DISSERTATION ON

# "A PROSPECTIVE STUDY OF ANATOMICAL VARIATION OF OSTEOMEATAL COMPLEX IN CHRONIC SINUSITIS PATIENTS"

Submitted in partial fulfillment of the requirements for

**M.S. DEGREE BRANCH -IV OTORHINOLARYNGOLOGY**

of

**THE TAMILNADU DR. M.G.R. MEDICAL UNIVERISTY,**


**UPGRADED INSTITUTE OF OTORHINOLARYNGOLOGY**

**MADRAS MEDICAL COLLEGE**

**CHENNAI – 600 003**

**MARCH – 2009**

# CERTIFICATE

This is to certify that this dissertation entitled "**A PROSPECTIVE STUDY OF ANATOMICAL VARIATION OF OSTEOMEATAL COMPLEX IN CHRONIC SINUSITIS PATIENTS**" submitted by **Dr. R.KARTHIKEYAN,** appearing for M.S. E.N.T.. Branch IV Degree examination in March 2009 is a bonafide record of work done by him under my direct guidance and supervision in partial fulfillment of regulations of the Tamil Nadu Dr. M.G.R. Medical University, Chennai. I forward this to the Tamil Nadu Dr.M.G.R. Medical University, Chennai, Tamil Nadu, India.

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# DECLARATION

I solemnly declare that the dissertation entitled "**A PROSPECTIVE STUDY OF ANATOMICAL VARIATION OF OSTEOMEATAL COMPLEX IN CHRONIC SINUSITIS PATIENTS**" is done by me at the Madras Medical College and Government General Hospital, Chennai during 2006-2008 under the guidance and supervision of Prof. S. KULASEKARAN, M.S., D.L.O.

This dissertation is submitted to The Tamilnadu Dr. M.G.R Medical University, towards partial fulfillment of regulation for the award of M.S. DEGREE IN Otorhinolaryngology. (BRANCH–IV).

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# CONTENTS

# INTRODUCTION

Sinusitis is one of the leading health care problems nowadays, increasing in both incidence and prevalence. Various articles have been published regarding aetiopathogenesis, microbiology, anatomical variations and management aspects.

**DEFINITION:**

American Academy of Otorhinolaryngology Head and Neck Surgery formulated certain working definitions.

Clinically, Sinusitis is defined as the condition manifest by an inflammatory response of the mucous membrane of the nasal cavity and para nasal sinuses, fluid within the cavity, and / or underlying bone.

Also defined as a group of disorders characterized by inflammation of the mucosa of the nose and para nasal sinuses lasting for atleast 12 weeks.[1]

At present diagnostic nasal endoscopic evaluation of nose and para nasal sinuses is a routine component for evaluating patients with evidence of suspected nose and para nasal sinus disease. Arrival of the endoscopes has

helped us in many ways to recognize the lesion or changes that are hidden from the naked eye or even from inspection under microscopes. With this, provisional diagnosis may be confirmed , expanded or revised. Also it helps the Otorhinolaryngologist in deciding the mode of treatment. All the patients who have significant findings in diagnostic nasal endoscopy are subject to CT Scan Para nasal sinus evaluation.

CT Scan Para nasal sinus is not routinely indicated in acute sinusitis except in the state of complication or no improvement with medical therapy. Whatever may be the diagnosis, CT Scan Para nasal sinus is mandatory before performing sinus surgery. This is to avoid inadvertent complications while performing the procedure. In patients with a history of chronic sinusitis over a period of months or years, and not responding to medical therapy, computed tomography should be performed.

As a number of lateral nasal wall diseases cannot be recognized and identified by endoscope, we perform tomography even when the diagnostic nasal endoscopic finding is insignificant, provided that the history and clinical findings suggest the presence of some disease.

The anatomical variations of lateral nasal wall and Para nasal sinuses are surgically and patho-physiologically important because they narrow the drainage pathway of the para nasal sinuses, which in turn lead on to

stagnation of secretions, then infection and inflammation of the mucosa lining the sinuses.

Diseases in extensively pneumatised sinuses lead on to exposure of important structures like Optic nerve and Internal Carotid artery, to infection and inflammation, and also increases risk during surgical procedure.

Hence , Endoscopic evaluation and CT Scan evaluation of nose and Para nasal sinuses is mandatory in chronic sinusitis patients, to evaluate the detailed anatomy (normal anatomy, anatomical variation and the extent of the disease process) that are commonly encountered in the osteomeatal complex and lateral nasal wall per se. This will help the endoscopic surgeon in pre-operative assessment and planning of the surgery, in complete eradication of the disease and to reduce the intra operative and post operative complications.

# AIMS OF THE STUDY

1. To study the incidence of anatomical variations of osteomeatal complex common in chronic sinusitis patients.

2. To study the anatomical variation commonly associated with each paranasal sinus inflammation.

3. To study the importance of pre-operative computed tomography evaluation of the osteomeatal complex variation in chronic sinusitis patients.

# REVIEW OF LITERATURE

## EMBRYOLOGY:

Classic anatomic treatises attribute initial paranasal sinus development to lateral nasal wall ridges called ethmoturbinals.[2] A series of five to six ridges first appear during the eighth week of development; through regression and fusion, however, three to four ridges ultimately persist . The first ethmoturbinal regresses during development; its ascending portion forms the agger nasi, while its descending portion forms the uncinate process. The second ethmoturbinal ultimately forms the middle turbinate, the third ethmoturbinal forms the superior turbinate, and the fourth and fifth ethmoturbinals fuse to form the supreme turbinate. These structures are all considered to be ethmoid in their origin. An additional ridge, the maxilloturbinal, arises inferior to these structures. This ridge ultimately forms the inferior turbinate but is not considered ethmoid in its embryologic origin.

The primary furrows that lie between the ethmoturbinals form the various nasal meati and recesses. The first primary furrow is located

between the first and second ethmoturbinals. Its descending aspect forms the ethmoidal infundibulum, hiatus semilunaris, and middle meatus, while its ascending aspect can contribute to the formation of the frontal recess. The primordial maxillary sinus develops from the inferior aspect of the ethmoidal infundibulum.[3-5] The second primary furrow forms the superior meatus and the third primary furrow forms the supreme meatus.

In their development from the lateral wall, the ethmoturbinals form bony structures that traverse the ethmoid complex to attach to the lamina papyracea of the orbit and skull base. The furrows develop into the various pre-recesses and recesses and contribute to the extensive and complex pneumatization of the ethmoid bone. As development progresses, secondary evaginations and invaginations emerge from the lateral nasal wall between the maxillo- and ethmoturbinal.[6,7] The nomenclature ascribed to these structures varies among authors and includes secondary concha or accessory concha of the middle nasal meatus for the evaginations and secondary furrows or accessory meati of the middle nasal meatus for the invaginations.[6,7] Given the fact that the precise mechanism of ridge and furrow development, hence the nomenclature, is subject to some interpretation, the primordial ethmoid bulla appears to arise as a secondary lateral nasal wall evagination, and the primordial supra and retrobullar

recesses (sinus lateralis) appear to arise from the secondary furrows that form above and behind the primordial ethmoid bulla.

# ANATOMY :

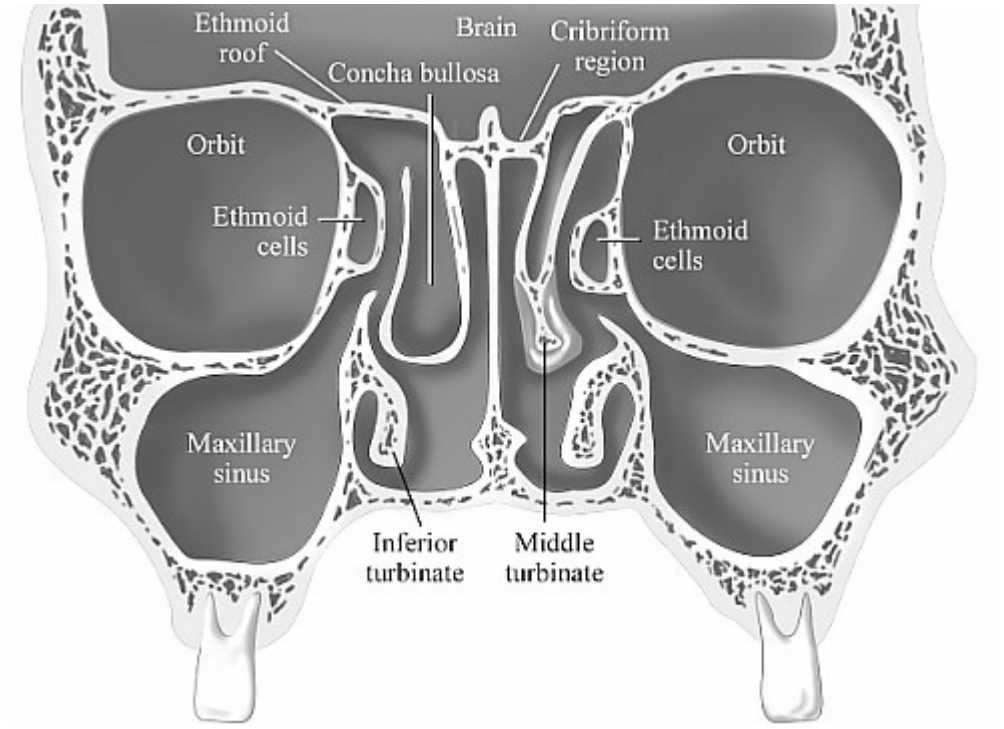



Fig : 1

**ANTERIOR OSTIOMEATAL COMPLEX : (**Fig : 2**)**

The anterior ostiomeatal unit is not a discrete anatomic structure but refers collectively to several middle meatal structures: the uncinate process, the ethmoid infundibulum, anterior ethmoid cells, and ostia of the anterior ethmoid, maxillary, and frontal sinuses .The ostiomeatal unit is a functional

rather than an anatomic designation, coined by Naumann in discussing the pathophysiology of sinusitis.[9] He emphasized that a small amount of obstruction in this critical region could lead to significant disease in the larger frontal and maxillary sinuses.

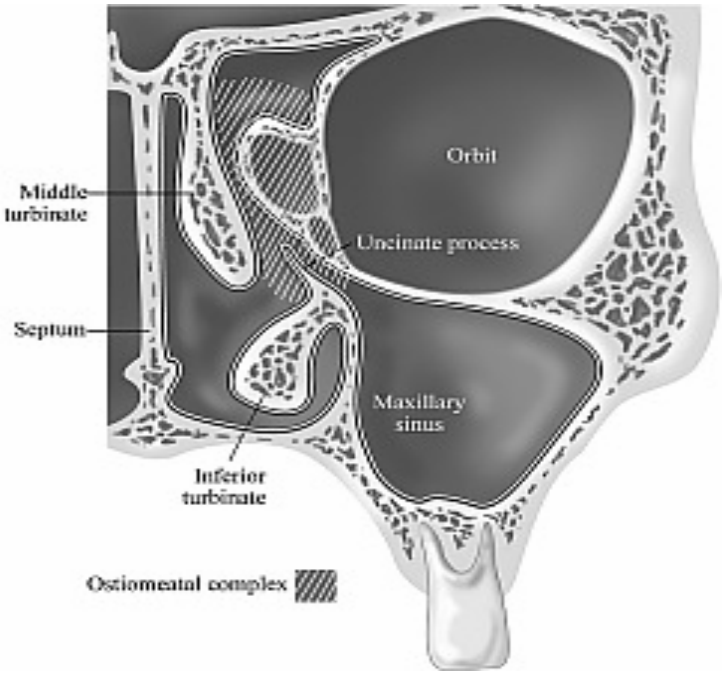



Fig : 2

**POSTERIOR OSTIOMEATAL COMPLEX**: (Fig : 3)

The relationship between the aerated portion of the sphenoid sinus and the posterior ethmoid sinus needs to be accurately perceived by the surgeon so as to avoid complications during surgery. This morphology is best displayed in the axial plane and with three-dimensional imaging. In most patients, aeration of the posterior ethmoid sinus is wider and somewhat

higher than that of the sphenoid sinus. Usually in the paramedian sagittal plane, the sphenoid sinus is the most superior and posterior air space. More laterally (1.5 to 2 cm from the nasal septum), the sphenoid sinus is situated more inferiorly, and the most posterosuperior air space is the posterior ethmoid sinus.

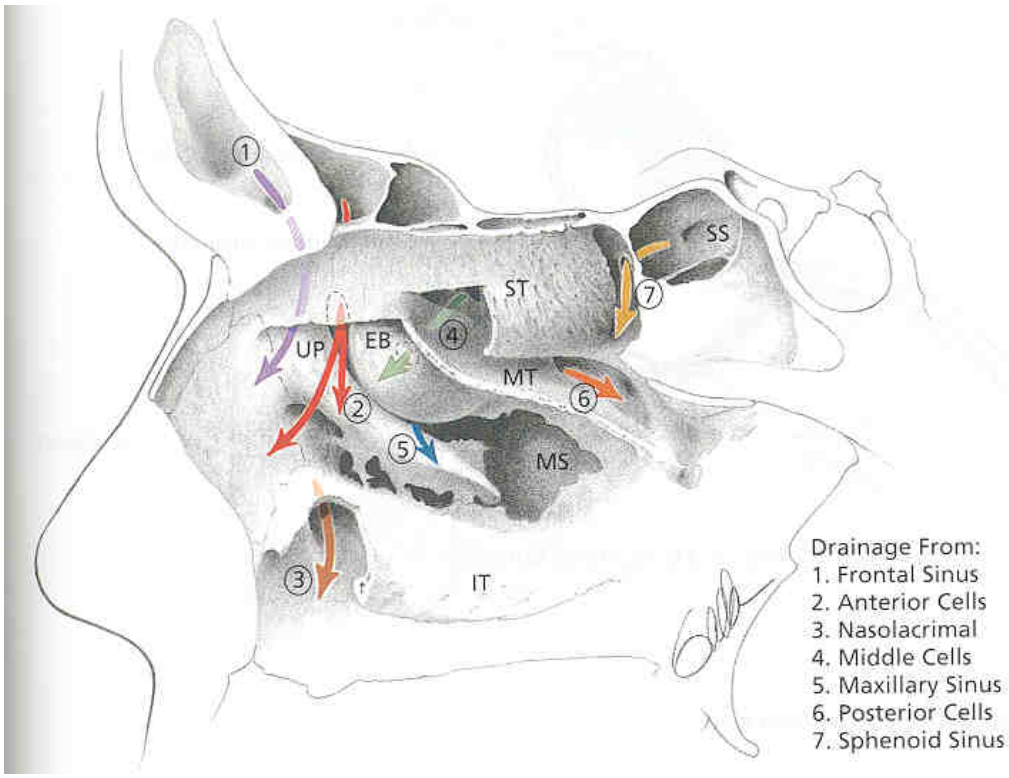
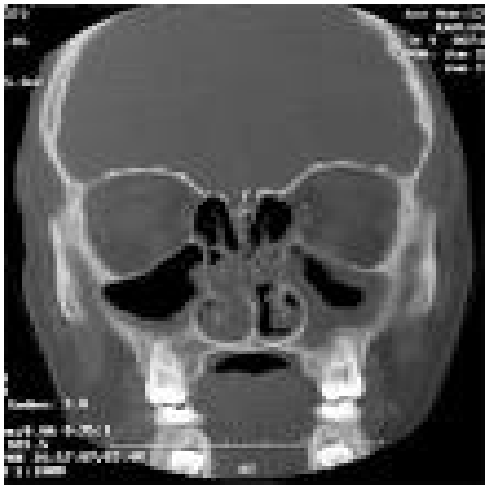



Fig : 3

**AGGER NASI**

On anterior rhinoscopy, a prominence can be easily appreciated at and just anterior to the middle turbinate's insertion into the lateral nasal wall.

Fig : 4



Chronic sinusitis patient -
CT scan para nasal sinuses.

Fig : 5

X-Ray paranasal sinus-
Chronic sinusitis patient

Fig : 6

Pansinusitis

Fig : 7

Purulent discharge from accessory ostium of posterior frontanel in chronic sinusitis patients

This region was designated as the agger nasi, taken from the Latin agger, meaning mound or eminence, and nasi, meaning nose. In many but not all cases, the agger nasi region is pneumatized by an anterior ethmoid cell, referred to as the agger nasi cell. This cell usually takes its origin from the superior aspect of the infundibulum or the frontal recess. [2,9,10]

The agger nasi cell is bordered ,

**Anteriorly** by the frontal process of the maxilla,

**Superiorly** by the frontal recess/sinus,

**Anterolaterally** by the nasal bones,

**Inferomedially** by the uncinate process of the ethmoid bone, and **Inferolaterally** by the lacrimal bone.

The intimate relationship of the cell to the lacrimal bone readily explains the finding of epiphora in select patients with sinus disease. The agger nasi can also be important in frontal sinusitis and its treatment. The superior aspect of the cell serves as the anteromedial floor of the frontal sinus and a significant portion of the anterior border of the frontal recess. This is relevant for understanding the pathophysiology of frontal sinusitis and the surgical treatment of the frontal sinus. The agger nasi can pneumatize inferomedially to pneumatize the uncinate process. In a small

percentage of patients, the pneumatization can be significant, and bulla formation of the uncinate may occur. [11,12]

The agger nasi cell is situated below the frontal sinus. It reaches the lacrimal fossa inferolaterlly and anterolaterally and is arched by the nasal bones. These cells usually border the primary floor of the frontal sinus ostium, lying anterior, lateral, and inferior to the frontal recess. In a study conducted by the author and others,[13] the agger nasi cell was found to occur in nearly all members of the population. This finding is echoed by Bolger et al.,[14] who found the agger nasi cell to present in 98.5% of his study population. These percentages would suggest that the agger nasi cell is a part of normal anatomy; however, some investigators reported the incidence of agger nasi cells to be as low as 3 to 23.6%.[15] This discrepancy could be due to the varying definitions of agger nasi cells; some authors consider only large agger nasi cells extending beyond the parameters described above, while others consider any structure fitting the above description of an air chamber below the frontal sinus to be an agger nasi cell. The method of analysis used to determine the prevalence of agger nasi cells could also be a reason for varying reports.[14] When CT scanning is used, the cell is easily detected, even when small. In anatomic dissection, however, agger nasi cells

are more difficult to detect, and reports using this method of analysis vary widely in the reported prevalence of the variation.

## UNCINATE PROCESS

The uncinate process is most easily appreciated by viewing a sagittal gross anatomic specimen after deflecting the middle turbinate superiorly . This ethmoid structure is nearly sagittally oriented, nearly paralleling the ethmoidal bulla. It is approximately 3 to 4 mm wide and 1.5 to 2 cm in length. Through most of its course, its posterior margin is free as it has no bony attachments. The hiatus semilunaris lies directly behind the posterior margin of the uncinate. Anteriorly and superiorly, it attaches to the ethmoidal crest of the maxillae, just inferior to the lateral attachment of the anterior aspect of the middle turbinate and agger nasi. Directly inferior to this, it fuses with the posterior aspect of the lacrimal bone.

Its anterior inferior aspect does not have a bony attachment Posteriorly and inferiorly, the uncinate attaches to the ethmoidal process of the inferior turbinate bone . The attachment here is thick, and the uncinate often splits or widens in this region to fuse with the stouter inferior turbinate bone.

At its posterior and superior limit, the uncinate also gives off a small bony projection to attach to the lamina perpendicularis of the palatine bone.[16]

The uncinate has no bony attachment anterior and posterior to its attachment to the inferior turbinate bone. Here, the lateral nasal wall is made not of bone but rather middle meatal mucosa, a small layer of intervening connective tissue, and sinus mucosa. These areas are referred to as the anterior and posterior fontanelles.. Accessory ostia are frequently encountered in the posterior fontanelle region, occurring in approximately 20 to 25% of patients.[17]

Returning to its superior aspect, the uncinate projects posterior and superior to the middle turbinate attachment and most commonly bends laterally to insert on the lamina papyracea of the orbit . Inferior and lateral to this portion of the uncinate lies the superior aspect of the infundibular air space, the recessus terminalis. Superior and medial to this portion of the uncinate (most commonly) lies the floor of the frontal recess. Alternatively, the uncinate can attach centrally to the skull base or medially to the superior aspect of the vertical lamella of the middle turbinate near the turbinate's insertion to the cribriform plate.[18]

In select cases, the uncinate is displaced medially to such an extent that it recurves on itself and has been misinterpreted as a duplication of the middle turbinate. Additionally, in a small percentage of cases, the uncinate process can be pneumatized. [19,20] An appreciation of uncinate variability is important. If lateral displacement of the uncinate with accompanying atelectasis of the infundibulum is not appreciated during infundibulotomy incision, inadvertent orbital injury can occur.[21]

**ETHMOID BULLA:**

The ethmoid bulla is one of the most constant and largest of the anterior ethmoid air cells. It is located within the middle meatus directly posterior to the uncinate process and anteriorto the basal lamella of the middle turbinate . The cell is based on the lamina papyracea and projects medially into the middle meatus . The cell has the appearance of a bulla, that is, a hollow, thin-walled, rounded, bony prominence. Superiorly, the anterior wall of the ethmoid bulla can extend to the skull base and form the posterior limit of the frontal recess. Posteriorly, the bulla can blend with the ground lamella.

Anatomic variations can occur in the ethmoid bulla. When highly pneumatized, the ethmoid bulla can be one of the largest ethmoid air cells

and can lie in the lower aspect of the middle meatus. In select cases, a low-lying bulla can potentially narrow the ethmoidal infundibulum and impair mucociliary transport and ventilation. The ethmoid bulla is formed by pneumatization of, and behind, the second basal lamella or bulla lamella.

When unpneumatized, a bony projection from the lamina papyracea results and is referred to as the torus lateralis.[22] It is estimated that this occurs in approximately 8% of subjects.

**HIATUS SEMILUNARIS :**

(Latin: hiatus, -a gap, cleft or passageway, and semilunaris, -crescent-shaped.)

Indeed, the hiatus semilunaris is a crescent-shaped gap between the posterior-free margin of the uncinate processand the anterior wall of the ethmoid bulla . It is through this two-dimensional, sagittally oriented cleft or passageway that the middle meatus communicates with the ethmoid infundibulum . This cleft is further designated as the hiatus semilunaris inferior by Grunwald to distinguish it from the smaller, less defined crescent- shaped cleft, the hiatus semilunaris superior.[22] The hiatus semilunaris superior is the cleft formed between the posterior wall of the ethmoid bulla and the basal lamellae of the middle turbinate and is the

passageway through which the middle meatus communicates with the lateral sinus (retro and suprabullar recess).

**ETHMOIDAL INFUNDIBULUM:**

(Latin root, infundibulum, - funnel or funnel-shaped structure or passage).[24]

The ethmoidal infundibulum is the funnel-shaped passage through which the secretions from various anterior ethmoid cells, the maxillary sinus, and, in some cases, the frontal sinus are transported or channeled into the middle meatus. The ethmoidal infundibulum is a three-dimensional space located in the anterior ethmoid region, bordered ,

medially by the mucosa-covered uncinate process,

laterally by the lamina papyracea, and

anteriorly and superiorly by the frontal process of the maxilla and lacrimal bone superolaterally.[23]

When viewed from a sagittal perspective, the ethmoidal infundibulum is curved in shape, corresponding to the course of the uncinate process and anterior wall of the ethmoid bulla.[22] The anterior wall of the ethmoid bulla forms the posterior border of the ethmoidal infundibulum. The ethmoidal infundibulum communicates with the middle meatus through the hiatus

semilunaris, a two-dimensional cleft between the uncinate process and ethmoid bullae. When viewed in a coronal perspective just above the level of the maxillary ostia, the medial boundary of the infundibulum is the uncinate process, the lateral boundary is the lamina papyracea, and the maxillary ostium forms the inferior boundary.

The superior boundary is formed by the anteriorEthmoidal Infundibulum anterior wall of the ethmoid bulla, recognizing that the superior medial boundary is formed by the hiatus semilunaris. The superior aspect of the infundibulum is important as it is intimately related to the frontal recess. The relationship of the infundibulum and frontal recess is largely determined by the attachment of the uncinate process. Most commonly, the uncinate bends laterally to attach to the lamina papyracea and forms the superior boundary of the ethmoidal infundibulum, the recessus Terminalis. The frontal recess will drain medial to the uncinate, if the uncinate attaches to the lamina papyracea laterally .Alternatively, the uncinate can attach to the ethmoid roof or insert into the middle turbinate. In these cases, the frontal recesses will be contiguous with the ethmoidal infundibulum.

. Tremendous variations in the uncinate attachment and the relationship of the infundibulum and frontal recess exist. The inferior aspect

of the infundibulum is also important, notably for its relationship to the maxillary ostium .The natural ostium of the maxillary sinus is most commonly located in the posteroinferior one-third of the ethmoid infundibulum. The most inferoposterior portion of the infundibulum terminates as it empties into the middle meatus and blends with the posterior fontanelle mucosa.

## SINUS LATERALIS (SUPRABULLAR AND RETROBULLAR RECESSES)

The sinus lateralis is a variable air space that lies behind and nabove the ethmoid bulla and is also referred to as the suprabullar and retrobullar recesses [22] . This space, initially described by Grunwald, can be highly developed, and in such cases, it is bordered by the ethmoid roof superiorly, the lamina papyracea laterally, the ethmoid bulla roof and posterior wall inferiorly and anteriorly, and the basal lamella of the middle turbinate posteriorly . As the sinus lateralis lies anterior to the basal lamella of the middle turbinate, it is anterior ethmoid in its location. It is not, however, considered an anterior ethmoid cell as it does not have a single ostia for ventilation and drainage. Rather, it is considered a recess or space that can communicate with the middle meatus via the hiatus semilunaris superior.

Stammberger points out that if the ethmoid bulla does not extend to the skull base to form the posterior wall of the frontal recess, the sinus lateralis can communicate with the frontal recess and the hiatus semilunaris inferior.[22,23] The ethmoid bulla often opens posteriorly into the sinus lateralis.

**PNEUMATISED SEPTUM:**

Not infrequently, air cells will be present within the posterior nasal septum .The ostia of these air cells are always in communication with the sphenoid sinus. These cells can also be infected by inflammatory disease and as their ostia close, they can evolve into a mucocele. One must be careful and prudent in distinguishing this pathologic entity from neoplasm or encephaloceles. MRI may prove to be indispensable in clearly defining these entities.

**HALLER CELLS (INFRAORBITAL RECESS CELLS): (**Fig : 18**)**

Haller cells are pneumatized ethmoid air cells that project along the medial roof of the maxillary sinus and the most inferior portion of the lamina papyracea, below the ethmoid bulla and lateral to the uncinate process. Most often, they arise from the anterior ethmoid cells and are closely relatedto the infundibulum. Less frequently, Haller cells may arise from posterior ethmoid

cells; in this case, however, they are less likely to compromise the infundibulum.[25] These cells contribute to the narrowing of the infundibulum and may also compromise the adjacent ostium of the maxillary sinuses. Consequently, many authors [26,27] cite Haller cells as a factor in recurrent maxillary sinusitis. A statistical analysis conducted by Bolger et al.[33] found no statistical difference between the prevalence of Haller's cells noted in patients presenting with recurrent maxillary sinusitis and those asymptomatic patients evaluated, leading these investigators to suggest evaluating the role of Haller's cells in disease on an individual basis, depending on the size, placement, evidence of inflammation, and mucosal contact evident in the cell. Wanamaker reported on a rare case [29] in which inflammation within the Haller's cell itself caused severe headache due to secondary obstruction of the infundibulum.[29] He also noted that the cells were found as part of diffuse sinus disease and identified them as predisposing factors for recurrent maxillary sinusitis. Tonai and Baba,[30] however, did not report any correlation between Haller's cells and the recurrence of disease in their population.

**ENLARGED ETHMOID BULLA: (**Fig : 14**)**

The ethmoid bulla is the air cell directly above and posterior to the infundibulum and hiatus semilunaris. Although it is the largest ethmoidal air cell, its excessive growth and pneumatization can impair sinus ventilation and drainage. Very large ethmoid bullae may encroach upon the infundibulum and middle meatus, sometimes growing to such size as to completely fill the sinus of the middle turbinate bone. An excessively enlarged ethmoid bulla is established as a potential cause of sinus infection, especially if pus, polyps, or cysts are present; however, Lloyd [31] reports this variation as one that is difficult to assess and suggests that it may be over diagnosed. His study also found that, when compared with other variations, enlarged ethmoid bulla had a slightly lower incidence of correlation with sinus disease.

**UNCINATE PROCESS—DEVIATION AND PNEUMATIZATION :**

Two main types of variation—deviation(Fig : 17) and pneumatization (Fig : 15)— are associated with the uncinate process. The structure may deviate laterally, compromising the infundibulum, or medially, compromising the middle meatus. Any deviation of the uncinate process is recognized by most authors as a detriment to the normal mucociliary

Fig : 8 Concha Bullosa

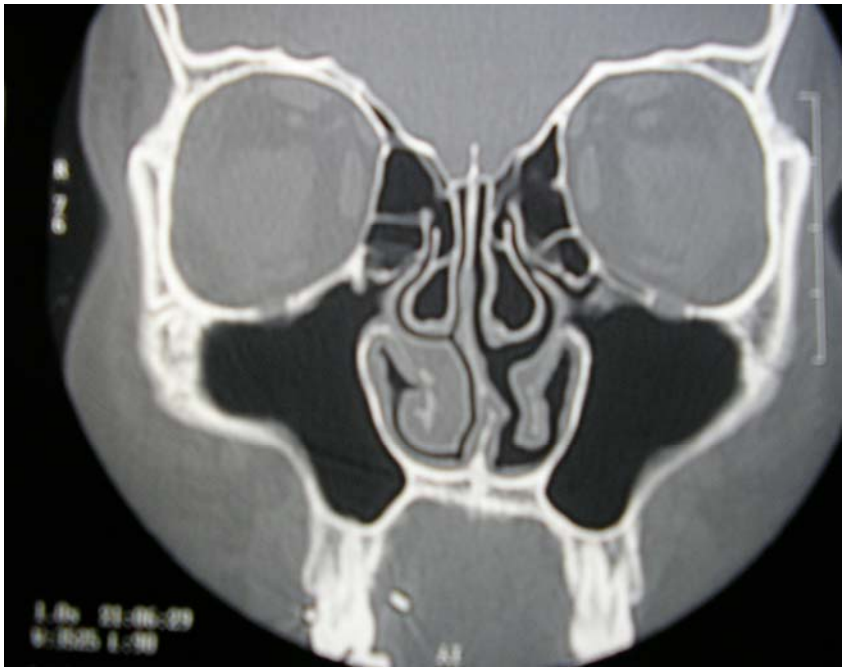


Fig : 9 Concha Bullosa

Fig : 10 Agger nasai cell

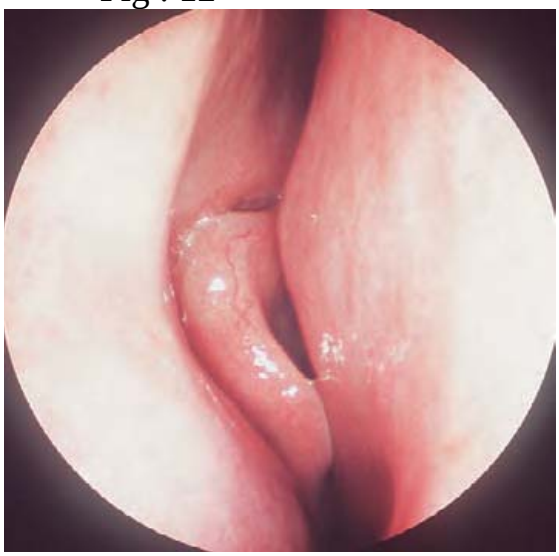
Fig :11 Agger nasai cell

drainage of the anterior ethmoid, frontal, and maxillary sinuses. The uncinate process may also be pneumatized. Bolger states that pneumatization of this structure occurs when an agger nasi cell extends into the most anterosuperior region of the uncinate process; [28] however, there is uncertainty expressed in the literature concerning the exact physiology behind this phenomenon. Pneumatization of the uncinate process is particularly likely to narrow the infundibulum, hampering sinus ventilation and drainage.

**PARADOXICAL MIDDLE TURBINATE:** **(**Fig : 12, 13**)**

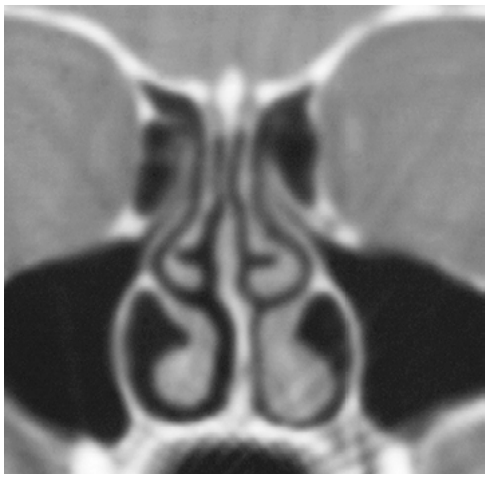
Paradoxical middle turbinate is identified when the curve of the middle turbinate projects laterally, toward the nasal septum. Usually, the turbinate curves more medially, toward the lateral sinus wall. Some paradoxical middle turbinates have been found to compromise the middle meatus and compress the infundibulum; because of this tendency, most authors agree that paradoxical middle turbinates can be a contributing factor to sinusitis.

Fig : 12



Paradoxical middle turbinate

Fig : 13

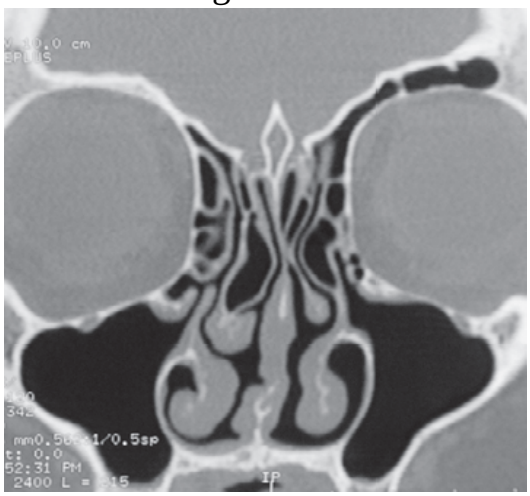


Paradoxical middle turbinate

Fig : 14

Prominent bulla ethmoidalis
and concha bullosa.

Fig : 15



Concha bullosa and
pneumatised uncinate process

**CONCHA BULLOSA:**

Any pneumatization of the middle turbinate is technically referred to as a concha bullosa. However, there is great variability among subjects as to the degree of pneumatization. If the vertical portion or lamella of the middle turbinate is pneumatized, the cell that is formed is referred to as the nterlamellar cell. The term interlamellar cell distinguishes this pattern of middle turbinate pneumatization from pneumatization that includes the more inferiorly located bulbous portion of the turbinate. This is more commonly referred to as a concha bullosa. The term concha bullosa is more clearly understood by examining the Latin roots: bulla (which has already been discussed), which is present within the concha, or turbinate. A large concha bullosa is an anatomic variation that can narrow the middle meatus and reduce mucociliary clearance and ventilation.

**NASAL SEPTAL DEVIATION:**

In normal anatomy, the cartilaginous and bony portions of the nasal septum form a straight wall. A common variation, however, is the bowing of this structure, especially at the junctions of the cartilaginous portions of the septum and the bony perpendicular ethmoid plate and vomer. It is widely recognized that this bowing can compress the middle turbinate laterally and compromise the middle meatus. Swollen membranes, secondary

inflammation, and infection of the middle meatus have also been reported as a result of this variation. Bony spurring at the above-mentioned junctions is also commonly observed; excessive spurring may further narrow the nasal and ethmoidal air passages.

**ONODI CELLS: (**Fig : 19**)**

The sphenoethmoid (Onodi) cell has received much attention throughout the past century as various sinus surgeries evolved. An Onodi cell is defined as the pneumatization of the most posterior ethmoid air cell, where a bulge of the optic canal into the posterior ethmoid is apparent. When an Onodi cell exists, this pneumatization causes the optic nerve to be closer to the posterior ethmoid sinus than is usually observed . Understanding the relationship between the optic nerve, the posterior ethmoid sinus, and sphenoid sinus is critical in completing a safe operative procedure and avoiding optic nerve injury during FESS. Onodi cells are also a potential cause for incomplete sphenoidectomy. If a surgeon is operating in an Onodi cell, he or she may recognize landmarks traditionally associated with the sphenoid sinus (internal carotid artery, optic nerve) and therefore may mistakenly conclude that the sphenoid sinus has been entered and consider the operation completed, when in fact it is not . Studies performed

Fig : 16

Intumescentia septi nasi anterior (ISNA):

Fig : 17

Medialised uncinate process

Fig : 18

Haller cell

Fig : 19

Onodi cell

to determine the prevalence of Onodi cells in the population have used a variety of analytical methods; consequently, their results vary widely. Habal et al.[34] and Maniscalco and Habal [35] found a prevalence of 25% using transorbital dissection, and Kainz and Stammberger [36] reported a 42% prevalence using endoscopic dissection. Gross anatomic and radiographic evaluation studies reported much lower prevalences, ranging anywhere from 1 to 11.6% [37,38] and 1.3 to 8% [39] respectively. Driben et al.[40] showed that coronal CT scans identified sphenoethmoid cells in 3 of 41 (7%) of their patient population. However, anatomic dissection identified Onodi cells in 16 of 41 (39%) of the subjects. Endoscopic evaluation reveals that the sphenoethmoid cell is a more common anatomic variation than previously appreciated. Awareness of this fact may help reduce the risk of optic nerve trauma during FESS.

**FRONTAL CELL :**

Frontal cells are a less common type of anterior ethmoid air cell . The recognition and subsequent definition of the appearance and etiology of frontal cells was initiated by J. Parson Schaeffer. During the course of his observations of the embryonic development of the sinuses, he discovered that it was possible, although unusual, for one cell to aerate each half of the

frontal bone, each with a separate communication to the frontal recess. Schaeffer coined the term “frontal cell” to describe this phenomenon.[42,43] Van Alyea [44,45,46] subsequently defined the frontal cell as a cell encroaching on the frontal recess or frontal sinus. He considered supraorbital ethmoid, agger nasi, and intersinus septal cells as well those limited to the frontal recess as frontal cells. Bent et al.[41] have defined frontal cells more specifically as belonging to one of four categories, detailed in Table. They also state that all frontal cells derive from the anterior ethmoid sinus behind the agger nasi cell and pneumatize the frontal recess above the agger nasi cell. Each type of frontal cell may obstruct the nasofrontal communication or the frontal sinus itself.

Type I Single frontal recess cell above agger nasi cell

Type II Tier of cells in frontal recess above agger nasi cell

Type III Single massive cell pneumatizing cephalad into frontal sinus

Type IV Single isolated cell within the frontal sinus

**Intumescentia septi nasi anterior (ISNA):** [47] (Fig: 16)

Intumescentia septi nasi anterior is a common anatomical variation that is not routinely noticed by surgeons or radiologists. ISNA is a mucosal

bulging located on each side of the anterior part of the septum. [47] In this study, computerized tomography (CT) scans of the paranasal sinus were obtained from 595 patients who had symptoms of chronic sinusitis. Among 595 subjects, ISNA was found in 332 (55.79 per cent) of subjects. It was found more frequently in males than females in every age group. Although ISNA is a common anatomical variation, it is generally overlooked. This is the first report on ISNA in different age groups and sexes.

**FRONTAL RECESS AND SINUS:**

The frontal sinus drains into the middle meatus and nasal cavity through a complex passage. Several authors describe a “nasofrontal duct” that forms the nasofrontal connection. Anatomic dissection reveals that a true duct, that is, “a tubular structure conducting any fluid,” does not exist. In an attempt to refine the nomenclature and more accurately characterize the anatomy, the term frontal recess has been recommended. The frontal recess is the most anterosuperior aspect of the anterior ethmoid sinus that forms the connection with the frontal sinus.[48] The boundaries of the frontal recess are the lamina papyracea laterally, the middle turbinate medially, the posterosuperior wall of the agger nasi cell (when present) anteriorly, and the anterior wall of the ethmoid bulla posteriorly. If the anterior wall of the

ethmoid bulla does not reach the skull base and form a complete posterior wall, the frontal recess may communicate with the suprabullar recess.[48] The frontal recess tapers as it approaches the superiorly located internal os of the frontal sinus; above the os, it again widens, as the anterior and posterior tables diverge to their respective positions. An hourglass-like appearance is evident, with the narrowest portion being the frontal ostium.

There is tremendous variation with respect to the pattern of the nasofrontal connection. The anatomic complexity of this region is better understood when the effect of the surrounding ethmoid cells, such as the agger nasi cell, frontal cells, and supraorbital ethmoid cells, are considered.

An intimate relationship therefore exists between the agger nasi cell and the frontal recess. Secretions from the frontal sinus destined for the nasal cavity usually follow a path through the frontal recess and over the posterior and medial surface of the agger nasi cell. If the agger nasi cell is extensively pneumatized, the frontal recess can be relatively narrowed, and hence the patient may be predisposed to frontal sinusitis. In surgery, an extensively pneumatized agger nasi can be mistaken for the frontal recess or sinus. If a large agger nasi cell is opened and mistaken for a frontal sinus, the residual superoposterior wall of the agger nasi cell can scar posteriorly to the

ethmoid roof, and iatrogenic stenosis or obstruction of the nasofrontal connection can occur.[50]

In addition to the agger nasi cell, there are other ethmoid cells that have an intimate relationship with the frontal recess. Van Alyea reported that approximately 50% of anatomic specimens had anterior ethmoid cells that encroached into the frontal sinus, and that one-third of these encroached into the area of the frontal ostium.He termed these cells “frontal cells.” Schaeffer pointed out that anterior ethmoid cells could pneumatize sufficiently into the frontal sinus to give the appearance of duplication of the sinus. Stammberger points out that “from the frontal recess, anterior ethmoid cells can develop into the frontal bone along side the frontal sinus.” These were called “the bulla frontalis” by Zuckerkandl.[2]

The supraorbital ethmoid cell is another anatomic variation in the region of the frontal recess. Supraorbital ethmoid cells commonly occur from pneumatization of the orbital plate of the frontal bone by ethmoid air cells. Kasper felt that these cells originated in the third and fourth frontal furrow regions, from which they pneumatized laterally and superiorly over the orbit into the orbital plate of the frontal bone. Pneumatization of the orbital plate of the frontal bone can also occur, however, from the frontal sinus proper .

**MAXILLARY SINUS:**

The maxillary sinus is usually a single chamber, with its limits being the orbital roof superiorly, the hard palate, alveolus and dental portion of the maxilla inferiorly, the zygomatic process laterally, a thin plate of bone separating the cavity from the infratemporal and pterygopalatine fossa posteriorly, and the uncinate process, fontanelles, and inferior turbinate medially. The maxillary sinus ostium is located within the most posteroinferior one-third of the infundibulum in 71.8%[51] The most common anatomic variation in the maxillary sinus region is the infraorbital ethmoidal cells or Haller's cells. Haller, an eighteenth century anatomist, first described the "ethmoidal cell which excavates the os planum and os maxillare, outwardly continuing from the ethmoid labyrinth capsule."[52] The cell is an ethmoid cell that pneumatizes into the floor of the orbit-roof of the maxillary sinus, inferolateral to the ethmoidal bulla, intimately related to the ethmoidal infundibulum and maxillary sinus ostium. Haller's cells are felt to arise from the anterior ethmoid in 88% and the posterior ethmoid in 12%.[53] A variety of terms have been used to refer to Haller's cells, including the maxillo-orbital cells, the maxilloethmoidal cells, and orbitoethmoidal cells.[54,55] Recommendations have recently been made to refine the nomenclature and refer to Haller's cells as the infraorbital ethmoidal cell.

This term is more exact, specifying the location of the cell and its origin and distinguishing it from the supraorbital cell that arises from the frontal recess or suprabullar recess.[48] Another anatomic variation is hypoplasia or atelectasis of the maxillary sinus.[56,57] In this variation, the maxillary sinus is smaller, the surrounding maxillary bone is thicker, and the uncinate process is hypoplastic and lies against the inferomedial orbit; hence, the infundibulum is atelectatic. Uncinectomy can be more difficult in these patients due to the lateral displacement of the structure and the risk of inadvertent orbital entry due to the lateral displacement of the uncinate against the orbit.

**POSTERIOR ETHMOID SINUS:**

The posterior ethmoid sinus is a collection of one to five ethmoid cells that drain into the superior and supreme meati as they are developmentally derived from the second and third primary furrows. The posterior ethmoid sinus is bounded anteriorly by the basal lamella of the middle turbinate, posteriorly by the anterior wall of the sphenoid sinus, laterally by the lamina papyracea, medially by the vertical portions of the superior and supreme turbinates and their accompanying meati, and superiorly by the ethmoid roof. An intimate understanding of the boundaries and limits of the posterior

ethmoid sinuses is important if surgeons operating in this region are to avoid intraoperative complications. The posterior ethmoids have specific surgical significance due to their proximity to the skull base and optic nerve. Anatomic variation in the posterior ethmoid is particularly important for surgeons to appreciate. Onodi performed detailed investigations of the variability in posterior ethmoid anatomy, and he specifically highlighted the relationship the “most posterior ethmoid cell” could have with the optic nerve.40 Onodi described 38 variations in the relationship of the most posterior ethmoids to the optic nerves, putting them into 12 major groups. He stressed that when the most posterior ethmoid cell was highly pneumatized, it could extend posteriorly along the lamina papyracea into the anterior wall of the sphenoid sinus. If this occurred, the optic nerve, usually considered to border the lateral and superior aspects of the sphenoid sinus, would actually be adjacent to the posterior ethmoid cell. Dissection in the posterior ethmoid could result in trauma to the optic nerve and blindness, if the anatomic variation was not appreciated. Modern endoscopic surgeons began to refer to this anatomic variation as an Onodi cell; however, the term sphenoethmoidal cell has been recommended, as it is more descriptive and anatomically precise.[48] If the sphenoethmoidal cell is large, the carotid canal can bulge into the posterior ethmoid sinus as well .Onodi tried many times to

dissuade the otolaryngologists of his time from the commonly held belief that the sphenoid sinus was situated directly behind the posterior ethmoid. He cautioned surgeons not to assume that to reach the sphenoid, one simply extended the dissection through the limit of the posterior ethmoid. Dissection within the posterior ethmoids should be oriented in an inferomedial direction, rather than a superolateral direction, to avoid cranial or orbital injury.

**SPHENOID SINUS :**

The sphenoid sinus is usually embedded into the clivus and bordered superoposteriorly by the sella turcica. Its ostium is anterosuperior to the nasal septum and is optimally demonstrated with a paramedian sagittal reconstruction. This ostium (as well as the posterior ethmoid air cells situated behind the basal lamella of the middle turbinate) drains into the sphenoethmoid recess via the superior meatus, supreme meatus, or other tiny ostia located just under the superior turbinate .The sphenoethmoid recess lies between the anterior wall of the sphenoid sinus and the posterior ethmoid sinus cells. Septations in the sphenoid sinus assume a vertical direction .It is important to note the number of these septations and whether these bony structures adhere to the carotid canal and optic canal. In such instances, the

surgeon operating in the sphenoid sinus must be extremely careful not to infringe on this relationship. Doing so could result in a carotid artery puncture or optic nerve injury. Horizontally situated “septations” are actually bony separations between the posterior ethmoid sinus and the sphenoid sinus and do not represent true septations in the sphenoid sinus. Horizontally oriented bony structures in the sphenoid sinus demonstrated on a coronal CT scan indicate posterior extension of the posterior ethmoid sinus above the aerated sphenoid sinus.

Sphenoid sinus shows great variability in size and shape. It is of three types,

Type I : Conchal sinus

It is most primitive and rarest type. 2-3% of incidence. Hence the sella turcica is totally surrounded by bone and remains totally unexposed to the aerated sinus

Type II : Pre sellar pneumatisation

About an incidence of 10-24 %. Here posterior half is surrounded by bone , while anterior part is pneumatised.

Type III : Sellar pneumatisation

Most commonest type with an incidence of 86 %.

# CHRONIC SINUSITIS:

Clinically sinusitis is defined as the condition manifest by an inflammatory response of the following, the mucous membrane of the nasal cavity and para nasal sinuses, fluid within the cavity, and / or underlying bone. (Fig : 4,6,7)

Also defined as group of disorders characterized by inflammation of the mucosa of the nose and para nasal sinuses lasting for atleast 12 weeks.

**CRITERIA FOR CHRONIC RHINOSINUSITIS :** (sinus and allergy health partnership in January 2002) [1]

1. Continuous symptom that persist for 12 consecutive weeks or longer and physical findings of chronic sinusitis on examination or radiographic sinus imaging.
2. One of these signs of inflammation must be present and identified in association with on going symptoms consistent wit chronic sinusitis,
    - discolored nasal drainage arising from the nasal passage , nasal polyp or polypoidal swelling on physical examination.

- Edema / Erythema of middle meatus of ethmoid bulla as identified on endoscopy.
- Generalized or localized erythema or edema or granulation tissue, if the middle meatus or bulla ethmoidalis not involved. Radiological imaging is required to confirmed the diagnosis.
- Imaging modalities for confirming the diagnosis,[1]
    - CT Scan demonstrating isolated or diffuse mucosal thickening, bone changes , air fluid level. (Fig : 4,6)
    - Plain sinus radiograph (waters view) revealing mucous membrane thickening of 5 mm or greater or complete opacification one or more sinuses. (Fig : 5)
    - MRI Scan is not recommended as an alternative to CT Scan for routine diagnosis of chronic sinusitis because of its excessive high sensitivity and lack of specificity.

**Factors associated with diagnosis of Chronic Rhinusinusitis:**

MAJOR:

1. Facial pain / pressure
2. Nasal obstruction / blockage
3. Nasal discharge / purulence
4. Discolored post nasal discharge

5. Hyposmia / anosmia
6. Purulence in nasal cavity on examination

MINOR:

1. Head ache
2. Fever
3. Halitosis
4. Fatigue
5. Dental pain
6. Cough
7. Ear pain / pressure / fullness

The factors responsible for sinusitis are,

- Ostial patency
- Ciliary activity
- Quality of mucous

About 2 liters of mucous secreated every day in para nasal sinuses. Its physical property (viscosity) is more important than its biochemical constituents. Normal mucous is 98% water and rest is composed of Ig A, lysozymes, mast cells, polymorphs, eosinophils, albumin and globulin.

Ciliary activity is highly directional and independent of the body position. It moves the mucous at the rate of 1 cm / minute. In the

maxillary sinus mucocilliary movement originates from the floor of the sinus and radiates along the walls of the sinus superiorly to reach the ostium. This upward movement is maintained even in the presence of the more inferior surgical nasoantral window.

The mucous blanket normally contains mast cells, polymorphs, eosinophils, lysozyme, and immunoglobulin A. the upper layer (gel layer) is highly viscous, which enables the cilia to move the blanket forward. The system captures 80 % of the inspired particles larger than 3-5 microns and 60% of those larger than 2 microns and exposes them to mast cells, polymorphs, etc., while sweeping them into the pharynx to be swallowed.

In the frontal sinus ciliary clearance proceeds along the septal wall to the roof and medially along the floor to reach the ostium. There is also some recirculation in the frontal recess. Ciliary activity in sphenoid and ethmoid air cells is towards their respective ostium.

Quinlan (1969), puchelle (1981) and sakakura (1985) described the relation between sinonasal dysfunction and impaired mucociliary clearance. Anatomical variations can compromise the ostia and drainage channels of the para nasal sinuses. When there is superadded inflammation it leads to mucosal swelling and apposition, which causes ostial occlusion.

This impairs the ventilation and drainage of the sinus leading to decreased pO2, increased pCO2, increased PH and retained secretions. This environment decreases ciliary motility and bacterial over growth resulting in viscid secretions, bacterial exotoxins are also released, further decreasing the ciliary activity resulting in a vicious cycle, which ends in sinusitis.

Hence come the basic concept of preserving normal ventilation and drainage of sinuses, to assist the diseased mucosa to recover and regenerate.

**NASAL CYCLE**:

Thickening and congestion of the nasal mucosa is a cyclical phenomenon occurring normally. Cycle may repeat in every 50 minutes – 6 hour period. It is controlled by the suprachiasmatic nucleus in the hypothalamus and this control decrease with age. Thickening is seen along the nasal septum, turbinates, and ethmoid sinus , sparing the maxillary, frontal and sphenoid sinuses.

Hence during interpretation of CT scan, unilateral thickening upto 3mm in those areas should be considered as physiological and not misinterpreted as pathological thickening.

# MATERIALS AND METHODS

**Patients selection criteria:**

- Adult patients > 17 yrs with complaints suggestive of chronic sinusitis for a period more than 12 weeks including those with acute exacerbation of chronic sinusitis.
- Patients who fulfill the criteria for chronic sinusitis clinically.
- Persistent chronic sinusitis despite medical therapy ( requiring surgical management )

**Exclusion criteria :**

- Patients with acute sinusitis
- Patient with mass or polyp obstructing the nasal cavity.
- Patients who where previously operated.
- Patient with facial anomalies

The age of the patients selected ranged from 17yrs to 55 yrs of which 63 were male and 37 were female patients.

After selecting the patients they were subject to endoscopic nasal evaluation.

100 patients were studied during the period of December 2006 to October 2008 in our institute.

All these patients are then evaluated with CT scan para nasal sinus.

**Patients preparation before CT Scan :**

- A course of antibiotics, nasal decongesants and antihistaminics given for a period of 4 weeks
- Nasal decongesants (xylometazoline) – 15 minutes prior to CT scan.
- Patient asked to blow the nose forcefully just prior to CT scan.

CT scan was performed in a Toshiba CT scanner in Barnard Institute of Radiology, Madras Medical College, Chennai.

Direct coronal sections were done in all patients.

Limited axial scans parallel to the orbitomeatal line , with the patients in supine position, were also done whenever required.

All films are taken without contrast. No intravenous contrast was used.

**Parameters**:

- Patients position : prone with chin extended
- Gantry angulation : perpendicular to hard palate
- Section thickness : 4 mm
- Scan limits : from glabella to the dorsum sella

**CT scan staging system in chronic sinusitis patients:**

The system advocated by **GLIKLICH and METSON** (1994) [1]

| | | |
|---|---|---|
| Stage 0 | : | < 2 mm mucosal thickening on any sinus walls. |
| Stage 1 | : | All unilateral disease or anatomical variations. |
| Stage 2 | : | Bilateral disease limited to Ethmoid or Maxillary sinus |
| Stage 3 | : | Bilateral disease with involvement of at least one Frontal or Sphenoid sinus |
| stage 4 | : | Pansinusitis |

The **Lund-Mackay system** was first proposed in 1993. It is a numeric system based on CT scan evaluation. It was modified in 1995 after discussions at the International Conference on Sinus Disease: In a comparison study with other staging systems, it was found to have significant "potential for clinical utility."[1]

| Sinus | Grade 0 | Grade 1 | Grade 2 | Left | Right |
|---|---|---|---|---|---|
| Frontal | | | | | |
| Anterior ethmoid | | | | | |
| Posterior ethmoid | | | | | |
| Sphenoid | | | | | |
| Maxillary | | | | | |
| Osteomeatal complex ** | | | | | |

Table : 1

Each sinus cavity is scored according to the amount of disease present:

0 = clear,

1 = partial opacification,

2 = total opacification.

**Scoring for the ostiomeatal complex: 0 = clear or 2 = occluded.

Total score ranges from 0 to 24, with a maximum of 12 for each side.

Radiation safety in CT Scan of para nasal sinuses :

The lens of the eyes are vulnerable organs to radiations and as they are included in the scan field, the safety of CT Scan during imaging of paranasal sinuses have been extensively studied. (Marmolya et al 1991; Maclennan 1995; Micheal sillers et al 1995). Micheal sillers in cadaveric

studies, with 5mm axial scans and coronal scans done through the paranasal sinuses shown that the average acute dose required to induce cataract was < 4 % of the dose associated with cataract. So the risk of radiation damage to the lens has been reduced to a negligible quantity.

**NASAL ENDOSCOPE :**

The nasal endoscope used for diagnostic nasal endoscopic examination was 4mm Hopkins rod endoscopes with 0º and 30º angulation. With these endoscopes, first, second, and third pass evaluation of nasal cavity and in turn about the paranasal sinuses by diagnostic nasal endoscopic evaluation done after proper decongestion of the nasal cavity of the patients.

**ETHICS APPROVAL:**

Institutional Ethical Committee, Government General Hospital & Madras Medical College, Chennai reviewed the experimental design and protocol as well as the letter of information and the consent form. Full approval of the board was granted under protocol number K.Dis.No.16328P &D3/Ethics/Dean/GGH/08. All patients were given information outlining the experimental protocol and all patients signed a consent form prior to entering the study.

# RESULTS AND ANALYSIS

This study is the prospective analysis of the anatomical variations of the osteomeatal complex that were commonly encountered in 100 chronic sinusitis patients, who were subject to surgery in our Upgraded Institute Of Otorhinolaryngology, Madras Medical College, Chennai, with the help of endoscopic evaluation and computed tomography of nose and paranasal sinuses.

The demographic profile shows the most common age group to be between 21-25yrs. Among the 100 cases studied 63% (63) of patients are male and 37%(37) of patients are female.

In our study most of the patients had more than one anatomical variation. Out of 100 patients studied, 88% (88) of patients had more than one anatomical variation, of these 62.5% (55) were males and 37.5% (33) were females. Only minor group of patients presented with one anatomical variation 12% (12). In our study all the patients had at least one anatomical variation.

Anatomical variations may present unilaterally or bilaterally. In our study, 82 (82%) patients out of 100 patients had bilateral anatomical variation. Only 18 (18%) patients had unilateral disease.

Nasal septal deviation is the most common anatomical variation noted in our study.

Even though septal deviation is the commonest anatomical variation in our study, it is not a part of osteomeatal complex. Hence it is not taken into account directly. But these septal deviations indirectly contribute to the narrowing of the osteomeatal complex, by means of compressing the lateral wall of nose which in turn lead to anatomical narrowing of osteomeatal complex , by causing paradoxical middle turbinate, lateralized uncinate process etc.,

Agger nasi is the most common anatomical variation of the osteomeatal complex per se, present in about 69 (69%) patients. Of which, unilateral presentation is 37 (53.6%) and bilateral presentation 32 (46.4%). Of the unilateral presentation right side is more common 23 patients and left side in 14 patients.

Our next common anatomical variation is Concha bullosa 60 % (60) that may present unilaterally or bilaterally .In our study most common is the unilateral presentation of concha bullosa 42 patients, which was also associated with other anatomical variations. Of this, unilateral presentation on right side is more common about 19 and left side is about 14 patients.

Bulla ethmoidalis comes next, seen in about 50 patients (50%). Of which unilateral presentation is common about 37 patients(74%) and bilateral presentation is 13 (26%). Of the unilateral presentation left side in 19 patients and right side in 18 patients.

Deviated nasal septum though it is not a part of osteomeatal complex , contributes to anatomical crowding of osteomeatal complex area. Deviated nasal septum was present in about 73(73%) patients. Of which right side deviation is common about 40 and left side 33 patients.

Paradoxical middle turbinate present in 46 patients (46%) of which unilateral is 31 (67.4%) and bilateral presentation is 15 (32.6%), right side being common 19 (41.3%) patients.

Medialised uncinate process presented in 21 (21 %) patients. Of which unilateral presentation is more common 14 (66.66%).

Frontal cell presented in 18 patients (18%), of which unilateral presentation is common, about 10 (55.5%).

Haller cell was noted in 4 patients (4%), of which unilateral presentation is common about 3 (75%).

Onodi cell presented in 6(6%) patients of which 2(33.3%) patients presented with bilateral presentation .

Table : 2 **AGE WISE DISTRIBUTION**

| Age distribution | 15-20 yrs | 21-25 yrs | 26-30 yrs | 31-35 yrs | 36-40 yrs | 41-45 yrs | 46-50 yrs | 51-55 yrs |
|---|---|---|---|---|---|---|---|---|
| No. of patients | 21 | 22 | 15 | 17 | 8 | 10 | 5 | 2 |
| Percentage % | 21 % | 22 % | 15 % | 17 % | 8 % | 10 % | 5 % | 2 % |

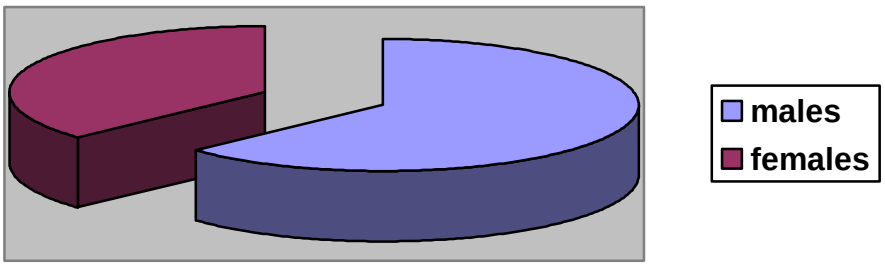
Table : 3 **SEX WISE DISTRIBUTION**

| | |
|---|---|
| Total no. of patients | 100 |
| Male patients | 63 (63%) |
| Female patients | 37(37%) |

Table : 4 **ANATOMICAL VARIATION**

| Anatomical variations | Male | Female |
|---|---|---|
| Single anatomical variation | 8 (66.7%) | 4 (33.3%) |
| Multiple anatomical variation | 55(62.5%) | 33(37.5%) |

## Chart of table 3 - SEX WISE DISTRIBUTION




## Chart of Table 4 - Anatomical variations

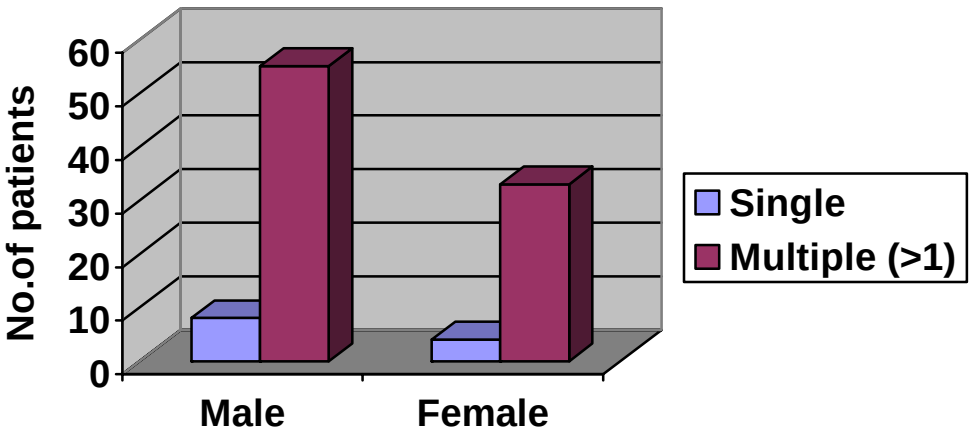


Table : 5 **DISTRIBUTION OF ANATOMICAL VARIATION**

| Anatomical variation | Male | Female | Total |
|---|---|---|---|
| Deviated nasal septum | 51 | 22 | 73 |
| Concha bullosa | 40 | 20 | 60 |
| Prominent bulla ethmoidalis | 31 | 19 | 50 |
| Paradoxical middleurbinate | 38 | 8 | 46 |
| Medialised uncinate process | 14 | 7 | 21 |
| Pneumatised uncinate process | 2 | 0 | 2 |
| Agger nasai cell | 48 | 21 | 69 |
| Frontal cell | 13 | 5 | 18 |
| Intumescentia septi nasi anterior | 25 | 9 | 34 |
| Onodi cell | 5 | 1 | 6 |
| Haller cell | 4 | 0 | 4 |
| Pneumatisation of septum | 3 | 1 | 4 |

Table : 6 **DEVIATED NASAL SEPTUM**

| Deviated nasal septum | To right | To left | Total |
|---|---|---|---|
| Male | 30 (58.8%) | 21(41.1%) | 51 |
| Female | 10(45.5%) | 12(54.5%) | 22 |

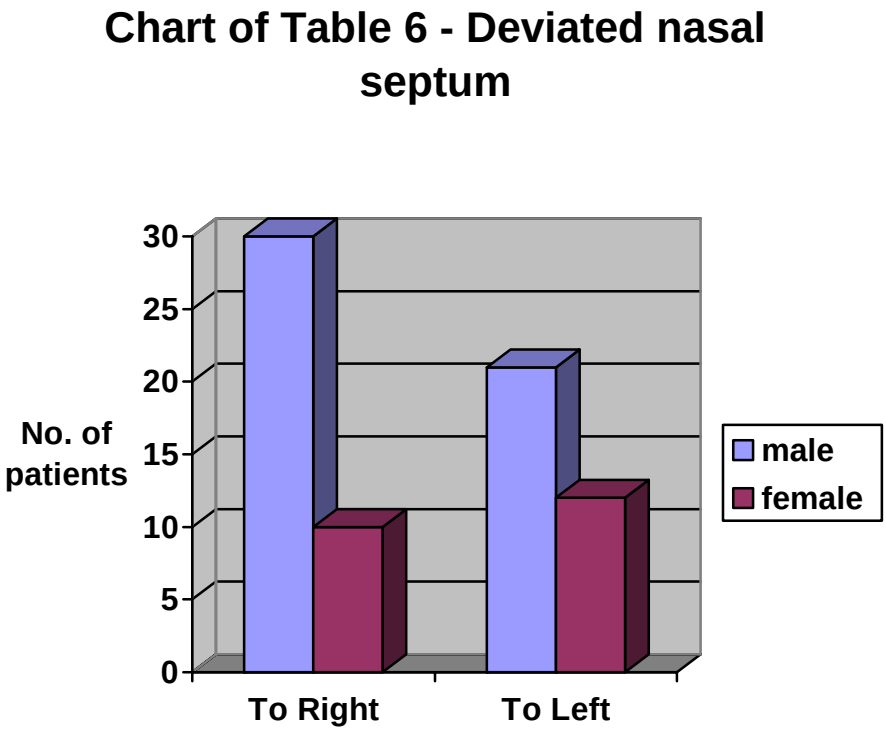


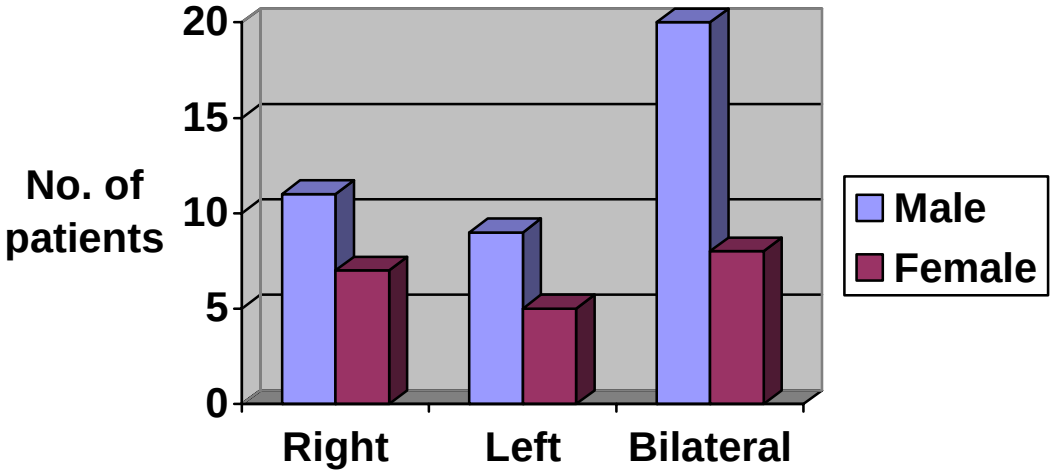
Table : 7 **CONCHA BULLOSA**

| Concha bullosa | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| Male | 11 | 9 | 20 | 40 |
| Female | 7 | 5 | 8 | 20 |

Table : 8 **PARADOXICAL MIDDLE TURBINATE**

| Paradoxical middle turbinate | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| Male | 16 | 10 | 12 | 38 |
| Female | 3 | 2 | 3 | 8 |

## Chart of table 7 - Concha bullosa




## Chart of table 8 - Paradoxical middle turbinate

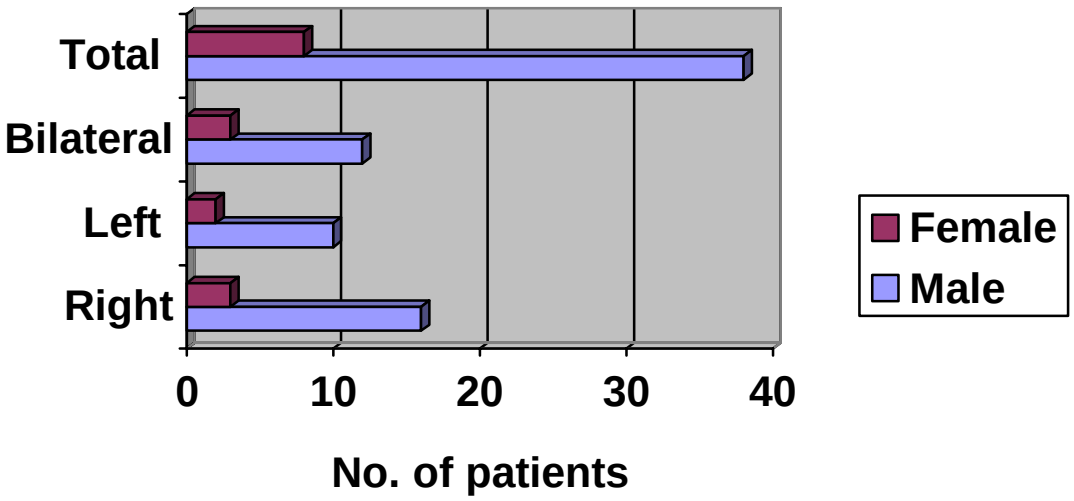


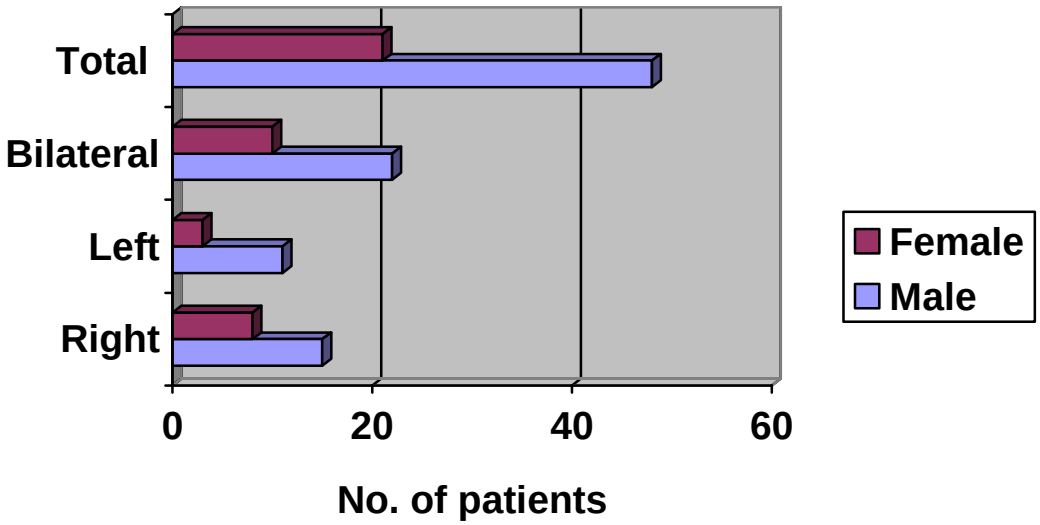
Table : 9 **AGGER NASI CELL**

| Agger nasi cell | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| Male | 15 | 11 | 22 | 48 |
| Female | 8 | 3 | 10 | 21 |

Table : 10 **PROMINENT BULLA ETHMOIDALIS**

| Prominent bulla ethmoidalis | Right | Left | Bilateral | total |
|---|---|---|---|---|
| Male | 10 | 14 | 7 | 31 |
| Female | 8 | 5 | 6 | 19 |

## Chart of table 9 - Agger nasi cell




## Chart of table 10 - Prominent bulla ethmoidalis

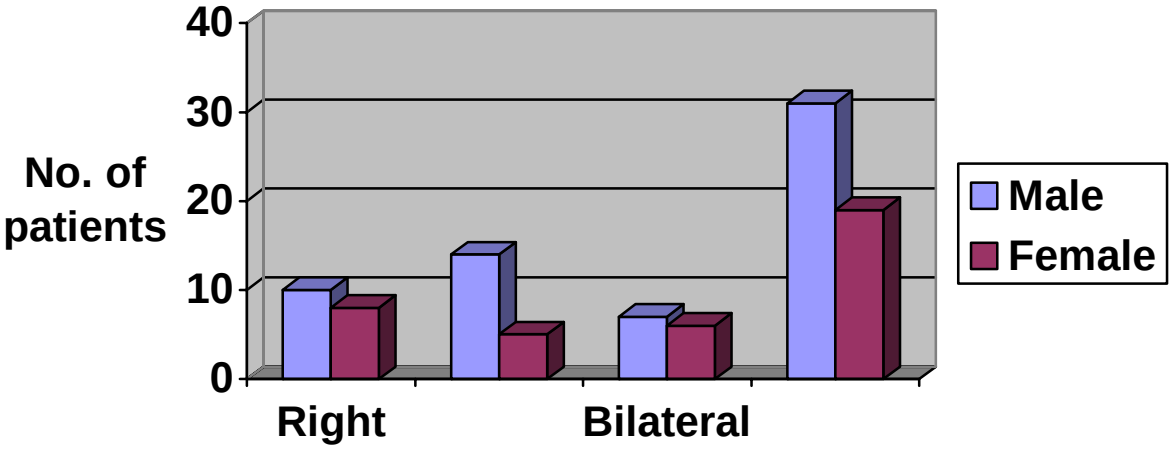


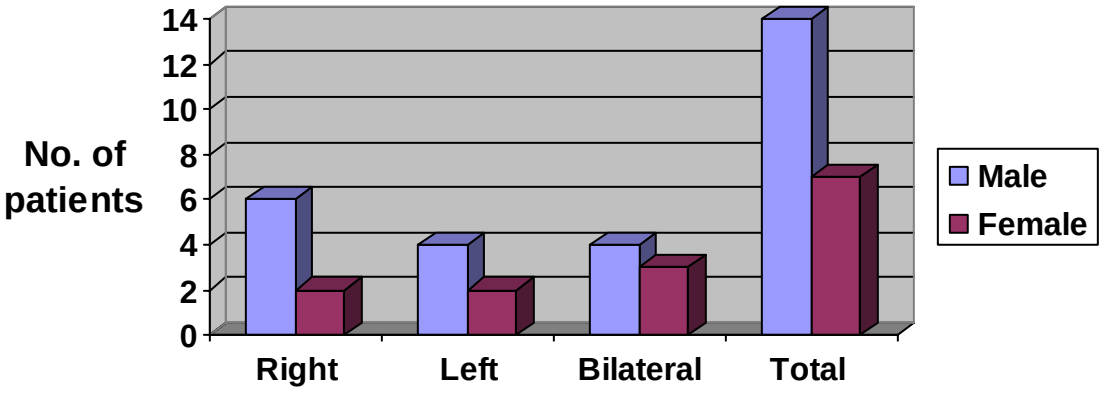
Table : 11 **MEDIALISED UNCINATE PROCESS**

| Medialised uncinate process | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| Male | 6 | 4 | 4 | 14 |
| Female | 2 | 2 | 3 | 7 |

Table : 12

| Anatomical variation | Anterior osteomeatal complex | Posterior osteomeatal complex |
|---|---|---|
| Male | 56 | 7 |
| Female | 32 | 5 |

## Chart of table 11 - Medialised uncinate process




## Chart of table 12- Anterior & posterior osteomeatal complex

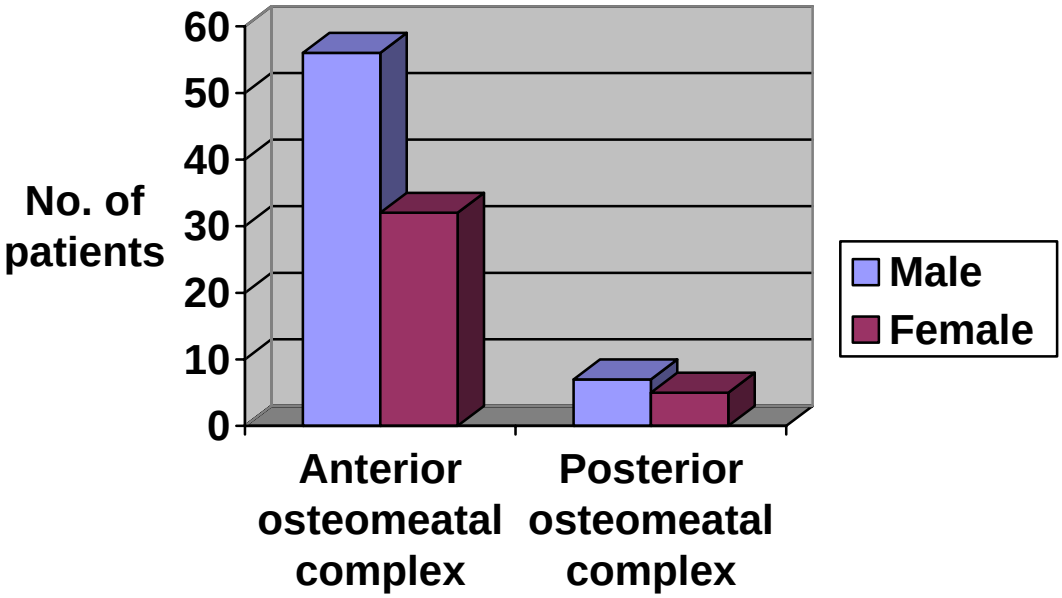


Table : 13 **PNEUMATISED UNCINATE PROCESS**

| Pneumatised uncinate process | Right | Left | Bilateral |
|---|---|---|---|
| Male | 2 | 0 | 2 |
| Female | 0 | 0 | 0 |

Table : 14 **HALLER CELL**

| Haller cell | Right | Left | Bilateral | Total |
|---|---|---|---|---|
| Male | 2 | 1 | 1 | 4 |
| Female | 0 | 0 | 0 | 0 |

Table : 15 **ANATOMICAL VARIATION COMMON IN SINUSES**

| SINUS involved | Anatomical variation commonly associated with it |
|---|---|
| Maxillary sinus | Concha bullosa |
| Frontal sinus | Agger nasi cell |
| Anterior ethmoid cells | Concha bullosa |
| Posterior ethmoid cells | Septal deviation |
| Sphenoid sinus | Onodi cell |

Even though septal deviation is the commonest anatomical variation in our study, it is not a part of osteomeatal complex. Hence it is not taken into account directly. But these septal deviations indirectly contribute to the narrowing of the osteomeatal complex by means of compressing the lateral wall of nose which in turn lead to anatomical narrowing of osteomeatal complex by means of paradoxical middle turbinate, lateralized uncinate process etc.,

# DISCUSSION

Stammberger [61] and Stammberger et al [62] proposed that stenosis of the osteomeatal complex, from either the anatomical configuration or hypertrophied mucosa, can cause obstruction and stagnation of secretions that may become infected or perpetuate infection.

According to Mackay and Lund [70] the osteomeatal complex acts a drainage pathway for maxillary, anterior ethmoids and frontal sinuses. Posterior osteomeatal unit was considered as part of the sphenoid sinus. In several areas of the osteomeatal complex over crowding due to anatomical variation, two mucosal layers contact each other, thus increasing the likelihood of local impairment of mucociliary clearance. Secretions may then be retained at the site, creating the potential for infection even without ostial closure. Anatomically, the most likely areas of mucosal contact are in the narrow mucosa lined channels of the middle meatus and the ethmoidal infundibulum

Deviated nasal septum or bony spur causes a decrease in the critical area of the osteomeatal unit predisposing to obstruction and related complications. It was found in 73 of 100 patients, the maximum anatomical variation in our study about 73 %. It was more than 55.7% in study by Maru [64] and more than that of 38% reported by Asruddin [65].

Concha bullosa (pneumatised middle turbinate) has been implicated as a possible aetiological factor in the causation of recurrent chronic sinusitis. It is due to its negative influence on paranasal sinus ventilation and mucociliary clearance in the middle meatus region as quoted by Tonai [67] . The incidence of concha bullosa was 60 % ,which is higher as compared to the reported incidence of 53.6% by Bolger et al [63], 42.6% by Maru et al [64], 28% by Asruddin et al [65]and 24% by Llyod [66].

The middle turbinate may be paradoxically curved i.e. bent in the reverse direction. This may lead to impingement of the middle meatus and thus to sinusitis . It was found in 40 % in our study . The incidence is higher to that of 12% by Asruddin et al [65] , 15% by Llyod [66]and Bolger et al (27%) [63].

Zinreich first observed that the uncinate process may be curved or bent. It can impair sinus ventilation especially in the anterior ethmoid, frontal recess and infundibulum regions. The medialised uncinate was found

in 21 % patients in our study. It is higher than that of 2.5% reported by Bolger [63] ,2% by Asruddin [65] and 9.8% by Maru et al [64].

Onodi cells are posterior ethmoid cells that extend posteriorly, laterally and sometimes superior to sphenoid sinus, lying medial to the optic nerve. The chances of injury of optic nerve are increased when the bony canal of the nerve is lying dehiscent. It was found in 6 % patients in our study. A similar incidence was found by Arslan in 12/200 patients and higher than the study by Jones in 8/ 200 patients [68].

Haller cells are ethmoid air cells that project beyond the limits of the ethmoid labyrinth into the maxillary sinus. They are considered as ethmoid cells that grow into the floor of orbit and may narrow the adjacent ostium of the maxillary sinus especially if they become infected [66]. The incidence of Haller cells in our study was 4 %. It was less than that reported by Bolger 45.9% [63], Llyod 15% [66,] Maru 36% [64] and Asruddin 28% [65].

The osteomeatal unit was found to be involved in all the patients in our study. Maxillary sinus is the most common sinus involved in chronic sinusitis in our study. Zinreich et al [58] found middle meatus opacification in 72% of the patients with chronic sinusitis, and of these 65% had maxillary sinus mucoperiosteal sinus thickening. Yousem et al found that when the middle meatus was opacified, the maxillary and ethmoid sinuses showed

inflammatory changes in 84% and 82% respectively. Another study found frontal or maxillary sinus disease in 84% patients who had OMC opacification [59]. Thus these findings support the contention that the anatomical variation in osteomeatal complex will lead to obstruction of the narrow drainage pathways, which in turn lead to subsequent sinus inflammation.

# SUMMARY

The Anatomical variations of osteomeatal complex per se are not the pathology for chronic sinusitis. But they predispose the individual to chronic sinusitis.

In our study, all the patients have at least one anatomical variation. 88 % patients had more than one anatomical variation and the remaining 12 % had one anatomical variation. About 82 % patients had bilateral involvement.

Anatomical variations in chronic sinusitis patients noted in our study are

| | | |
|---|---|---|
| Nasal septal deviation | : | 73% |
| Agger nasi | : | 69% |
| Concha bullosa | : | 60% |
| Prominent bulla | : | 50% |
| Paradoxical middle turbinate | : | 46% |
| Intumescent septi nasii | : | 34% |
| Medialised uncinate process | : | 21% |
| Frontal cell | : | 18% |

| | | |
|---|---|---|
| Onodi cell | : | 6% |
| Haller cell | : | 4% |
| Pneumatisation of septum | : | 4% |

As we see, nasal septal deviation, agger nasi and concha bullosa are the commonest anatomical variation noted in chronic sinusitis patients, of which agger nasi is the commonest anatomical variation of osteomeatal complex.

As we see, maxillary sinus inflammation is common with anatomical variation of anterior osteomeatal complex.

The following anatomical variations are common cause for the corresponding sinus pathology,

| | | |
|---|---|---|
| Frontal sinus | : | agger nasi |
| Maxillary sinus | : | concha bullosa |
| Anterior ethmoids | : | concha bullosa |
| Posterior ethmoids | : | septal deviation |
| Sphenoid sinus | : | onodi cell |

# CONCLUSION

Computed Tomography of the para nasal sinuses has improved the visualization of para nasal sinus anatomy and has allowed greater accuracy in evaluating para nasal sinus disease. It evaluates the osteomeatal complex anatomy which is not possible to such an extent with plain radiographs. Anatomical variations studied on Computed Tomography Scan are found to block the osteomeatal complex, leading to impaired drainage of para nasal sinuses, thus causing chronic sinusitis.

Our present prospective study of anatomical variation of osteomeatal complex reveals many parameters:

1. Among the anatomical variations of the osteomeatal complex in patients with chronic sinusitis not responding to medical therapy, a combination of anatomical variations is more commonly found.
2. Of the anatomical variations in patients with chronic sinusitis, nasal septal deviation is the commonest abnormality noted.
3. Of the anatomical variations of the osteomeatal complex in patients with chronic sinusitis, agger nasi 69 % and concha bullosa 60 % are the commonest abnormalities noted.

4. According to the results, nasal septal deviation was the most common anatomic variation and the Haller cell and pneumatised septum are the rarest ones noted in our study.
5. Also, there was a strong correlation between the unilateral Concha bullosa and contra lateral septal deviation, which was evident based on the studies.

Moreover, 90% of anatomic variations are septal deviation, Agger nasi cell and Concha bullosa

Most of the anatomic variations originated from aerated cells of ethmoid sinus.

With the proper pre-operative evaluation of anatomical variation, we can reduce inadvertent complications during surgery and also ensure the complete clearance of the disease.

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# PROFORMA

Case no. : Date:

Name : Age / Sex :

Address : Hospital no.:

CLINICAL HISTORY :

| | Continuous | Intermittent | Unilateral | Bilateral |
|---|---|---|---|---|
| Nasal obstruction | | | | |
| Nasal discharge | | | | |
| Smell disturbance | | | | |

| | Grade I | Grade II | Grade III |
|---|---|---|---|
| Head ache | | | |
| Fever | | | |
| Dental pain | | | |

Grade I : no need of analgesics

Grade II : controlled by analgesics

Grade III : not controlled by analgesics

| | Yes | No |
|---|---|---|
| Halitosis | | |
| Cough | | |

History of previous medical treatment:

- Antibiotics
- Antihistamines
- Local decongesants
- Steroids
- Any other treatment

History of previous surgical treatment:

- Antral wash
- Nasal polypectomy
- Septoplasty
- Endoscopic sinus surgery
- Caldwell luc

Clinical examination:

1. Anterior Rhinoscopy :

    - Nasal discharge : none/ mucoid/ mucopurulent /purulent
    - Mucosa : normal / congested
    - Septum : normal / deviated
    - Inferior turbinate: normal / hypertrophied
    - Middle turbinate : normal / paradoxical / boggy

2. Posterior Rhinoscopy :

    - Posterior choana : normal / discharge / polyp / mass
    - Turbinates : normal / hypertrophied

3. Oropharynx:

    - posterior pharyngeal wall :

      Normal / granular / congested/ dry/ post nasal drip

4. Face :

    - PNS tenderness : present /absent
    - Swelling : present / absent

5. Radiological evaluation of Para Nasal Sinus:

    - Findings : normal / hazy / air fluid level

6. Diagnostic Nasal Endoscopy :

| | | |
|---|---|---|
| Septal deviation | : | present / absent |
| Mucosa | : | normal / pale / edematous / congested |
| Discharge | : | mucoid / purulent / mucopurulent |
| Inferior turbinate | : | normal / hypertrophied |
| Inferior meatus | : | normal / discharge |
| Middle turbinate | : | normal / boggy / paradoxical |
| Middle meatus | : | normal / narrow / discharge / polyp |
| Bulla ethmoidalis | : | normal / prominent |
| Agger nasi | : | normal / prominent |
| Uncinate process | : | normal / medialised |
| Accessory ostium | : | present / absent / anterior / posterior |
| Superior meatus | : | normal / discharge |

Spheno ethmoidal recess : normal / discharge

7. Computerized Tomography scan of Paranasal Sinus :

| | Right | Left | Bilateral |
|---|---|---|---|
| Septal deviation | | | |
| Concha bullosa | | | |
| Paradoxical middle turbinate | | | |
| Medialised uncinate process | | | |
| Pneumatised uncinate process | | | |
| Agger nasal cell | | | |
| Haller cell | | | |
| Onodi cell | | | |
| Prominent bulla ethmoidalis | | | |
| Frontal cell | | | |
| Maxillary sinus | | | |
| Frontal sinus | | | |
| Anterior ethmoid cells | | | |
| Posterior cells | | | |
| Sphenoid | | | |
| Miscellaneous | | | |

# MASTER CHART

| s. no | Name | age/ sex | Ip.no | DNS | | CB | | | AN | | | BE | | | PMT | | | MUP | | | OC | | | HC | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rt | Lt | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl |
| 1 | Anadeswari | 35/f | 85927 | | + | + | | | | | | + | | | + | | | + | | | | | | | | |
| 2 | Rajesh | 20/m | 02269 | + | | | + | | | + | | + | | | + | | | | | | | | | | | + |
| 3 | Nadhiya | 18/f | 02677 | | | | | | | | | | | | | | | | + | | | | | | | |
| 4 | Muthu | 45/m | 21820 | | + | + | | | | + | | | + | | | | | + | | | | | | | | |
| 5 | Rajeswari | 37/f | 22307 | + | | | + | | | + | | + | | | | | | | | | | | | | | |
| 6 | Suresh | 18/m | 23484 | | | + | | | + | | | | | | | + | | | | | | | | | | |
| 7 | Chandra | 30/f | 26967 | | | | | | | | | | + | | | | | | | | | | | | | |
| 8 | Ramalingam | 20/m | 23564 | + | | | + | | | + | | + | | | | | | + | | | | | | | | |
| 9 | Jayasree | 19/f | 29110 | + | | + | | | + | | | | | | | | | | | | | | | | | |
| 10 | Muniammal | 42/f | 24355 | | + | | + | | | + | | + | | | + | | | | | | | | | | | |
| 11 | Selvi | 35/f | 32697 | | | | | | | | | | + | | | + | | | | | | | | | | |
| 12 | Arun kumar | 19/m | 32680 | + | | | + | | | + | | + | | | + | | | | | | | | | | | |
| 13 | Afzal | 30/m | 38589 | | + | | | | | | | | | | | | | | | | | | | | | |
| 14 | Shanthi | 33/f | 67910 | + | | + | | | + | | | | + | | | | | | | | | | | | | |
| 15 | Anand | 20/m | 62522 | + | | + | | | + | | | | | | | | | + | | | | | | | | |
| 16 | Pallavan | 20/m | 59270 | | + | | | | | | | + | | | | + | | | | | | | | | | |
| 17 | Dinakaran | 22/m | 57887 | + | | | + | | + | | | | | | | | | | | | | | | | | |
| 18 | Vasantha | 47/f | 28559 | | | | | | + | | | | + | | | + | | | | | | | | | | |
| 19 | Prabaharan | 16/m | 57901 | + | | | | | | | | | + | | | + | | | + | | | | | | | |
| 20 | Kalaiselvi | 27/f | 68408 | | + | | + | | | + | | | | | | | | + | | | | | | | | |
| 21 | Selvam | 47/m | 70532 | + | | + | | | + | | | | + | | | | | | | | | | | | | |
| 22 | Sathik basha | 38/m | 71956 | | + | | | + | | + | | + | | | | | | | | | | + | | | | |
| 23 | Jeyachandran | 30/m | 73214 | | | | | | | | | | | | | + | | | | | | | | | | |
| 24 | Selvam | 30/m | 74886 | | + | + | | | | + | | | + | | | | | | | | | | | | | |
| 25 | Ganesh | 23/m | 75782 | + | | | + | | | + | | + | | | + | | | | + | | | | | | | |
| 26 | Subramani | 31/m | 75122 | + | | + | | | | + | | | | | | + | | + | | | | | | | | + |
| | | | | | | | | | | | | | | | | | | | | | | | | | | |
| s. no | Name | age/ sex | Ip.no | DNS | | CB | | | AN | | | BE | | | PMT | | | MUP | | | OC | | | HC | | |
| | | | | Rt | Lt | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl | Rt | Lt | Bl |
| 27 | Prakash | 28/m | 75468 | | | | | | + | | | | | | | | | | | | | | | | | |
| 28 | Janarthanan | 23/m | 78036 | + | | + | | | | | | | + | | | + | | | | | | | | | | |
| 29 | Kala | 24/f | 78037 | + | | + | | | + | | | | + | | | + | | | | | | | | | | |
| 30 | Daraniraj | 33/m | 79475 | | + | | | + | | + | | | | | | | | | + | | | | | | | |
| 31 | Banumathi | 53/f | 81445 | + | | | | | | | | | | | | | | | | | | | | | | |
| 32 | Kumar | 38/m | 82315 | + | | + | | | | + | | | + | | | + | | | | | | | | | | |
| 33 | Roksana | 22/f | 83326 | | + | | | + | | + | | + | | | | | | + | | | | | | | | |
| 34 | Anandh | 19/m | 84979 | | + | | | + | + | | | | | | | | | + | | | + | | | | | |
| 35 | Kannan | 24/m | 85236 | + | | | + | | | + | | | | | + | | | | | | | | | | | |
| 36 | Munian | 42/m | 86332 | | | | | + | | | | | | | | | | | | | | | | | | |
| 37 | Lingeswaran | 24/m | 00563 | + | | + | | | + | | | | + | | | | | | | | | | | | | |
| 38 | Rajkumar | 39/m | 01769 | | + | | | + | | | | | | | + | | | | | | | | | | | |
| 39 | Bilal | 18/m | 03186 | | | + | | | + | | | | + | | | | | | | | | | | | | |

| 40 | Chakravarthini | 28/f | 05837 | + | | + | | | + | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | Chitty | 23/f | 06418 | | | | + | | | | |
| 42 | Sudha | 28/f | 07711 | + | + | + | + | | | | |
| 43 | Aruna | 22/f | 09667 | + | | | + | | | | |
| 44 | Muthu | 21/m | 10263 | + | + | + | | + | + | | |
| 45 | Shankar | 32/m | 12431 | | + | | | | | | |
| 46 | Lakshmi | 43/f | 13626 | + | | + | | | + | | |
| 47 | Vasu | 28/m | 15386 | + | + | | + | + | | | |
| 48 | Geetha | 18/f | 15338 | | | | | | | | |
| 49 | Vimala | 33/f | 17824 | + | + | + | | | | | |
| 50 | Nagappan | 19/m | 21342 | + | + | + | + | + | | | + |
| 51 | Ranjan | 27/m | 24768 | + | | + | + | + | + | | |
| 52 | Durai | 35/m | 26177 | + | + | | | | | + | |
| 53 | Rukesh | 31/m | 27564 | | | + | | | | | |
| S .no | Name | age/ sex | Ip.no | DNS Rt Lt | CB Rt Lt Bl | AN Rt Lt Bl | BE Rt Lt Bl | PMT Rt Lt Bl | MUP Rt Lt Bl | OC Rt Lt Bl | HC Rt Lt Bl |
| 54 | Easwaran | 26/m | 28976 | + | + | + | + | + | | | |
| 55 | malini | 23/f | 29458 | + | + | + | | | | | |
| 56 | Ramu | 37/m | 31547 | + | + | + | | + | + | | |
| 57 | Meganathan | 19/m | 34132 | + | + | | | + | | | |
| 58 | Thilagavathy | 17/f | 34940 | + | + | + | + | | | | |
| 59 | Sivakumar | 30/m | 34202 | + | | + | | + | + | | |
| 60 | Mohan | 20/m | 34909 | | + | + | | + | | | |
| 61 | Alex | 26/m | 36751 | + | + | + | | | + | | |
| 62 | Sasikala | 21/f | 36755 | | | | | | | | |
| 63 | Ponnusamy | 36/m | 34888 | + | + | + | | + | | | |
| 64 | Amsa | 24/f | 38600 | + | + | + | + | | | | |
| 65 | Dillibai | 32/m | 38711 | | + | | | | | + | |
| 66 | Bakyaraj | 24/m | 40358 | + | | + | + | + | + | | |
| 67 | Senthil | 37/m | 40385 | + | + | + | + | + | + | | |
| 68 | Veeraragavan | 33/m | 40360 | + | + | | + | + | | | |
| 69 | Devaraj | 22/m | 42235 | | | + | + | + | + | | |
| 70 | Harish rani | 18/f | 41556 | | + | + | | | | | |
| 71 | Poongavanam | 47/m | 47898 | + | + | + | + | + | | | + + |
| 72 | Rajeswari | 34/f | 47936 | + | | | + | + | | + | |
| 73 | Sangeetha | 18/f | 49052 | | | | + | | | | |
| 74 | Vasudevan | 24/m | 49060 | | + | | | | | | |
| 75 | Ram | 35/m | 48642 | + | + | + | | + | | | |
| 76 | Selvarani | 50/f | 49749 | + | + | + | | | + | | |
| 77 | Kaliyamoorthy | 54/m | 49758 | + | + | + | | + | | | + |
| 78 | Vasu | 35/m | 52945 | + | | | + | + | + | | |
| 79 | Kavitha | 25/f | 52946 | | | + | + | | | | |
| 80 | Ranjani | 29/f | 54560 | + | + | + | + | | | | |
| S | Name | age/ | Ip.no | DNS | CB | AN | BE | PMT | MUP | OC | HC |

| .no | | sex | | Rt Lt | Rt Lt Bl | Rt Lt Bl | Rt Lt Bl | Rt Lt Bl | Rt Lt Bl | Rt Lt Bl | Rt Lt Bl |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 81 | Subramani | 35/m | 55612 | + | + | + | + | + | + | | |
| 82 | Palanivelu | 43/m | 52442 | + | + | + | + | + | | | |
| 83 | Durga | 23/f | 5569 | | + | + | + | + | | | |
| 84 | Yasodha | 32/f | 5565 | + | | | | | | | |
| 85 | Thiyagarajan | 45/m | 55656 | + | + | | + | + | | | |
| 86 | Ilavarasi | 42/f | 57430 | | + | + | | | | | |
| 87 | Alaudin | 20/m | 57367 | + | + | + | | + | | | |
| 88 | Balaji | 21/m | 57487 | + | + | + | | | | | |
| 89 | Sumathi | 42/f | 59400 | | | | | | | | |
| 90 | Parthasarathy | 37/m | 59743 | + | | + | + | + | | | |
| 91 | Purusothaman | 25/m | 60468 | + | + | | + | + | | | |
| 92 | Ravi | 45/m | 60435 | | + | | | | | | |
| 93 | Sumathi | 23/f | 6119 | + | + | | + | | | | |
| 94 | Rakesh | 27/m | 61146 | + | + | + | | + | | | |
| 95 | Sujatha | 24/f | 63175 | | + | + | | + | | | |
| 96 | Krishnamoorty | 17/m | 64749 | + | + | | | + | | | |
| 97 | Kandasamy | 49/m | 64268 | + | | + | + | + | | | |
| 98 | Kumaresan | 33/m | 64841 | + | + | + | | | | + | |
| 99 | Ethiraj | 19/m | 66764 | + | | + | + | + | | | |
| 100 | Devaki | 45/f | 64879 | | + | + | + | | | | |

DNS: Deviated nasal septum CB: Concha bullosa AN: Agger nasi BE: Bulla ethmoidalis OC: Onodi cell

PMT: Paradoxical middle turbinate MUP: medialised uncinate process

HC: Haller cell FC: Frontal cell

ISNA: Intumescentia septi nasi anterior Pn.S: pneumatised septum

Pn.UP: pneumatised uncinate process