=1.39cm	Left		1.2mm=0.12cm		Left	776.72	7.76	Left	14369	14.36	Left		floor				Left	p		Left			mucositis
127	42	m	Right				Right			Right				Right	1045.8	10.45	Right	20445	20.44	Right		floor				Right	p		Right			mucositis
			Left				Left			Left				Left	993.51	9.93	Left	21062	21.06	Left		floor				Left	p		Left			mucositis
128	45	m	Right				Right			Right				Right	466.44	4.66	Right	8442.5	8.44	Right						Right	p		Right			
			Left				Left			Left				Left	644.8	6.44	Left	12670	12.67	Left						Left	p		Left			
129	48	m	Right				Right			Right				Right	810.24	8.1	Right	15840	15.84	Right		floor	lateral wall			Right		a	Right			mucositis
			Left				Left			Left				Left	852.44	8.52	Left	17304	17.3	Left		floor				Left	p		Left			mucositis
130	40	m	Right				Right			Right				Right	773.8	7.73	Right	13618	13.61	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	642.96	6.42	Left	10705	10.7	Left					complete	Left		a	Left		sinusitis	
131	45	m	Right				Right			Right				Right	945	9.45	Right	18900	18.9	Right		floor	lateral wall	medial wall		Right	p		Right			mucositis
			Left				Left			Left				Left	706.86	7.06	Left	13854	13.85	Left				medial wall		Left	p		Left	polyp		
132	41	m	Right		✓		Right	12.7mm=1.27cm	6.0mm=0.6cm	Right		1.9mm=0.19cm		Right	1112.01	11.12	Right	17458.5	17.45	Right						Right		a	Right			
			Left	✓			Left	18mm=1.8cm	9.4mm=0.94cm	Left		1.6mm=0.16cm		Left	868.14	8.68	Left	15800.1	15.8	Left						Left		a	Left			
133	40	m	Right			✓	Right	13.1mm=1.31cm	5.9mm=0.59	Right		1.4mm=0.14cm		Right	1412.03	14.12	Right	29440	29.44	Right	roof		lateral wall	medial wall		Right	p		Right		sinusitis	
			Left				Left			Left				Left	1328.22	13.28	Left	27294	27.29	Left					complete	Left	p		Left		sinusitis	
134	40	m	Right				Right			Right				Right	432.96	4.32	Right	740.36	7.4	Right						Right		a	Right			
			Left				Left			Left				Left	348.4	3.48	Left	547.11	5.47	Left			lateral wall			Left		a	Left	polyp		
135	42	m	Right				Right			Right				Right	544.48	5.44	Right	9419.5	9.41	Right				medial wall		Right		a	Right			mucositis

135	42	m	Left				Left			Left				Left	720.1	7.2	Left	14438	14.43	Left		floor				Left		a	Left			mucositis
136	46	m	Right				Right			Right				Right	334.41	3.34	Right	4731.9	4.73	Right						Right	p		Right			
			Left			✓	Left	14.1mm=1.41cm	18.4mm=1.84cm	Left		1.7mm=0.17cm		Left	398.31	3.98	Left	6691.6	6.69	Left						Left	p		Left			
137	42	m	Right		✓		Right	13.3mm=1.33cm	34.2mm=3.42cm	Right	0.8mm=0.08cm			Right	762.3	7.62	Right	15703	15.7	Right		floor		medial wall		Right	p		Right			mucositis
			Left		✓		Left	15.0mm=1.5cm	34.5mm=3.45cm	Left		1.2mm=0.12cm		Left	1045.44	10.45	Left	21536	21.53	Left	roof	floor				Left	p		Left			mucositis
138	45	m	Right		✓		Right	17.6mm=1.76cm	21.8mm=2.18cm	Right		1.5mm=0.15cm		Right	1012.5	10.12	Right	2106.8	21.06	Right		floor	lateral wall	medial wall		Right	p		Right			mucositis
			Left			✓	Left	15.5mm=1.55cm	16.2mm=1.62cm	Left		1.9m0.19cm		Left	1425.6	14.25	Left	29866	29.86	Left		floor	lateral wall	medial wall		Left	p		Left			mucositis
139	41	m	Right				Right			Right				Right	365.42	3.65	Right	5883.2	5.88	Right						Right		a	Right			
			Left				Left			Left				Left	332.88	3.32	Left	4177.6	4.17	Left						Left	p		Left			
140	48	m	Right				Right			Right				Right	781.92	7.81	Right	18046	18.04	Right		floor		medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	720.12	7.2	Left	14114	14.11	Left			lateral wall	medial wall		Left		a	Left			mucositis
141	45	m	Right		✓		Right	18.0mm=1.8cm	12.2mm=1.22cm	Right		1.5mm=0.15cm		Right	780.16	7.8	Right	14315	14.31	Right	roof	floor	lateral wall	medial wall		Right	p		Right			mucositis
			Left		✓		Left	15.1mm=1.51cm	9.8mm=0.98cm	Left		1.1mm=0.11cm		Left	736.32	7.36	Left	13401	13.4	Left						Left		a	Left			
142	42	m	Right				Right			Right				Right	739.97	7.39	Right	13652	13.65	Right						Right		a	Right			
			Left				Left			Left				Left	518.42	5.18	Left	9824.05	9.82	Left		floor	lateral wall	medial wall		Left	p		Left			mucositis
143	40	m	Right				Right			Right				Right	816.64	8.16	Right	13597	13.59	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	730.8	7.3	Left	12167	12.16	Left			lateral wall			Left		a	Left			mucositis
144	42	m	Right	✓			Right	11.4mm=1.14cm	8.9mm=0.89cm	Right		1.5mm=0.15cm		Right	492.5	4.92	Right	8224.75	8.22	Right			lateral wall			Right	p		Right			mucositis
			Left			✓	Left	17.6mm=1.76cm	13.9mm=1.39cm	Left		1.9mm=0.19cm		Left	994.84	9.94	Left	20991	20.99	Left		floor	lateral wall			Left	p		Left			mucositis
145	40	m	Right				Right			Right				Right	849.03	8.49	Right	14603	14.6	Right			lateral wall			Right	p		Right			mucositis
			Left				Left			Left				Left	901.53	9.01	Left	16362	16.36	Left						Left		a	Left			
146	42	m	Right				Right			Right				Right	588.25	5.88	Right	9647.3	9.64	Right						Right		a	Right			
			Left			✓	Left	20.9mm=2.09cm	29.6mm=2.96cm	Left	0.9mm=0.09cm			Left	613.36	6.13	Left	10181	10.18	Left						Left		a	Left			
147	42	m	Right				Right			Right				Right	963.98	9.63	Right	16966	16.96	Right						Right		a	Right			
			Left				Left			Left				Left	607.84	6.07	Left	9664.6	9.66	Left						Left		a	Left			
148	41	m	Right		✓		Right	14.9mm=1.49cm	17.7mm=1.77cm	Right		1.1mm=0.11cm		Right	1097.4	10.97	Right	21948	21.94	Right						Right	p		Right			
			Left			✓	Left	13.9mm=1.39cm	13.3mm=1.33cm	Left		1.7mm=0.17cm		Left	1100.8	11	Left	22401.2	22.4	Left						Left	p		Left			
149	40	m	Right				Right			Right				Right	886.73	8.86	Right	17246	17.24	Right						Right		a	Right			
			Left		✓		Left	14.9mm=1.49cm	8.5mm=0.85cm	Left		1.9mm=0.19cm		Left	1056.96	10.56	Left	17598	17.59	Left						Left		a	Left			
150	47	m	Right		✓		Right	9.7mm=0.97cm	5.6mm=0.56cm	Right		1.5mm=0.15cm		Right	513.92	5.13	Right	1032.7	10.32	Right		floor		medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	390.5	3.9	Left	6308.02	6.3	Left		floor				Left		a	Left			mucositis

GROUP IV (25 f, 25 m)

151	50	f	Right				Right			Right				Right	872.64	8.72	Right	16274	16.27	Right						Right	p		Right			
			Left				Left			Left				Left	820.52	8.2	Left	14851	14.85	Left						Left	p		Left			
152	55	f	Right				Right			Right				Right	680.2	6.8	Right	12175	12.17	Right						Right		a	Right			
			Left		✓		Left	19mm=1.9cm	11.8mm=1.18cm	Left		2mm=0.2cm		Left	726.9	7.26	Left	12430.8	12.43	Left					complete	Left		a	Left		sinusitis	
153	55	f	Right				Right			Right				Right	869.4	8.69	Right	16301	16.3	Right				medial wall		Right	p		Right	polyp		
			Left				Left			Left				Left	920.62	9.2	Left	16939	16.93	Left		floor		medial wall		Left	p		Left			mucositis
154	55	f	Right				Right			Right				Right	429.76	4.29	Right	7757.16	7.75	Right						Right		a	Right			
			Left				Left			Left				Left	406.5	4.06	Left	6687.7	6.68	Left						Left		a	Left			
155	56	f	Right				Right			Right				Right	645.24	6.45	Right	10775	10.77	Right						Right	p		Right			
			Left				Left			Left				Left	889.56	8.89	Left	14722	14.72	Left						Left	p		Left			
156	50	f	Right	✓			Right	15.4mm=1.54cm	7.4mm=0.74cm	Right		1.7mm=0.17cm		Right	537.24	5.37	Right	10073	10.07	Right						Right		a	Right			
			Left	✓			Left	14.3mm=1.43cm	6.6mm=0.66cm	Left		1.6mm=0.16cm		Left	674.24	6.74	Left	12473	12.47	Left						Left		a	Left			
157	56	f	Right				Right			Right				Right	205.2	2.05	Right	3652.56	3.65	Right						Right	p		Right			
			Left	✓			Left	12.9mm=1.29cm	8.1mm=0.81cm	Left		1.5mm=0.15cm		Left	252.96	2.52	Left	3503.49	3.5	Left						Left	p		Left			
158	50	f	Right				Right			Right				Right	746.4	7.46	Right	11531	11.53	Right						Right	p		Right			
			Left		✓		Left	14.6mm=1.46cm	11.2mm=1.12cm	Left		1.5mm=0.15cm		Left	615.78	6.15	Left	9667.7	9.66	Left						Left	p		Left			
159	55	f	Right		✓		Right	13.5mm=1.35cm	8.2mm=0.82cm	Right		1.0mm=0.1cm		Right	913.44	9.13	Right	16304	16.3	Right						Right		a	Right			
			Left				Left			Left				Left	762.84	7.62	Left	12548	12.54	Left						Left		a	Left			
160	52	f	Right				Right			Right				Right	444.69	4.44	Right	7381.85	7.38	Right						Right		a	Right			
			Left				Left			Left				Left	364.24	3.64	Left	6483.4	6.48	Left						Left	p		Left			
161	53	f	Right				Right			Right				Right	786.9	7.86	Right	13888	13.88	Right			lateral wall			Right	p		Right	polyp		
			Left				Left			Left				Left	873.24	8.73	Left	16504	16.5	Left			lateral wall			Left	p		Left	polyp		
162	52	f	Right				Right			Right				Right	875.33	8.75	Right	18863	18.88	Right						Right	p		Right			
			Left				Left			Left				Left	887.6	8.87	Left	20414	20.41	Left						Left	p		Left			
163	58	f	Right				Right			Right				Right	409.5	4.09	Right	6961.5	6.96	Right						Right	p		Right			
			Left				Left			Left				Left	573.3	5.73	Left	10749	10.74	Left						Left	p		Left			
164	50	f	Right				Right			Right				Right	818.4	8.18	Right	14608	14.6	Right						Right	p		Right			
			Left				Left			Left				Left	793.35	7.93	Left	14042	14.02	Left						Left	p		Left			
165	50	f	Right				Right			Right				Right	958.82	9.58	Right	18646	18.64	Right						Right	p		Right			
			Left			✓	Left	15mm=1.5cm	13.5mm=1.35cm	Left		1.9mm=0.19cm		Left	839.31	8.39	Left	16912	16.91	Left						Left	p		Left			
166	50	f	Right				Right			Right				Right	379.47	3.79	Right	6507.91	6.5	Right						Right	p		Right			
			Left				Left			Left				Left	399.96	3.99	Left	5259.4	5.25	Left						Left	p		Left			
167	55	f	Right				Right			Right				Right	588.72	5.88	Right	8477.56	8.47	Right						Right	p		Right			
			Left				Left			Left				Left	488.67	4.88	Left	7305.61	7.3	Left						Left	p		Left			
168	58	f	Right				Right			Right				Right	613.83	6.13	Right	10956	10.95	Right		floor				Right	p		Right			mucositis
			Left				Left			Left				Left	815.85	8.15	Left	15256	15.25	Left						Left	p		Left			
169	58	f	Right				Right			Right				Right	473.04	4.73	Right	8420.11	8.42	Right		floor	lateral wall			Right	p		Right			mucositis
			Left				Left			Left				Left	543.84	5.43	Left	9680.35	9.68	Left						Left	p		Left			
170	50	f	Right				Right			Right				Right	520.96	5.2	Right	9924.28	9.92	Right						Right		a	Right			
			Left				Left			Left				Left	480.48	4.8	Left	9249.24	9.24	Left						Left		a	Left			
171	56	f	Right				Right			Right				Right	686.2	6.86	Right	12042	12.04	Right						Right	p		Right			
			Left				Left			Left				Left	470.53	4.7	Left	8375.43	8.37	Left						Left	p		Left			
172	55	f	Right				Right			Right				Right	778.8	7.78	Right	14952	14.95	Right						Right		a	Right			
			Left				Left			Left				Left	709.5	7.09	Left	13622	13.62	Left		floor				Left		a	Left			mucositis
173	59	f	Right				Right			Right				Right	643.5	6.43	Right	10649	10.64	Right			lateral			Right		a	Right		sinusitis	
			Left				Left			Left				Left	823.64	8.23	Left	13260	13.26	Left					complete	Left		a	Left		sinusitis	
174	59	f	Right				Right			Right				Right	594.94	5.94	Right	10798	10.79	Right						Right		a	Right			
			Left				Left			Left				Left	613.2	6.13	Left	10792	10.79	Left						Left		a	Left			
175	50	f	Right				Right			Right				Right	674.61	6.74	Right	13559	13.55	Right						Right		a	Right			
			Left				Left			Left				Left	559.44	5.59	Left	10741	10.74	Left		floor				Left		a	Left	polyp		
176	53	m	Right				Right			Right				Right	886.17	8.86	Right	16881	16.88	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	809.2	8.09	Left	15658	15.65	Left		floor				Left		a	Left			mucositis
177	50	m	Right				Right			Right				Right	599.98	5.99	Right	10289	10.28	Right		floor				Right		a	Right			mucositis
			Left				Left			Left				Left	464.8	4.64	Left	7831.88	7.83	Left		floor				Left		a	Left			mucositis
178	55	m	Right		✓		Right	19.4mm=1.94cm	18.2mm=1.82cm	Right		1.6mm=0.16cm		Right	1039.5	10.39	Right	22557	22.55	Right	roof		lateral wall			Right		a	Right			mucositis
			Left				Left			Left				Left	1099.3	10.99	Left	22977	22.97	Left	roof	floor	lateral wall	medial wall		Left		a	Left			mucositis
179	58	m	Right				Right			Right				Right	580.5	5.8	Right	8475.3	8.47	Right						Right		a	Right			
			Left				Left			Left				Left	417.6	4.17	Left	7182.72	7.18	Left						Left		a	Left			
180	55	m	Right				Right			Right				Right	1222.2	12.22	Right	25727	25.72	Right						Right	p		Right			
			Left				Left			Left				Left	837.09	8.37	Left	16281	16.28	Left						Left		a	Left			
181	52	m	Right				Right			Right				Right	538.56	5.38	Right	9532.5	9.53	Right						Right		a	Right			
			Left				Left			Left				Left	441.76	4.41	Left	6781.01	6.78	Left	roof		lateral wall	medial wall		Left		a	Left			mucositis
182	50	m	Right				Right			Right				Right	303.81	3.03	Right	4025.48	4.02	Right						Right		a	Right			
			Left				Left			Left				Left	358.14	3.58	Left	5372.1	5.37	Left						Left		a	Left			
183	58	m	Right	✓			Right	14.1mm=1.41cm	10.2mm=1.02cm	Right		1.6mm=0.16cm		Right	614.25	6.14	Right	10411	10.41	Right	roof	floor	lateral wall	medial wall		Right		a	Right			mucositis
			Left				Left			Left				Left	654.16	6.54	Left	12101	12.1	Left	roof	floor	lateral wall	medial wall		Left		a	Left			mucositis
184	50	m	Right				Right			Right				Right	675.18	6.75	Right	9992.66	9.99	Right	roof	floor	lateral wall	medial wall		Right	p		Right			mucositis
			Left				Left			Left				Left	622.66	6.22	Left	8966.3	8.96	Left		floor				Left	p		Left			mucositis
185	53	m	Right			✓	Right	12.8mm=1.28cm	17.5mm=1.75cm	Right		1.1mm=0.11cm		Right	830.22	8.3	Right	15151	15.15	Right		floor	lateral wall			Right	p		Right			mucositis

			Left				Left			Left				Left	824.6	8.24	Left	16368	16.36	Left			lateral wall			Left		a	Left			mucositis
186	56	m	Right		✓		Right	12.8mm=1.28cm	8.2mm=0.82cm	Right		1.4mm=0.14cm		Right	407.5	4.07	Right	5256.75	5.25	Right		floor		medial wall		Right		a	Right			mucositis
			Left		✓		Left	12.0mm=1.2cm	12.8mm=1.28cm	Left		17mm=0.17cm		Left	369.74	3.69	Left	5675.5	5.67	Left						Left		a	Left			
187	59	m	Right				Right			Right				Right	929.1	9.29	Right	18767	18.76	Right						Right	p		Right			
			Left			✓	Left	12.7mm=1.27cm	12.4mm=1.24cm	Left			2.2mm=0.22cm	Left	786	7.86	Left	14776	14.77	Left			lateral wall			Left	p		Left			mucositis
188	52	m	Right				Right			Right				Right	716.1	7.16	Right	11958	11.95	Right	roof	floor	lateral wall	medial wall		Right	p		Right			mucositis
			Left	✓			Left	15.2mm=1.52cm	17.1mm=1.71cm	Left			2.2mm=0.22cm	Left	716.1	7.16	Left	12531	12.53	Left		floor	lateral wall	medial wall		Left		a	Left			mucositis
189	50	m	Right		✓		Right	12.1mm=1.21cm	15.2mm=1.52cm	Right		1.7mm=0.17cm		Right	534.39	5.34	Right	9592.3	9.59	Right						Right		a	Right			
			Left			✓	Left	13.8mm=1.38cm	17.1mm=1.71cm	Left		1.8mm=0.18cm		Left	698.36	6.98	Left	12535	12.53	Left						Left		a	Left			
190	50	m	Right	✓			Right	17mm=1.7cm	14.4mm=1.44cm	Right		1.7mm=0.17cm		Right	777.48	7.77	Right	14033	14.03	Right						Right		a	Right			
			Left		✓		Left	19.3mm=1.93cm	13.8mm=1.38cm	Left		1.6mm=0.16cm		Left	872.96	8.72	Left	16586	16.58	Left						Left		a	Left			
191	52	m	Right				Right			Right				Right	833.86	8.33	Right	16010	16.01	Right						Right	p		Right			
			Left				Left			Left				Left	362.37	3.62	Left	5530.71	5.53	Left						Left	p		Left			
192	51	m	Right				Right			Right				Right	1230.66	12.3	Right	24059	24.05	Right		floor	lateral wall	medial wall		Right	p		Right		sinusitis	
			Left				Left			Left				Left	829.92	8.29	Left	14897	14.89	Left					complete	Left	p		Left		sinusitis	
193	57	m	Right				Right			Right				Right	432.74	4.32	Right	6274.73	6.27	Right		floor	lateral wall			Right		a	Right			mucositis
			Left				Left			Left				Left	573.76	5.73	Left	7774.4	7.77	Left						Left		a	Left			
194	58	m	Right				Right			Right				Right	382.93	3.82	Right	5092.96	5.09	Right						Right		a	Right			
			Left				Left			Left				Left	388.89	3.88	Left	5172.23	5.17	Left						Left		a	Left			
195	58	m	Right				Right			Right				Right	1175.64	11.75	Right	22513	22.51	Right		floor				Right	p		Right			mucositis
			Left				Left			Left				Left	990.84	9.9	Left	18828	18.82	Left		floor				Left		a	Left	polyp		
196	50	m	Right				Right			Right				Right	401.45	4.01	Right	7547.26	7.54	Right						Right		a	Right			
			Left				Left			Left				Left	441.6	4.41	Left	7772.16	7.77	Left						Left		a	Left			
197	52	m	Right				Right			Right				Right	281.94	2.81	Right	3876.6	3.87	Right					complete	Right		a	Right		sinusitis	
			Left				Left			Left				Left	367.78	3.67	Left	5902.86	5.9	Left		floor	lateral wall	medial wall		Left		a	Left		sinusitis	
198	57	m	Right				Right			Right				Right	1385.67	13.85	Right	27159	27.15	Right					complete	Right	p		Right		sinusitis	
			Left				Left			Left				Left	1138.47	11.38	Left	20606	20.06	Left					complete	Left	p		Left		sinusitis	
199	51	m	Right				Right			Right				Right	469.05	4.69	Right	7035.7	7.03	Right						Right		a	Right			
			Left				Left			Left				Left	597	5.97	Left	10775	10.77	Left						Left		a	Left			
200	55	m	Right				Right			Right				Right	699.2	6.99	Right	13494	13.49	Right						Right		a	Right			
			Left				Left			Left				Left	781.44	7.81	Left	12445	12.44	Left						Left	p		Left			