**Sudan University of Sciences and Technology**

**College of Graduated Studies**

# Study of Anatomical Variations of Paranasal Sinuses among Sudanese Using Computed Tomography

**دراسة الاختلافات التشريحية في الجيوب الانفية لدي السودانين بأستخدام الاشعة المقطعية المحوسبة**

A thesis submitted for partial fulfillment for the requirements of M.Sc. degree in Diagnostic Radiological Imaging

**By**

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## الآية

قال تعالي:( قَالَ رَبِّ اشْرَحْ لِي صَدْرِي (25) وَيَسِّرْ لِي أَمْرِي (26) وَاحْلُلْ عُقْدَةً مِنْ لِسَانِي (27)يَفْقَهُوا قَوْلِي)

**سورة طه الاية24**

**صدق الله العظيم**

**Dedication**

*This work is dedicated, first and foremost, to my father's soul*

*To my family*

*To my colleagues and friend.*

*To my teachers in all stages of my education*

*To those who helped shape my experience in life and provided support and council whenever needed.*

**Acknowledgement**

This research project would not have been possible without the assistance of many great people. Much gratitude to my supervisor **Dr. Ahmed Mustafa Abukonna**, for his time, patience and invaluable guidance. My thanks also extend to those who offered a helping hand when others would not. Also the staff of the radiology department in Alfaisal specialized hospital.

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## List of abbreviations

| **Abbreviation** | **Full explanation** |
|---|---|
| CT | Computed Tomography |
| PNS | Paranasal Sinuses |
| MHU | Million Heat unit |
| PACS | Picture Archiving& Communication System |
| DNS | Deviated Nasal Septum |
| FESS | Functional Endoscopic Sinus surgery |
| MDCT | Multi Detector Computerize Tomography |
| CTA | CT Angiography |
| DAS | Data Acquisition System |
| CB | Concha Bullosa |
| GE | General Electric |

**Abstract**

Anatomical variations in paranasal sinus may differ among the different ethnic groups. And it is important to recognize the clinical and surgical significance of these variations.

This descriptive study was conducted at Khartoum - Sudan to evaluate anatomical variants of paranasal sinus region.100 images of Computed Tomography for paranasal sinus (61females and 3**9**males) were evaluated in both axial and coronal plane, nasal septal deviation, haller cells, onodi cells, and aggar cells nasi and concha bullosa were identified in the images.

The result of the study showed that the most common anatomical variant of the paranasal sinuses and nasal cavity was nasal septal deviation it was present in 78 of 100 patient (78%), male tend to have higher prevalence 46.1% than female. The second most common variant was aggar cell nasi present in 62 of 100 patients (62%) female have higher prevalence. Haller and onodi were the third most anatomical variant present to some extent in (32%), and concha bullosa consider to be the less common anatomical variant in population (26%).The most frequent bilateral paranasal sinus and nasal cavity anatomic variants present in 42 of 62 patients those have agger cell nasi.

Analysis of every routine CT scan of the paranasal sinuses obtained for sinusitis or rhinitis for the presence of different anatomic variants is of questionable value unless surgery is planned. For patients who are planning to undergo functional endoscopic or other skull base surgery, however, it is important to be aware of certain anatomic variants.

## الخلاصة

قد تختلف الاختلافات التشريحية في الجيوب الأنفية بين المجموعات العرقية المختلفة. ومن المهم التعرف على الأهمية السريرية والجراحية لهذه الاختلافات.

أجريت هذه الدراسة الوصفية في الخرطوم - السودان لتقييم المتغيرات التشريحية لمنطقة الجيوب الأنفية. تم تقييم 100 صورة من التصوير المقطعي للجيوب الأنفية (61 من الاناث و 39 من الذكور) في كل من المستوى المحوري والإكليلي . انحراف الحاجز الأنفي ، والخلايا الرقيقة ، وخلايا اونودي ، والخلايا القاتمة ومحارة الأنف تم تحديدها في الصور.

وأظهرت نتائج الدراسة أن الشكل التشريحي الأكثر شيوعًا في الجيوب الأنفية والتجويف الأنفي هو انحراف الحاجز الأنفي الذي كان موجودًا في 78 مريضًا من أصل 100 مريض (78٪) ، حيث يميل الذكور إلى نسبة انتشار أعلى بنسبة 46.1٪ من الإناث. أما الشكل الثاني الأكثر شيوعًا فهو خلايا أغر بنسبة تواجد 62 من 100 مريض (62٪) وهي اكثر شيوعيا بين الاناث دون الذكور. كان وجود خلاياهالر وأونودي ثالث أكثر الأشكال التشريحية إلى حد ما في (32 ٪) ، ويعتبر والخلايا القاتمة ومحارة الأنف أقل اختلاف تشريحي شائع بنسبة (26 ٪). معظم هذه الاختلافات احادية الجانب عدا خلايا اغر والتي توجد تعبر الاكتر تواجدا ع جانبي الجيب الانفيه.

تحليل كل الأشعة المقطعية الروتينية للجيوب الأنفية التي تم الحصول عليها لالتهاب الجيوب الأنفية أو التهاب الأنف لوجود اختلافات تشريحية ذات قيمة مشكوك فيها ما لم يتم التخطيط لعملية جراحية. لكن بالنسبة للمرضى الذين يخططون لإجراء جراحة تنظيرية وظيفية أو أي جراحة أخرى في قاعدة الجمجمة ، من المهم أن تكون على دراية ببعض المتغيرات التشريحية.

# CHAPTER ONE

## Introduction

### 1.1Introduction

A precise knowledge of the anatomy of paranasal sinuses is essential for knowing, and diagnosing of sinus disease. Conventional radiology does not permit a detailed study of the nasal cavity and paranasal sinuses, and has now largely been replaced by computed topography (CT) imaging which gives an applied anatomical view of the region and the anatomical variants that are very often found. CT has been used successfully as diagnostic modalities in sinus disease to determine the mucosal abnormalities, bony anatomic variations of paranasal sinus and assess the possible. Endoscopic surgery requires the surgeons to have detailed knowledge of the anatomy of the lateral nasal wall, paranasal sinuses, surrounding vital structures and anatomical variants in the region.

The frequency of the anatomic variations may differ among the different ethnic groups. And it is important to recognize the clinical and surgical significance of these variations.

The most common ones are Agger nasi cells, infraorbital ethmoidal (Haller) cells, sphenoethmoidal (Onodi) cells, nasal septal deviation, and concha bullosa (Kantarci etal., 2004).

The Agger nasi cells are the most anterior ethmoidal air cells locate anterior, lateral, and inferior to the frontal recess (Sivasli et al., 2003). Infraorbital ethmoidal (Haller) cells are ethmoidal cells that extend downward under the medial floor of the orbit adjacent to and above the maxillary sinus ostium lateral to the infundibulum (Stallman JS, 2004). Sphenoethmoidal (Onodi) cells are posterior ethmoidal cells that extend laterally, superiorly, and posterior to the sphenoid sinus and are intimately associated with the optic nerve (Kantarci M et al., 2004).

Nasal septal deviation is defined as any bending of the septal contour on coronal CT scans and is present in more than one half of the population (Azila A et al., 2001). Concha bullosa is commonly defned as pneumatization of the middle turbinate involving its inferior bulbous portion and is usually bilateral (Fadda GL et al.,2012) Pneumatization of the lamina of the middle turbinate is usually not defned as concha bullosa and occurs fairly frequently, as does pneumatization of the superior turbinate(Braun H, 2003).

Less common anatomic variants of the paranasal sinuses include pneumatization of the uncinate process (or an uncinate bulla), large ethmoidal bullae, supra orbital cells, and pneumatized crista galli (Nouraei SA et al., 2009). A supra orbital ethmoidal air cell is located posterolateral to the frontal sinus, superior and lateral to the lamina papyracea, and anterior to the anterior ethmoidal artery and can be identified by the presence of a bony septum between the frontal and anterior ethmoidal sinuses on axial CT images(Nouraei SA et al., 2009).

## 1.2 Problem of Study:-

The revolutionary changes in the surgical treatment of sinus disease, particularly in endoscopic surgery, require the surgeons to have detailed knowledge of the anatomy of the lateral nasal wall, paranasal sinuses and surrounding vital structures because these variations might induce ostiomeatal obstruction, predisposing to sinus disease.

### 1.3Objectives of Study:-

#### 1.3.1General objectives:-

The general objective was to study anatomical variation of paranasal sinuses using computerized tomography.

#### 1.3.2The specific objectives:

1-To characterize the anatomical variations of paranasal sinuses and assess the frequency of their occurrence.

2-To provide information regarding various anatomical variations of sinuses, and their importance before planning for sinuses surgery.

3-To determine the incidence of sinonasal anatomic variants and it is relation with sex and age.

### 1.4 Overviews of the study:

This study was fall into five chapters, chapter one is an introduction, problem of the study, objectives and overview. Chapter two include theoretical background and literature review, while chapter three include material used and the method of data collection and analysis. Chapter four presents the result of the study and finally chapter five which include the discussion, conclusion and recommendations for future studies in addition to references and appendices.

# Chapter Two

## Theoretical Background and literature review:

### 2.1 Anatomy:

#### 2.1.1The Face:

The face is made up of several bones. These osseous structures are necessary to sustain different intracranial and extra cranial organs such as the brain, the eyes and the pituitary gland. They anchor all the facial muscles. Importance of the facial structures the rigidity of the bones and cartilages, and the strong connections with the mucosa avoid the collapse of the mucosa during inspiration. The particular organization of the bony and cartilaginous structures in the nasal cavities ensures close contact and an important surface area to the inspired air. These structures also play a role in voice resonance. The close relationship between nasal functions and skull base development has been confirmed by studies in rats, showing that nasal obstruction is able to cause anatomical changes of the maxilla, the skull base and the mandible with abnormal skeletal growth

#### 2.1.2 External nose:

The bony roof of the anterior part of the nasal cavity consists of the nasal bones and the ascending process of the maxillary bones. The covering is completed by the upper and lower lateral cartilages. The bony-cartilaginous roof is covered by muscles. Individual and racial variations in the external nose are numerous. Ohki, in 1991, showed that the dimensions of the nostrils were statistically different in healthy Caucasian, Oriental or black adults. The width of the nose was 34.0 mm in Caucasian, 38.7 mm in Oriental and **42.5** mm in black persons.(Watelet and Cauwenberge 1999)

### 2.1.3 Nasal cavities:

The anterior part of the nasal cavity opens interiorly in the nostril while the nose communicates posterior with the rhino pharynx. Usually, authors divide the nasal cavity into three parts: the nasal vestibule, the olfactory region and the respiratory region. The junction of the vestibule with the nasal cavity is called the internal nasal valve. It is situated between the caudal end of the upper alar cartilage laterally, and the septum medially. Its apical angle has angulations of less than **15'.** It is the narrowest site of the nasal cavity, only 0.3 cm2 on each side

### 2.1.4 Nasal septum:

The septum divides the nasal cavity into two halves. Depending on the expansion of the perpendicular plate and the vomer, i.e. the bony parts of the septum, the cartilaginous septum reach adult dimensions at the age of **2** years. The bony part of the septum consists of the perpendicular plate of the ethmoidal bone and the vomer while the cartilaginous part is formed by the quadrilateral cartilage. The anterior part defines the columella and the postero-superior angle has contact with the sphenoid bone. The nasal septum lays in the crista nasalis of the bony palate.(Watelet and Cauwenberge 1999)

### 2.1.5 Turbinate:

The lateral nasal wall supports the three turbinate (inferior, middle, superior and sometimes there is even a supreme) that divide this lateral wall into three meats (inferior, middle, superior). Before 9 weeks of gestation, three soft tissue elevations (the pre turbinate) can be identified within the nasal cavity; they are orientated both in size and position in a similar way to the inferior, middle and superior turbinate in the adult. The turbinate contain cartilage at 9 weeks of gestation. The inferior turbinate ossification appears to proceed that of the middle turbinate (17 week's **vs**19weeks of gestation)**.** The head of the inferior turbinate interferes directly with the entering airflow and its tail, in case of hypertrophy, can significantly reduce the choanalsize. The middle turbinate covers the ostium of the major sinuses medially, while the supreme turbinate is not always present.

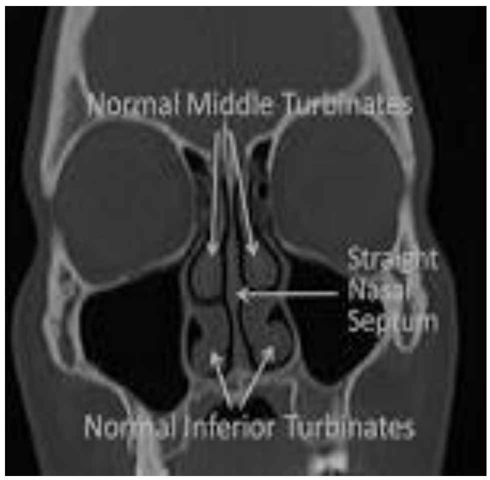


**Fig2.1** coronal CT image illustrate nasal turbinate and nasal septum

**2.1.6 Paranasal sinuses:**

The paranasal sinuses are air-containing cavities in the facial bones and are connected to the nasal cavity. The maxillary sinus is the most important in size: its global volume can reach 15 ml. Asymmetries between the two sides and inter individual variations are frequent. Its ostiuin is placed at the upper part of the cavity, and opens into the middle meats. The superior part of the maxillary sinus supports the orbit and the posterior part is also the anterior wall of the pterygopalatine fossa containing the maxillary artery, the sphenopalatine ganglion and branches of the trigeminal nerve and the autonomic system. The variations in form and size of the frontal sinus are numerous but usually the volume reaches 7 ml. In 3-5 % of individuals the frontal sinus is completely absent in one or both sides. Its posterior wall is the anterior wall of the anterior cranial fossa and its floor covers the orbit. The ethmoidal sinuses contain six to 10 cells subdivided into anterior and posterior cells; their Ostia drain, respectively, into the middle and the superior meats. They are localized at the medial part of the orbit and the inferior Dart of the skull base. (Watelet and Cauwenberge 1999)

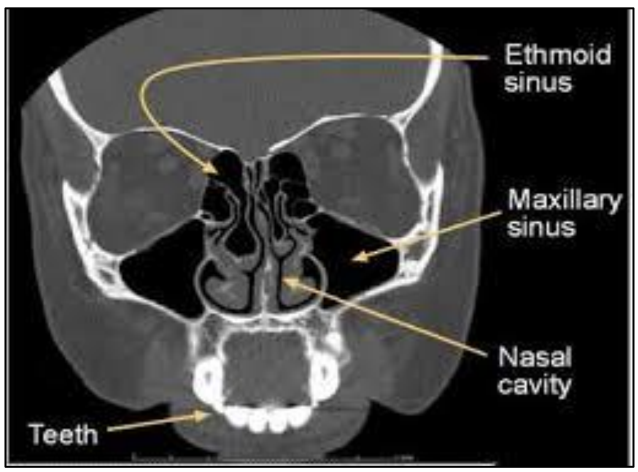


**Fig 2.2** coronal CT image illustrate paranasal sinuses.

**2.1.7 Importance of the paranasal sinuses:**

The nasal cavities and sinuses in the child differ from the adult in size and in proportion**.** The intrinsic functions of the paranasal sinuses are controversial. None of them has been proven. They may assure harmony in facial growth and make the skull lighter. The sinuses can be a protector of the brain. Other hypotheses seem less valid: the paranasal sinuses probably do not contribute to efficient air conditioning by increase of the contact between mucosa and inspired air, nor to speech resonance, nor to smell perception.(Watelet and Cauwenberge 1999)

**2.1.8 Embryology:**

Maturation of the epithelial lining on the septum and the lateral wall precedes that of the adjacent paranasal sinuses. Before the ninth week of gestation, the nasal cavity is lined by undifferentiated cells .The pseudo stratified ciliated epithelium appears at 9 weeks of gestation, while the process of differentiation continues throughout the next 14weeks. The lamina propria of the nasal mucosa becomes. (Watelet and Cauwenberge 1999)

**2.1.2: Computed tomography (CT scan):**

**Fig**2.3 illustrate CT machine


2.4.1Helical scanning in the late 1980s, helical CT has revolutionized clinical imaging. Also called spiral (or continuous acquisition) scanning, helical scanning brought dramatic improvement in scanning speed by eliminating the inters can delay. There are three basic ingredients that define a helical scan process: a continually rotating x-ray tube, constant x-ray output, and uninterrupted table movement. Increasing the scan speed results in improved image resolution owing to the ability to obtain images with Improved iodinated contrast concentration, decreased respiratory and Cardiac motion artifact, and superior multiplanar and three dimensional (3-D) reformation capabilities. In addition to improved diagnostic Accuracy, the speed associated with helical scanning is also beneficial in Regards to patient comfort and department productivity. (Lois E.2011). Helical scanners were constructed with a single row of detectors. Since Then, MDCT systems with as many as 64 detector rows have been Introduced. By further improving scan speed, these systems have made Clinical applications, such as CT angiography (CTA). (Lois E.2011).

**2.1.2.1 CT Machine Equipment:**

The rotating part of the system consists of the X-ray tube, High voltage Generator, Detectors and Data acquisition system (DAS). The stationary Part consists of the front-end memory and computer and the first stage High voltage component. The X-ray tube and detectors rotate Continuously during data collection because the cable wraparound30 Problem has been eliminated by slip ring technology. Because large Amounts of projection data are collected very quickly, increased storage is

Needed. This accommodated by the front-end memory fast solid state, and Magnetic disk storage. In spiral CT scanners, the X-ray tube is energized For longer periods of time compared with conventional CT tubes. This character requires X- ray tubes that are physically larger than conventional X-ray tubes and has heat unit's capacities greater than 3 Million heat units (MHU) and anode cooling rates of (1 MHU) per minute. X-ray detectors for single slice spiral CT scanning are one dimensional (ID) array and should be solid state because their overall efficiency is greater than gas ionization detectors.

The high voltage generator for spiral CT scanner is a high frequency generator with high power output. The high voltage generator is mounted on the rotating frame of the CT gantry and positioned close to the X-ray tube. X- Ray tubes operate are high voltages (about 80 to 140 kVp) to produce X- rays with the intensity needed for CT scanning. At such high Voltages, arcing between the brushes and rings of the gantry may occur during scanning. To solve this problem, one approach (high voltage SR) is to divide the power supply into a first stage on the stationary part of the scanner, where the voltage is increased to an intermediate level and a second stage on the rotating part of the scanner, where the voltage is increased to the requirement high voltages needed for X-ray production and finally rectified to direct current potential. Another approach passes a low voltage across the brushes to the slip rings, the high voltage generator and then the X-ray tube. In both designs, only a low to intermediate voltage is applied to the brush / slip ring interface, thus decreasing the Chances of arcing.

**2.2 Literature review:**

(Perez-Pinas, Sabate et al. 2000) examined the anatomical variants observed in the nasal fossae and paranasal sinuses in 110 Spanish subjects, by direct coronal and axial CT scans, they found agger nasi cells in all of the subjects and subsequently discounted it, to find the various most often seen are the deviated nasal septum (55%), CB (25%), the ethmoidal air cells (10%), the ethmoidal uncinate process (4%), and other sites (6%).

(Landsberg and Friedman 2001) studied the anatomy of nasofrontal region, to characterize the attachments of the superior uncinate process and the diameter of the frontal sinus ostium in population of Philadelphia USA. Among their results, was a prevalence of 81% of Agger nasi cells, in only 6% of those, the cells were unilateral?

(Maru and Gupta 2001)investigated the incidence of anatomical variations in the ostiomeatal complex and distribution of mucosal abnormalities in each paranasal sinus was in Indore, India by direct coronal scans. In 61 patients they reported the following distribution agger nasi cells 88.5%; deviated nasal septum 55.7%, CB 42.6%, Haller cells 36.1% and Onodi 9.8%.

(Nitinavakarn, Thanaviratananich et al. 2005) studied the anatomical variations of the lateral nasal wall and paranasal sinuses in Thai adult patients. They found agger nasi cells in 92%, concha bullosa in 34%, Haller's cell in 24%, and Onodi cell in 25%. They also noted that Haller's cell was a coincident finding not a risk factor for maxillary rhinosinusitis. Concha bullosa was anon statistically significant, risk factor for maxillary rhinosinusitis.

(Keast, Sofie et al. 2008) conducted a similar study in New Zealand, but specifically in the ethnic group of the Polynesian, as compared to New Zealanders of europian decent, because of the unique skull shape Polynesians are known to have. They concluded that there are no specific anatomical variations in the sinuses of Polynesian, and they show a prevalence of CB, Agger's cells, Haller cells, and onodi cells to be 28%, 94%, 33% and 11% respectively. Although the sample size was relatively small (36 indivuals), the results did agree with previous studies conducted on the Polynesians.

(Riello and Boasquevisque 2008) evaluated frequency and types of anatomical variants of the ostiomeatal complex in 200 residents of RJ Brazil, they observed at least variations in 83.5% of them, the most common variation was CB, appearing in 84% of the subjects followed by deviated nasal septum in 34%, Agger nasi cells in 16%, and Haller Cells in 10% of the sample.

(Smith, Edwards et al. 2010) reviewed 883 CT scans taken of the sinuses of the residents of Michigan,USA, to determine the prevalence of CB and deviated nasal septum and heir potential relationship to maxillary sinusitis, 67.5% CB, 49.3% of whom showed signs maxillary sinusitis. 19.4% exhibited deviated septum, 19.4% had both? They concluded that, Although CB is a common occurrence in the nasal cavity, no statistically significant relationship between the presences of concha bullosa or nasal septal deviation and maxillary sinusitis were found.

In Turkey, (Kayalioglu, Oyar et al. 2000) performed a similar study on 172 adult patients, 90 of whom, had a sinus pathology. They failed to find a correlation between the prevalence of the variations with age intervals, nor a significant difference between males and females. They did find CB, deviated nasal septum, Haller's cells, Agger's cells, and pneumatized nasal septum in 27.9%, 17.4%, 4.6%, 6.3%, and 7.7% respectively.

(Kaplanoglu, Kaplanoglu et al. 2013) also studied the variations in 500 turkish patients, they focused on the ethmoid roof and the height of lateral lamella cribriform plate, but they did find, in agreement with other authors, the deviated nasal septum to be the most prevalent 81.8%. Agger nassi cells were found in 63.8%, and CB in 30% of the sample.

(Caughey, Jameson et al. 2005) studied the anatomic variations of the paranasal sinuses in a sample of the resident of the state of Virginia, in attempt to find the hypothesized correlation between this variations and sinus diseases, in the 250 subjects they found a statistically significant correlation, claiming its due to the contribution of the variations to the narrowing of the ostiomeatal complex, causing mucosal thinking. CB and haller's cells were present in 27% of the sides, with males showing higher prevalence.

(Simões, Carneiro et al. 2017) in contrast, looked into the prevalence of the same variations and the pathological presences , they found it to be 80.7%, 35.1%, 9.6% and 3.3% for septal deviation, CB, Haller’s cells and ethimoidal bulla respectively. However, they didn’t find an assoisiaion between this variations and increased chances of obstruction of drainage of frontal, ethmoidal and maxillary sinuses.

This is in agreement with (Saunders, Birchall et al. 1998) findings. In a sample of 10 patients, they found no anatomical difference in the ostiomeatal complex between patients with and without rhinosinusitis, although its likelihood did increase in patients with more laterally positioned uncinate process.

(Aramani, Karadi et al. 2014) also studied the variations on chronic rhinosinusitis, at least two variations were observed in 53.7%, and a single variation in 33.3%. They also found the deviated nasal septum to be the most common, followed by CB, but Agger’s and haller’s cells were found in just one case each.

# Chapter Three

# Materials and Method

## 3.1: Materials:

### 3.1.1 Machine Used

A Toshiba Astion 16 slices, were used to obtain 53 of the scans in the radiology department of Alfaisal specialized hospital. The rest were performed in AlBugaa private Hospital using a GE Bright speed 16 slice CT scanner.

### 3.1.2 Inclusion criteria:

All adult patients underwent CT scan for paranasal sinuses.

### 3.1.3 Exclusion criteria:

All patients under 18 years of age or with previous history of sinus surgery or invasive disease, serious facial deformity were excluded.

## 3.2 Methodology:

This is prospective study conducted at Alfaisal specialize hospital and AlBugaa private hospital, in the state of khartoum,form january 2017 to march 2018, 100 patients undergone CT scan of the paranasal sinuses in the axial plan, and a coronal images were retrospective reconstructed, reviewed in high resolution and smooth algorithms.

### 3.2.1 Data collection and analysis:

The variables were collected in data sheets, they included age, gender and the anatomic variations noted. Mean of the age, frequencies of the anatomical variations among age groups and gender, cross tables, chi square and spearman correlation were obtained from IBM SPSS software 21th edition.

### 3.2.2 Image Interpretation:

Two radiologists diagnosed the images and noted the presence and side of the five variants.

# Chapter Four

## Results

The sample of this study included 100 patients, 61 females and 39 males, with an age range of 56 years (18-74 years), having a mean of 41.8 years (SD=13.7).

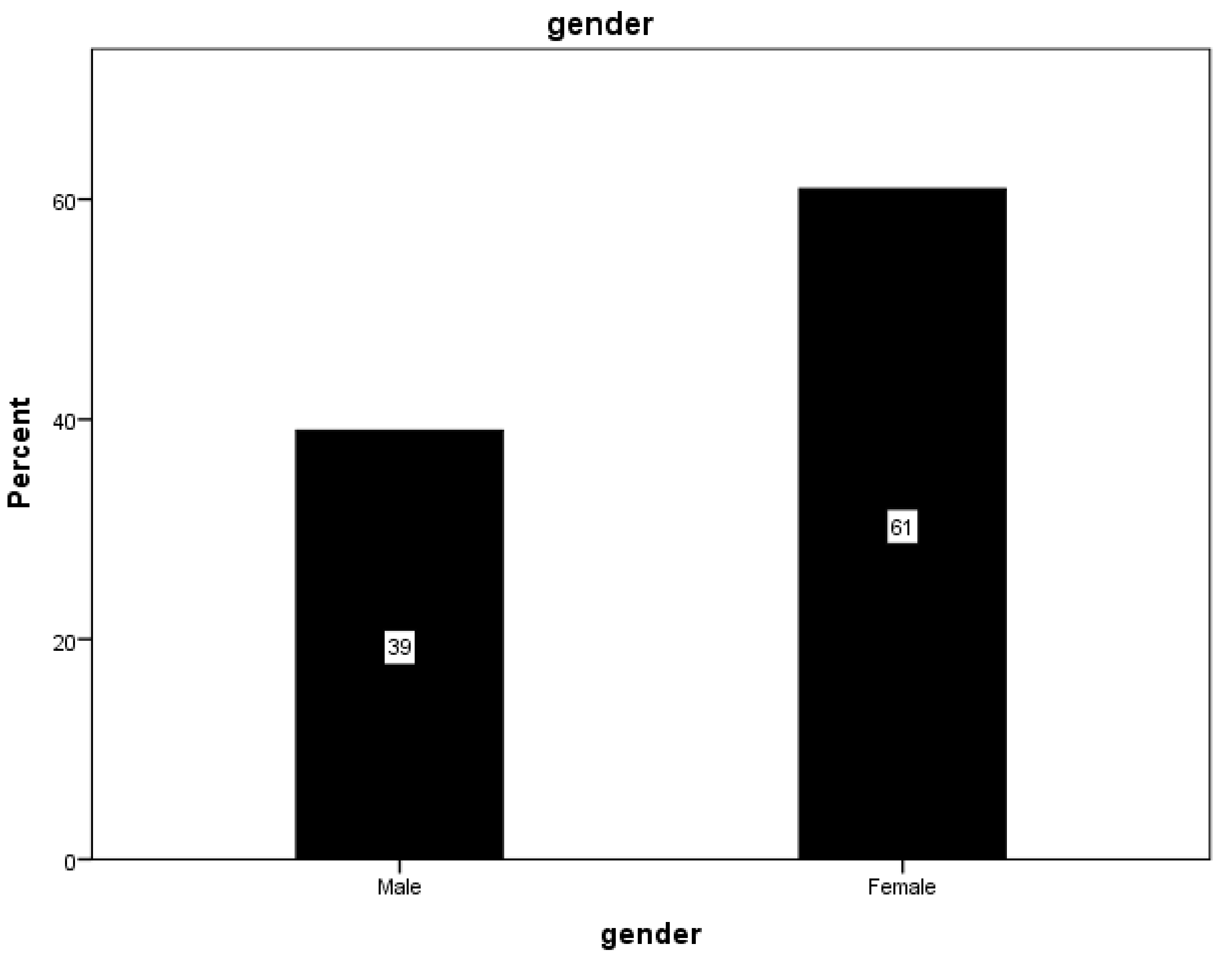


**Fig 4.1 Gender g distribution**

**Table 4.1** distribution of nasal septal deviation

| Gender | nasal septal deviation | | | Total |
|---|---|---|---|---|
| | right | Left | None | |
| Male | 14 | 18 | 7 | 39 |
| Female | 18 | 28 | 15 | 61 |
| Total | 32 | 46 | 22 | 100 |

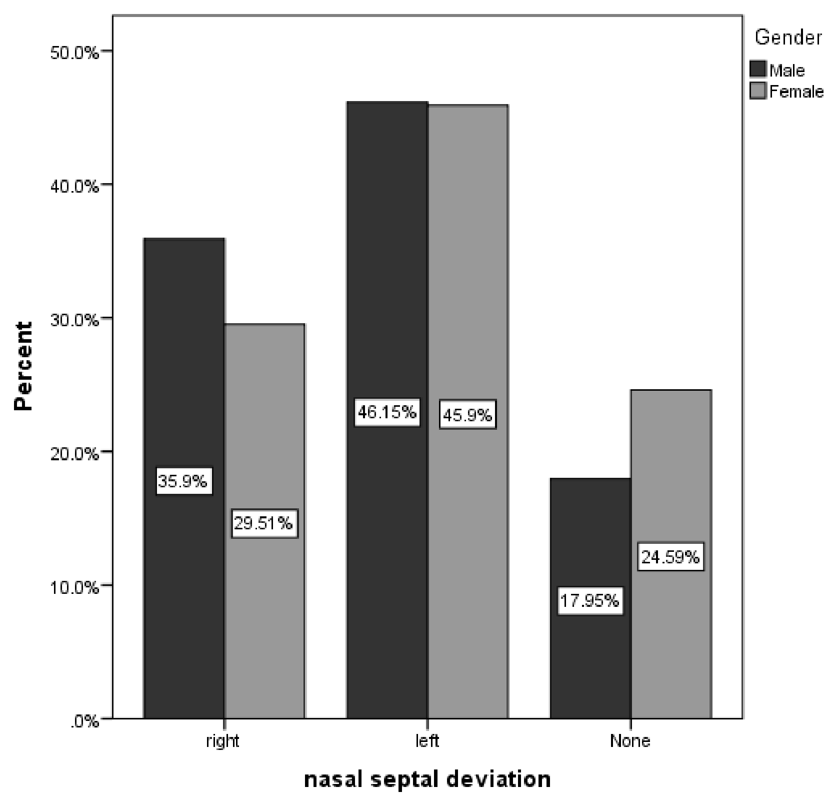


**Fig 4.2 showed nasal septal deviation side in male and female**.

**Table 4.2** distribution of concha bullosa

| | | concha bullosa | | | Total |
|---|---|---|---|---|---|
| | | Unilateral | Bilateral | None | |
| Gender | Male | 5 | 5 | 29 | 39 |
| | Female | 11 | 5 | 45 | 61 |
| Total | | 16 | 10 | 74 | 100 |

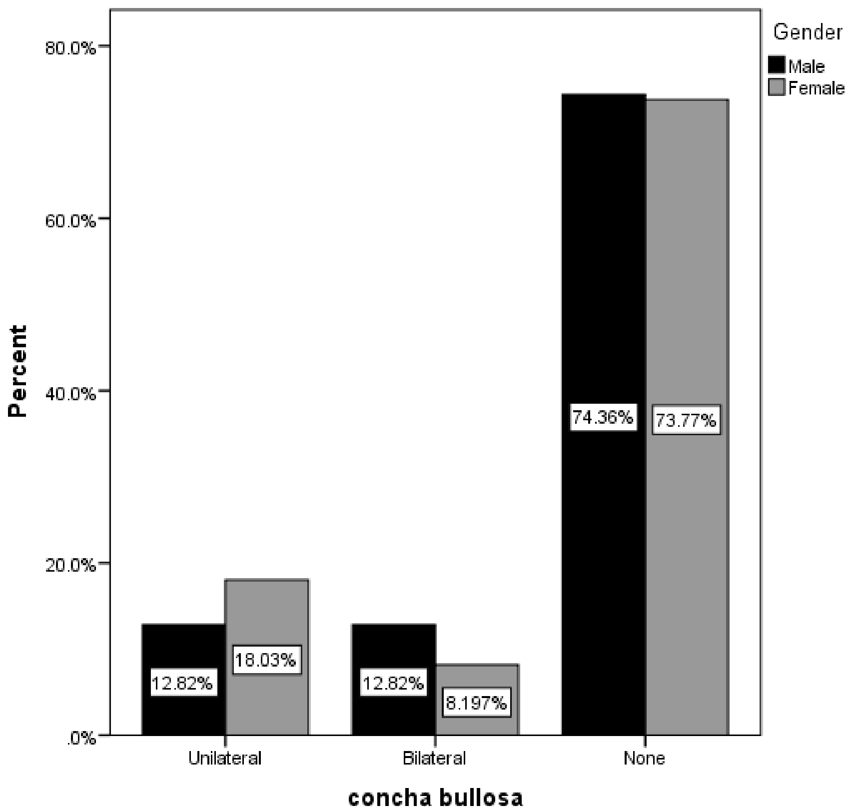


**Fig 4.3 showed distribution of concha bullosa in male, female and its position.**

**Table 4.3** distribution of agger cell nasi

| | | agger cell nasi | | | Total |
|---|---|---|---|---|---|
| | | Unilateral | Bilateral | None | |
| Gender | Male | 7 | 17 | 15 | 39 |
| | Female | 13 | 25 | 23 | 61 |
| Total | | 20 | 42 | 38 | 100 |

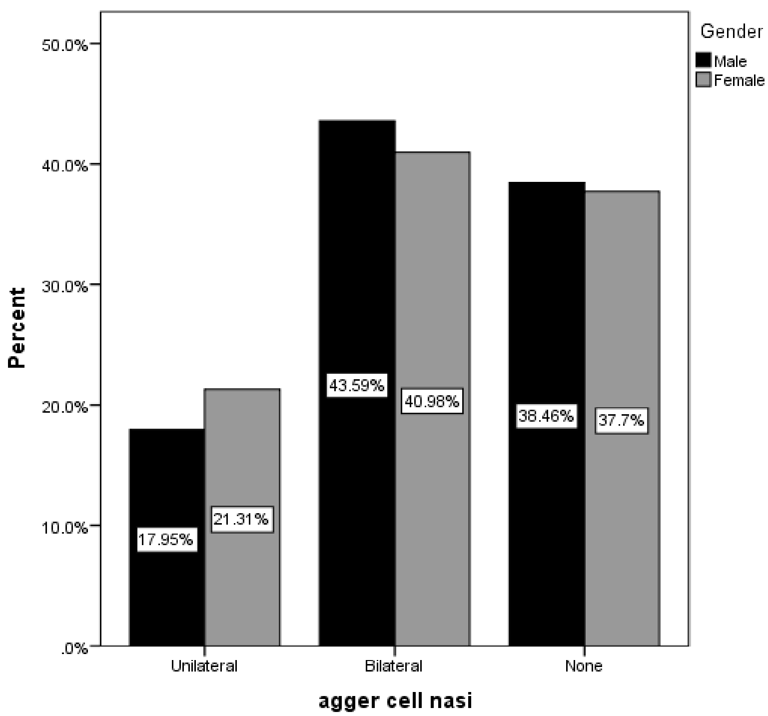


**Fig4.4 showed distribution of agger cell nasi between male and female and its position**

**Table 4.4** distribution of haller cell

| | | haller cells | | | Total |
|---|---|---|---|---|---|
| | | Unilateral | Bilateral | None | |
| gender | Male | 6 | 9 | 24 | 39 |
| | Female | 9 | 9 | 43 | 61 |
| Total | | 15 | 18 | 67 | 100 |

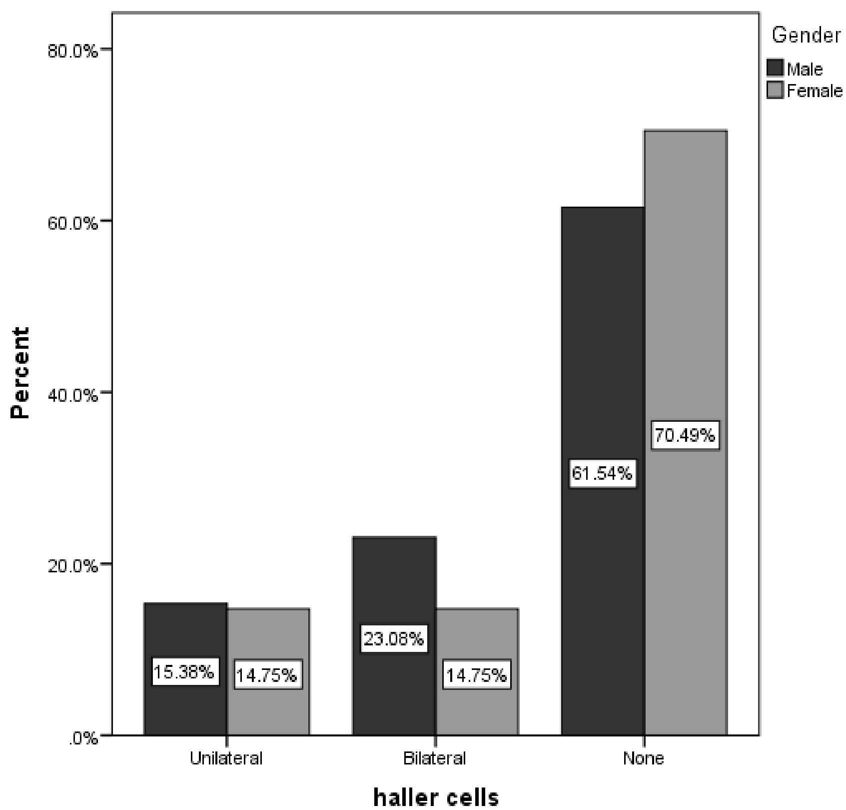


**Fig 4.5 showed distribution of haller cells in male and female and its position.**

Table 4.5 distribution of onodi cells

| | | onodi cells | | | Total |
|---|---|---|---|---|---|
| | | Unilateral | Bilateral | None | |
| Gender | Male | 4 | 8 | 27 | 39 |
| | Female | 12 | 9 | 40 | 61 |
| Total | | 16 | 17 | 67 | 100 |

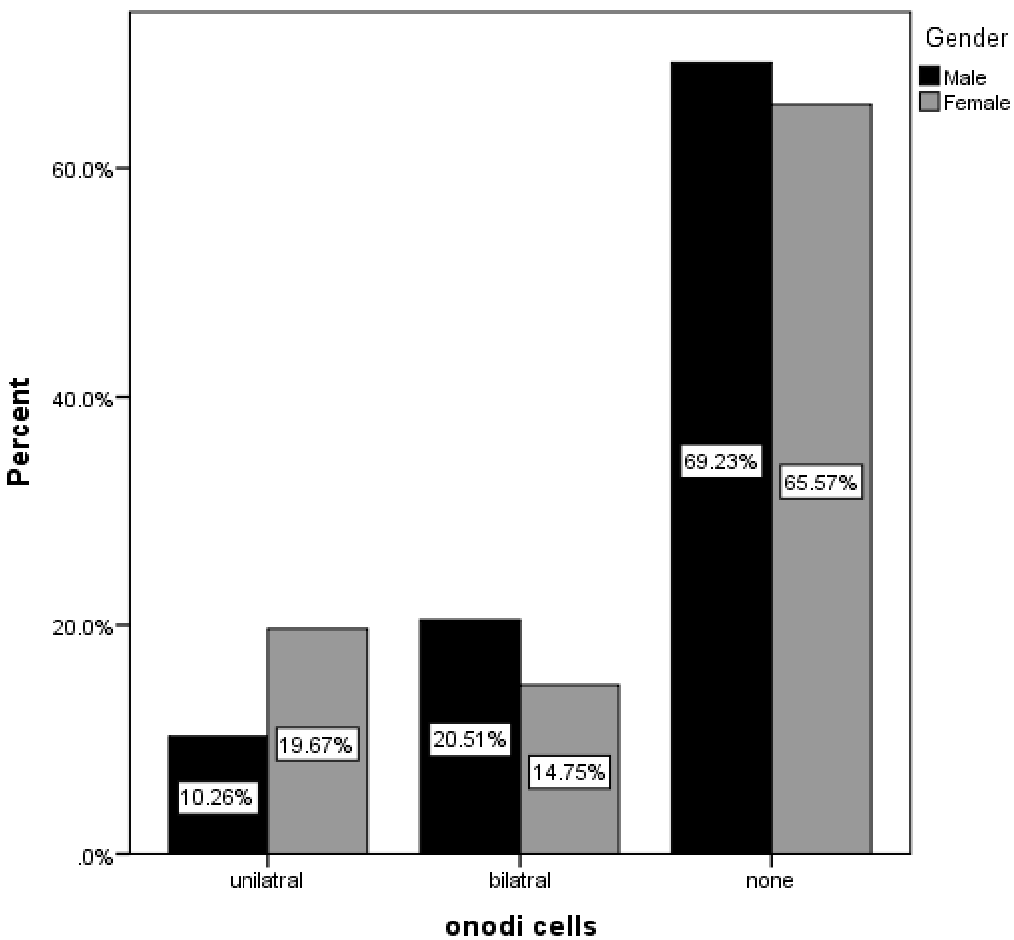


**Fig 4.6 showed distribution of onodi cells in male and female, and its position.**

## Chapter Five

## Discussion, Conclusion and Recommendation

### 5.1 Discussion:

This study of the anatomic variations in the paranasal sinuses showed that 82% of men and 75.4% of women had a deviated nasal septum; deviation to the left side was more common in both genders. 25.6 % of men and 26.3% of women had a CB in at least on side. Agger's cells were present in 61.5% of the man and 62.3% of the women. Haller's cells appeared in 38.4% of the men and 29.5% of the women. Onodi cells existed in at least one side in 30.7% of men and 34.3% of the women.

The result showed that overall, the most common anatomic variant of the paranasal sinuses and nasal cavity was nasal septal deviation it was present in 78 of 100 patient (78%), men tend to have higher prevalence 46.1%as illustrate in( Table 4.1, fig3.2) .the second most common variant was aggar cell nassi present in 62 of 100 patient (62%) female have higher prevalence) as illustrate in (Table 4.3 fig 4.4). haller and onodi were the third most anatomical variant present to some extent in (32%) as illustrate in (Table4.4 and 4.5 consequently) , and conch bullosa consider to be the less common anatomical variant in population (26%) as illustrate in (Table4.2 and fig4.3).

The most frequent bilateral paranasal sinus and nasal cavity anatomic variants was agger cell nassi present in 42 of 62 patients those have agger cell nassi as illustrate in (Table 4.3 fig 4.4)

Interestingly, none of the 100 randomly selected subjects showed any variation what so ever, all of them had at least two variations. This variation showed no statistically significant difference in destruction between the two genders, although men have slightly higher percentages over all, except in onodi cell's and to an even lesser degree in Haller's cells.

Nasal septum devotion was the most prevalent, appearing in o78% of the sample, and CB was the rarest, only 26% showed at least one, between them came, in decreasing order, Agger's cells 62%, and Haller's and Onodi cells sharing a 33% over all prevalence.

The study could not find in similar studies on the Sudanese population, and upon comparing to other countries, vast deference's can observed, for example, in thailand, (Nitinavakarn, Thanaviratananich et al. 2005) found that CB is the most common variation, occurring in 92% where it's the rarest in the current studies.

On the other hand, in the study of (Perez-Pinas, Sabate et al. 2000), in agreement with the current study, found the deviated nasal septum to the most common occurrence (55%) but CB did come in the second place.

The study concluded that, the different habitats and environment of different people of the world, leading to adaption, is a sound explanation for the variability in the distribution of this variations.

## 5.2 Conclusion:

The paranasal sinuses are of vital importance to the practice of modern medicine, and studding their peculiar normal variation is of similar importance, this study looked into five sinuses variations, nasal septum deviation, concha bullosa, Agger's cells, onodi cells, and haller's cells, and found them to quiet prevalent. With the deviated septum being the most common and CB to be rarest. This results call attention to the importance of scanning and determining the variations of every one undergoing surgery, on or through the paranasal sinuses.

This study was limited in terms of sample size and number of variations studied, future studies with larger samples and include all the variations in known to exist in the human populations.

## 5.3 Recommendation:

- Different age should be included in future research as well as different ethnic group.
- Large Sample size should be used
- Additional image planes should be used in measurements.

## 5.4 Appendixes

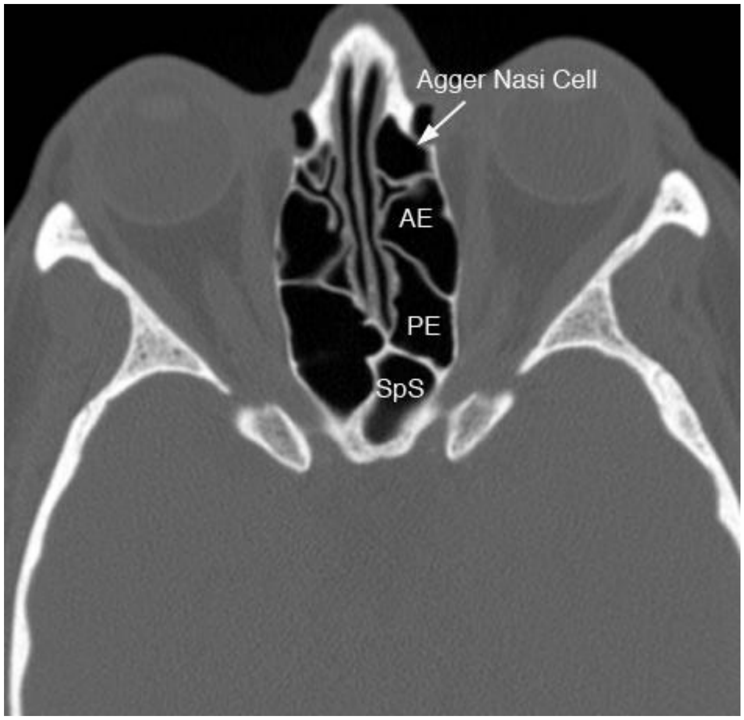


**Fig1.1 illustrate agger nassi cell axial CT image**

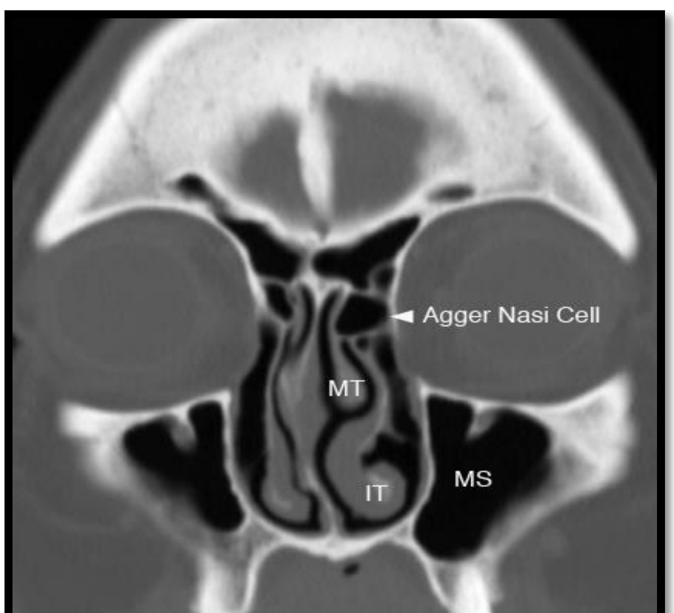


**Fig1.2 coronal CT image illustrate agger nassi cell**

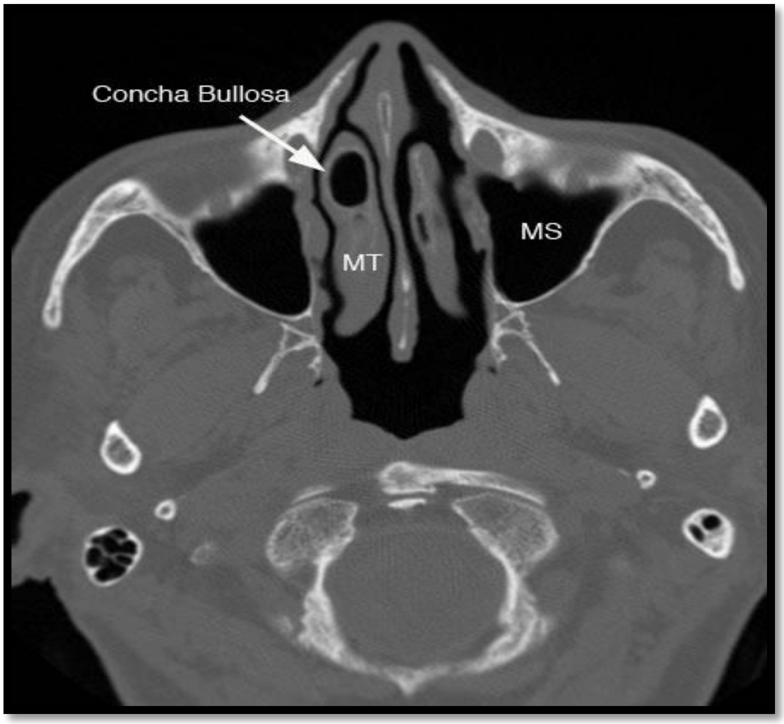


**Fig1.3 axial CT image illustrate concha bullosa**

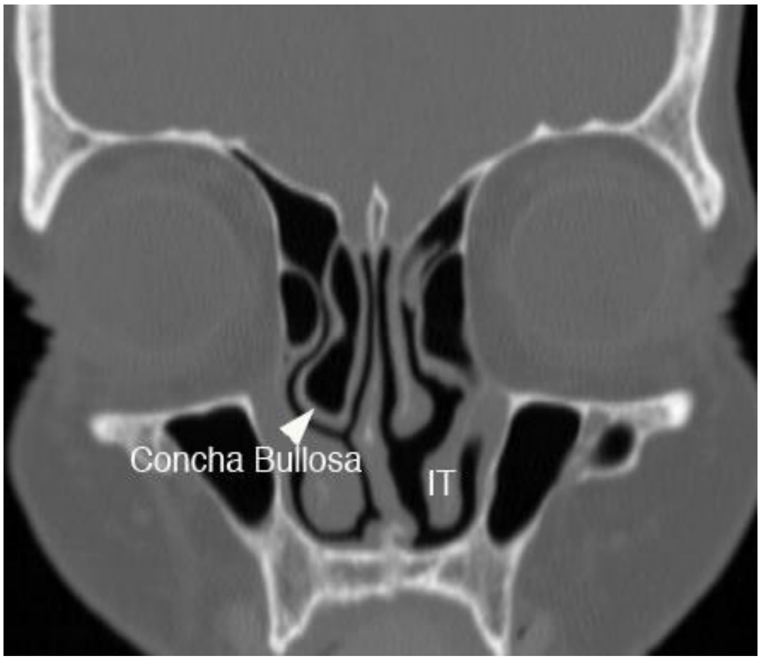


**Fig 1.4 coronal CT illustrate concha bullosa**

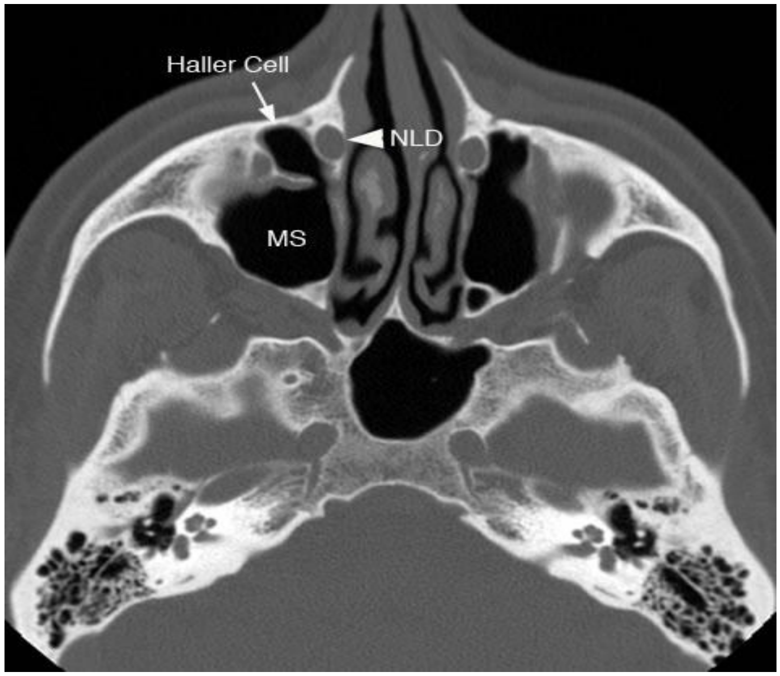


**Fig1.5 axial CT image illustrate haller cell**

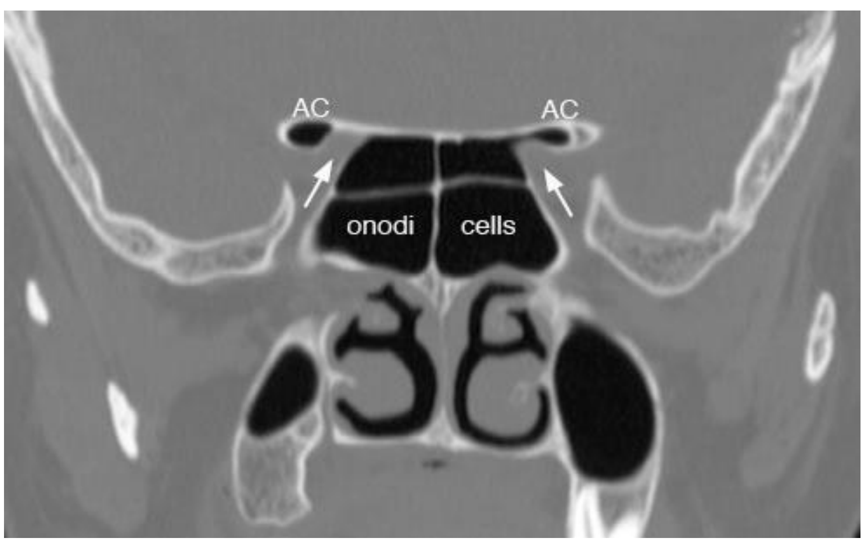


**Fig1.6 coronal CT image illustrate onodi cells**

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