Sarcouncil Journal of Internal Medicine and Public Health

ISSN(Online): 2945-3674

Volume- 05| Issue- 06| 2026

Research Article **Received:** 10-10-2026 | **Accepted:** 05-11-2026 | **Published:** 19-11-2026

Frequency of Anatomical Variations in Ctscan in Patients with Chronic Rhinosinusitis

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Abstract: Introduction: Chronic rhinosinusitis is a very common disease in which a number of factors play a role like systemic and environmental factors. We have to identify these factors and eliminate them to prevent the inflammation from becoming chronic. **Aims:** This study was designed to assess the following: 1-The frequency of anatomical variations in Paranasal Computed Tomography of patients with chronic rhinosinusitis. 2-The association between presence of anatomical variants and occurrence of chronic rhinosinusitis using modern Biostatistics methods(odds ratio). **Patients and Methods:** This is a prospective, randomized; clinical case-control study that is conducted at department of Otolaryngology /Imam-al-Hussein Medical Teaching City/Holy Karbala Directorate over a period of twelve months(from June 2023-July 2024) on 50 patients with clinical diagnosis of chronic rhinosinusitis. The control group(25)were chosen from neurological clinic with diagnosis other than sinusitis(headache, migraine, facial pain..etc). the distributions of age, sex, residence and the odds of anatomical variants in chronic rhinosinusitis patients (95% confidence interval) were studied. **Results:** 50-25 case-control study with mean age of 28-31year respectively, most of them in18-25yr age group making male to female ratio=1.5:1 for CRS patients that 60% reside in rural area with remarkable difference of anatomical variants between both group making significant odds of septal deviation & agger nasi cells with occurrence of chronic rhinosinusitis;4.51&2.25 respectively in 95% confidence interval. **Conclusions:** 1-There is an increase the frequency of these variants in patients with chronic rhinosinusitis when compared with the normal group. 2-An important relationship exists among different anatomical variants and CRS (specially for septal deviation &agger nasi cells using the odds ratio with 95%confidence interval.

Keywords: (CRS) chronic rhinosinusitis, Ctscan, environmental factors.

INTRODUCTION

Anatomical Variations

There is a considerable range of anatomical variation in this area which has been implicated in the aetiology of sinus infection (**Figures 1**, **2,3,4,5** and **6**).This includes pneumatization of the middle turbinate(concha bullosa), enlargement of the ethmoidal bulla, a paradoxically bent middle turbinate, everted uncinate process and the presence of infraorbital (Haller cells) or a septal deflection. The incidence with which these are seen in a 'normal' population may appear to be less frequent than in those individuals with chronic rhinosinusitis, but on closer inspection it is clear that it is narrowing of the ostiomeatal complex rather than the existence of the variant which is the important factor. (Zinreich, S. J. *et al*., 1988; Liyod, G. A. S. *et al*., 1991)

anatomic variations are common in the general population and are often seen more frequently in patients with chronic inflammatory disease. The significance of an anatomic variant is determined by itsrelationship to the ostiomeatal channels and nasal air passages. The ability of the variation to obstruct the air passages may imply a role in the development and recurrence of sinusitis, although such a causal relationship has never been documented. The most common variationsare discussed in the following paragraphs. (Nafi Aygun, S. 2010)

Concha Bullosa

Is defined as an aeration of the middle turbinate (Fig.1). It may be unilateral or bilateral. Less frequently, aeration of the superior turbinate can occur, whereas aeration of the inferior turbinate is uncommon. A concha bullosa in the middle turbinate may enlarge to obstruct the middle meatus or the infundibulum. The air cavity in a concha bullosa is lined with the same epithelium as the rest of the nasal cavity; thus, these cells can undergo the same inflammatory disorders experienced in the paranasal sinuses. Obstruction of the drainage of a concha bullosa can lead to mucocele formation. (Nafi Aygun, S. 2010)

Nasal Septal Deviation

Nasal septal deviation is an asymmetric bowing of the nasal septum that may compress the middle turbinate laterally, narrowing the middle meatus (Fig. 4). Bony spurs are often associated with septal deviation, which may further compromise the ostiomeatal unit. Nasal septal deviation is usually congenital but may be a posttraumatic finding in some patients. (Nafi Aygun, S. 2010)

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DOI- https://doi.org/10.5281/zenodo.24361540

Paradoxic Middle Turbinate

The middle turbinate usually curves medially toward the nasal septum. However, its major curvature can project laterally and, thus, narrow the middle meatus and infundibulum. This variant is called a *paradoxic middle turbinate* (Fig. 3). The inferior edge of the middle meatuscan assume various shapes with excessive curvature, which in turn can obstruct the nasal cavity, infundibulum, and middle meatus. (Nafi Aygun, S. 2010)

Variations in the Uncinate Process

The course of the free edge of the uncinate process varies. In most cases, it extends slightly obliquely toward the nasal septum with the free edge surrounding the inferior or anterior surface of the ethmoid bulla, or it extends more medially to the medial surface of the ethmoid bulla. (Nafi Aygun, S. 2010)

Sometimes, the free edge of the uncinate adheres to the orbital floor or the inferior aspect of the lamina papyracea, which is termed an *atelectatic uncinate process* (Fig. 5). This variant is usually associated with a hypoplastic, and often opacified, ipsilateral maxillary sinus resulting from closure of the infundibulum. It is important to note this variant in the planning for surgery because there is an increased risk of orbital penetration when it is present. (Nafi Aygun, S. 2010)

Haller or Infraorbital Cells

Infraorbital cells are ethmoid air cells that extend along the medial roof of the maxillary sinus (Fig. 2&6). Their appearance and size vary. Large Haller cells may cause narrowing of the infundibulum. These cells may exist as discrete cells or may open into the maxillary sinus o rinfundibulum. (Nafi Aygun, S. 2010)

Onodi or Sphenoethmoidal Cells

Sphenoethmoidal cells are uncommon. They are lateral and posterior extensions of the posterior ethmoid air cells. They extend the paranasal sinus cavity very near the optic nerves as the nerves exit the orbits. These cells can surround the optic nerve tract, putting the nerve at risk during surgery. (Nafi Aygun, S. 2010)

Giant Ethmoid Bulla

The largest of the ethmoid air cells, the ethmoid bulla, can enlarge to narrow or obstruct the middle meatus and infundibulum (Figure 6). (Nafi Aygun, S. 2010)

Extensive Pneumatization of the Sphenoid Sinus

Pneumatization of the sphenoid sinus can extend into the anterior clinoid processes and the clivus, surrounding the optic nerves. When this situation occurs, the risk of damage to the optic nerves is increased during surgical exploration. (Nafi Aygun, S. 2010)

Medial Deviation or Dehiscence of the Lamina Papyracea

Medial deviation or dehiscence of the lamina papyracea may be a congenital finding or the result of prior facial trauma. Regardless, the intraorbital contents are at risk during surgery because of the common dehiscences in the area and the ease of confusing this medial bulge with the ethmoid bulla. Excessive medial deviation and bony dehiscence tend to occur most often at the site of the insertion of the basal lamella into the lamina papyracea, thus making this portion of the lamina papyracea most delicate. (Nafi Aygun, S. 2010)

Aerated Crista Galli

Aeration of the crista galli can occur. When aerated, these cells may communicate with the frontal recess. Obstruction of this ostium can lead to chronic sinusitis and mucocele formation. It is important to recognize this entity preoperatively and to differentiate it from an ethmoid air cell to avoid extension of surgery into the cranial vault. (Nafi Aygun, S. 2010)

Asymmetry in Ethmoid Roof Height

It is important to note any asymmetry in the height of the ethmoid roof. The incidence of intracranial penetration during FESS is higher when this anatomic variation occurs. Intracranial penetration is more likely to occur on the side where the position of the roof is lower. (Nafi Aygun, S. 2010)

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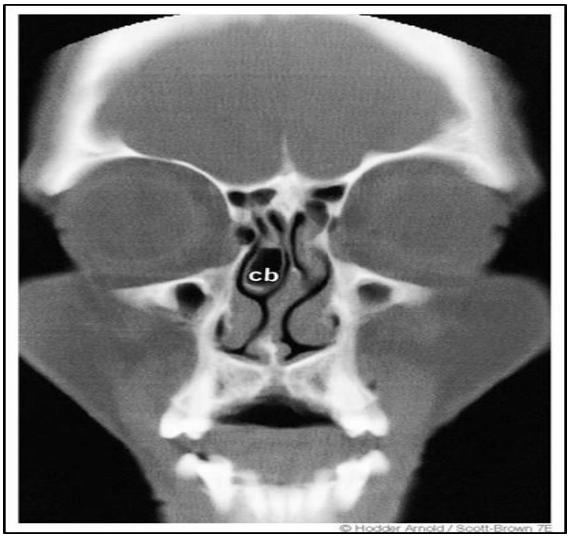


Figure 1: Coronal CTscan showing concha bullosa (cb). (Zinreich, S. J. *et al*., 1988)

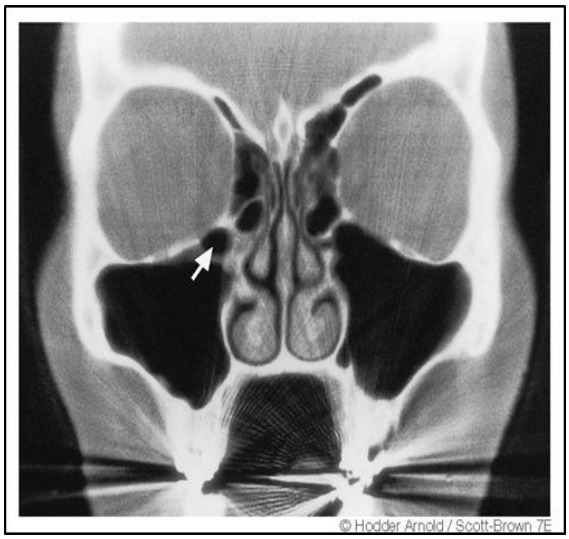


Figure 2: Coronal CT scan showing infraorbital (Haller) cells (arrow). (Zinreich, S. J. *et al*., 1988)

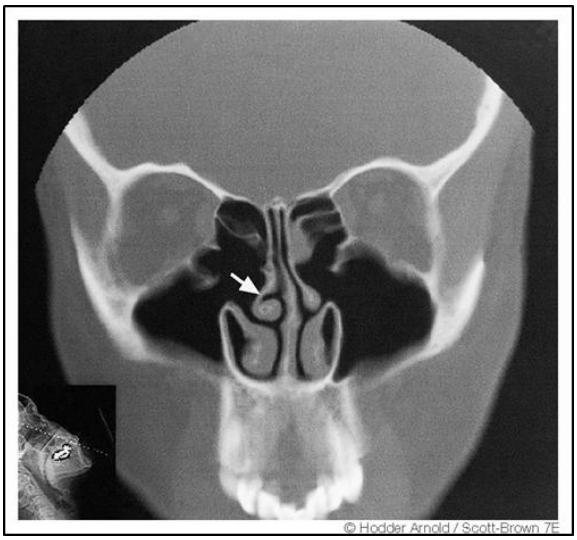


Figure 3: Coronal CT scan showing paradoxically bent middle turbinate (arrow). (Zinreich, S. J. *et al*., 1988)

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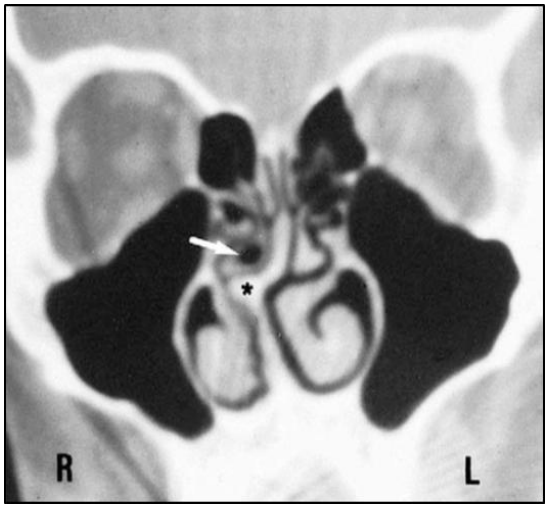


Figure 4: The coronal computed tomography scan shows deviation of the nasal septum toward the right side with a right-sided cartilaginous nasal spur (asterisk). Note the ipsilateral concha bullosa (arrow). (Nafi Aygun, S. 2010)

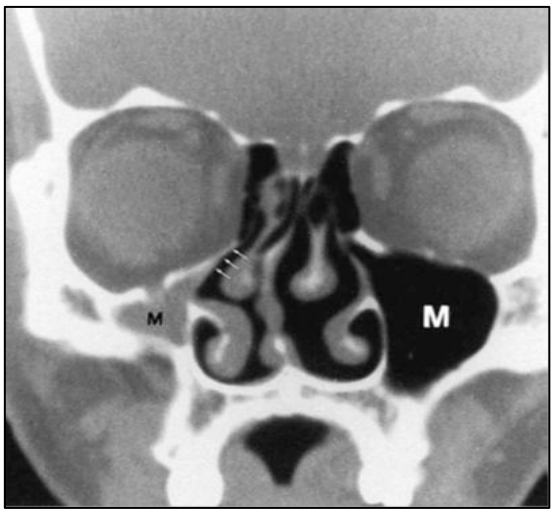


Figure 5: Coronal CTScan showing the atelectatic rt. uncinate process is apposed to the inferomedial aspect of the orbit (arrows),this process is associated with hypoplasia of the ipsilateral maxillary sinus. (Nafi Aygun, S. 2010)

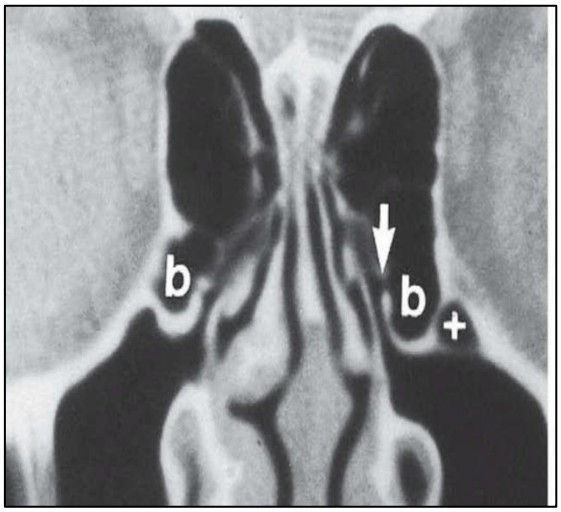


Figure 6. Coronal CTScan showing the left Haller cell (plus sign) with the ethmoid bulla (b) ostium (arrow) located medially opening into the infundibula. . Note theire close proximity to the uncinate process and their influence on the infundibula(arrows). (Nafi Aygun, S. 2010)

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Rhinosinusitis

Definitions

Rhinosinusitis' is the preferred term to describe the inflammation of the nose and paranasal sinuses. There are a number of factors that play a role in the development of rhinosinusitis, including both host and environmental factors. A widely accepted set of classifications or definitions was developed by the Rhinosinusitis Task Force of the American Academy of Otolaryngology-Head and Neck Surgery (Anon, J. B. *et al*., 1997)and reported by Lanza and Kennedy (Lanza, D. C., & Kennedy, D. 1997) (**Table 1**). These criteria are based in large part on temporal time frames. The distinctions between acute rhinosinusitis (ARS),recurrent acute rhinosinusit is (RARS), subacute rhinosinusitis (SRS), chronic rhinosinusitis (CRS)and acute exacerbation of chronic rhinosinusitis (AECRS) are based on the temporal differencesin the clinical presentation. There are also differences in the histopathology and the bacteriology of acute and chronic rhinosinusitis. (Lanza, D. C., & Kennedy, D. 1997).

Table 1: Classification of rhinosinusitis. (Lanza, D. C., & Kennedy, D. 1997)

Classification	Duration
Acute (ARS)	7 days to≤4 weeks
Subacute	4–12 weeks
Recurrent acute	≥4 episodes of ARS per year
Chronic (CRS)	≥12 weeks
Acute exacerbation of chronic	Sudden worsening of CRS with return baseline after

Acute bacterial rhinosinusitis has been defined as sudden in onset and with a duration of less than four weeks. Since many cases of rhinosinusitis occur following a viral upper respiratory tract infection and since upper respiratory infection (URI) symptoms may mimic those of an episode of rhinosinusitis, a minimal duration of symptoms is generally recommended prior to the determination of an acute bacterial rhinosinusitis, typically five to seven days. Recurrent acute infections are defined by four or more episodes per year, with each lasting greater than seven to ten days and an absence of intervening signs or symptoms that would suggest an ongoing or chronic rhinosinusitis. Chronic rhinosinusitis occurs when the duration of symptoms is greater than 12 weeks in duration. There may be occasional acute worsening of symptoms in individuals with chronic rhinosinusitis, suggestive of an acute exacerbation of the chronic condition. With treatment of the acute symptoms, they return to the baseline chronic rhinosinusitis. This entity is referred to as 'acute exacerbation of chronic rhinosinusitis'. Since individuals with acute rhinosinusitis have symptoms for less than four weeks and those with chronic rhinosinusitis have symptoms for greater than 12 weeks, those who have symptoms from four to 12 weeks are considered to have a subacute infection, or 'subacute rhinosinusitis'. Some of these will resolve within that time frame and others will progress to chronic rhinosinusitis. (Lanza, D. C., & Kennedy, D. 1997)

Diagnostic Criteria for CRS

The Rhinosinusitis Task Force's definitions1996 include a group of symptoms to be applied to these conditions to allow for clinical diagnosis (**Table 2**). In addition, since in acute infections viral infections are almost always self-limited, the most interest has been in those with a bacterial disease. Furthermore, although the symptoms noted in **Table2**are valuable in the diagnosis of acute bacterial rhinosinusitis (ABRS), they are more difficult to apply to subacute and chronic rhinosinusitis. (Benninger, M. S. *et al*., 2003)

Individuals with rhinosinusitis may present with symptoms of nasal congestion, nasal discharge, facial pressure or pain, hyposmia, or anosmia.The pain of acute rhinosinusitis is typically a stabbing pain or ache, localized over the involved sinus. Thus, pain may provide a clue as to which sinus is involved (Table 3). Maxillary sinus pain may elicit infraorbital tenderness extending to the maxillary teeth and occasionally to the ear. Ethmoid pain is typically reported between the eyes and over the nasal dorsum. Frontal pain may present as headaches extending to the temple or occiput. Isolated sphenoid sinus pain may present with headache, particularly at the vertex of the skull. Headaches and facial pain are rarely associated with rhinosinusitis, unless a concomitant nasal symptom is present. (Benninger M.S. & Joshua Gottschall. 2006)

Definitions for CRS have been particularly difficult to establish due to the wide variety of

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conditions that have been found to be associated with CRS.

Therefore, the symptom based diagnosis used to define ARS is not likely to be insufficient to define CRS.

Table 2: Rhinosinusitis symptoms/signs (requires two major factors, or one major and two minor). (Benninger, M. S. *et al*., 2003)

Major symptoms	*Minor symptoms*
Facial pain/pressure	**Headache**
Facial congestion/fullness	**Fever (nonacute)**
Nasal obstruction/blockage	**Halitosis**
Nasal discharge/purulence/discoloured posterior drainage	**Fatigue**
Hyposmia/anosmia	**Dental pain**
Purulence on nasal examination	**Cough**
Fever (acute RS only)	**Ear pain/pressure/fullness**

Table 3: Pain and Associated Sinus Involvement (Benninger M.S. & Joshua Gottschall. 2006)

Sinus	Associated pain
Maxillary	Infraorbital, maxillary teeth, referred otalgia
Ethmoid	Medial canthus, nasal dorsum
Frontal	Supraorbital, bitemporal, occipital
Sphenoid	Vertex of skull

SO in2003RTF's definition was amended to require confirmatory radiographic or nasal endoscopic or physical examination finding in addition to suggestive history.The2003diagnostic criteria for CRS require the above factors for>12weeks in addition, one of the following signs of inflammation must be present identified with anterior rhinoscopy after decongestant or nasal endoscopy:

- Discolored nasal drainage, nasal polyp or polypoidal swelling.
- Edema or erythema of middle meatus or ethmmoid bulla.
- Generalized or localized erythema, edema,or granulation tissue.

If the middle meatus or ethmoid bulla not involved radiological confirmation is required which include the following:

- CTScanning demonstrating isolated or diffuse mucosal thickening bone changes or air fluid level.

OR

- Plain sinus radiography revealing air fluid level or greater than5mm of opacification of one or more sinuses but has low sensitivity and specificity.
- MRI not recommended for routine diagnosis because of its excessive sensitivity and lack of specificity and lack of bony detail needed for surgical intervention.(Benninger, M. S. *et al*., 2003)

Therefore in general CTScanning is considered the imaging standard for evaluation of CRS.(Marple, B. F. *et al*., 2009) The latest executive summary on adult CRS, The *European Position Paper on Rhinosinusitis and Nasal Polyps* proposed the criteria for diagnosis of chronic rhinosinusitis in adults as 12 or more weeks of persistent symptoms and signs with no complete resolution. Rhinosinusitis (including nasal polyps) is defined as inflammation of the nose and the paranasal sinuses characterized by two or more of the following symptoms:

- Nasal blockage/congestion;
- Anterior/posterior mucoprulent discharge;
- facial pain/pressure/fullness;
- reduction or loss of smell; plus either:[documantation sign of inflammation]
- endoscopic signs of:
- polyps;
- mucopurulent discharge from middle meatus;
- or oedema/mucosal obstruction primarily in middle meatus; and/or:

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- computed tomography (CT) changes:
- mucosal changes within ostiomeatal complex and/or sinuses. (European Academy of Allergology and Clinical Immunology, 2005)

Zinreich *etal* popularized a protocol for computer-assisted tomography (CT) using sections taken in the coronal plane with 'wide' window settings to show optimally fine bone detail (2000–4000 HU). A wide range of protocols is recommended in the literature (**Table 4**).The newer technology has reduced the scan duration and radiation dose, whilst improving visualization, andthe surgery may be assisted by 3D imaging and navigational techniques in selected cases. (Zinreich, S. J. *et al*., 1987)

Reconstructed coronals derived from fine cut axials on the newer scanners may obviate the need for direct coronal sections in which the patient must hyperextend the head. However, as the coronal plane approximates closest to the surgical field and best demonstrates the ostiomeatal complex and skull base, coronal cuts of the highest possible resolution are always required. However, when pathology is present in the posterior ethmoids and sphenoids, axial views are also required to optimally show the optic nerve and carotid artery. Reconstructed sagittals can be of considerable assistance in evaluating the frontal recess. (Lund, V. J. *et al*., 2000).

Table 4: Protocols for CT scanning in chronic rhinosinusitis. (Zinreich, S. J. *et al*., 1987)

Protocol	**Zinreich *et al*.**	**Charing Cross**	**RNTNE**
Plane	Direct coronal	Direct coronal	Direct coronal
Slice thickness	4 mm	2 mm	5 mm (2.5 mm through the OMC)
Increments	3 mm	8 mm	5 mm (2.5 mm through the OMC)
Scan images	20–25	10 + 2 axial	18–20
Window	2000 Hounsfield units	2000 Hounsfieldunits	Width, 4000; level +350
Radiation	125 kV, 450 mAs	120 kV, 200 mAs	120 kV, 100 mAs

Magnetic resonance imaging (MRI) provides excellent soft tissue detail, but only offers bone detailas a signal void, whilst tending to 'over diagnose' clinically relevant inflammatory changes in the sinuses. Thus CT remains the primary imaging modality and is generally reserved for patients who have failed appropriate medical therapy and are being considered for surgery in uncomplicated rhinosinusitis. The timing of the scan should take into account the effect of the common cold which produces sinus opacification in up to 87 percent of sinuses and the persistence of changes on imaging many weeks after bacterial infection despite clinical resolution. (Leopold, D. A. *et al*., 1994)

PATHOPHYSIOLOGY

An inflammatory response is an expected sequela of an infectious process. Inflammation in the nose and sinuses from a variety of causes can result in sinus ostia obstruction and predispose to the development of an infection. Many factors have been described as playing a role in the development of ABRS, (Lanza, D. C., & Kennedy, D. 1997; Benninger, M. S. *et al*., 2000; Benninger, M. S. *et al*., 1997) These include factors related to the host: genetic factors such as immotile cilia syndrome or cystic fibrosis; anatomic abnormalities such as a concha bullosa, septal spur or paradoxical turbinate; certain systemic diseases or medical treatments that predispose individuals to infections; neoplasms; and allergic or immune disorders. Rhinosinusitis may also develop in relationship to environmental factors: bacterial, viral, or fungal infections, or inflammation that occurs secondary to fungal or bacterial colonization. (Benninger, M. S. *et al*.,2003; Meltzer, E. O. *et al*.,2004) trauma; primary or secondary tobacco smoke exposure, (40) chronic or acute irritants or noxious chemicals; or iatrogenic factors including surgery, medications, nasal packing or nasogastric tube placement. There is growing evidence that individuals with allergies have a higher incidence of developing both acute and chronic rhinosinusitis and an association of acute bacterial rhinosinusitis with asthma has also been suggested, although this may also relate to the presence of allergic rhinitis. (Benninger, M. S. 1992; Slavin, M. R. G. *et al*., 1988; Kaliner, M. A. *et al*., 1997).

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Table 5: Etiologic Factors in Chronic Rhinosinusitis(Alexis, H. & Jackman, D.W. 2006)

Systemic host factors
Genetic/congenital conditions—cystic fibrosis (CF), primary ciliary disorders (PCD)Immunodeficiencies/immunosuppression—HIV, iatrogenic-s/p transplant, chemotherapy
Autoimmune—
Granulomatosis (sarcoid, Wegener's)
Vasculitis (SLE)
Idiopathic—Samter's syndrome
Local host factors
Anatomic abnormalities
Bony inflammation
Neuromechanisms
Mucoceles
Neoplasms (benign and malignant)
Environmental factors
Infectious—bacterial, fungal, biofilms, superantigens
Allergy—IgE-mediated, non-IgE-mediated hypersensitivities
Pollutants—pollution, smoke, dust, volatile organic compounds

The gross pathological expression of CRS is more variable, and has been divided into two major categories—CRS with nasal polyps (CRSwNP) and CRS without nasal polyps (CRSsNP). CRSwNP is characterized by extensive mucosal edema with goblet cell hyperplasia and mononuclear cell infiltration, whereas CRSsNP is often noted to have epithelial damage with demonstrated to be increased in patients with CRSsNP and include IL-1, IL-6, IL-8, TNF-*a*, GM-CSF, ICAM-1, MPO (myeloperoxidase),and ECP (eosinophilic cationic protein) . Patients with nasal polyposis (NP) have also been shown to have increased amounts of these mediators, but additional inflammatory mediators in the subset of patients with NP include a subset of the IL-8 superfamily referred to as regulated on activiation-normal T expressed and secreted (RANTES) as well as IL-4 and IL-5, which have been shown to directly activate and increase the survival of eosinophils.all the above factors are summarised in (table 5). (Alexis, H. & Jackman, D.W. 2006)

Prevalence of Rhinosinusitis

It is difficult to make good estimates of the disease prevalence of rhinosinusitis. Differences in prevalence rates may vary in part from differences in definitions of the disease and from differences in the populations in which the prevalence is assessed. According to the US National Center for Health Statistics, chronic and acute rhinosinuisitis are diagnosed more frequently than all of the other respiratory diseases in adults and may affect as many as 32 million Americans, which is approximately 14 percent of the population. (Chronic Sinusitis Statistics by National Center for Health Statistics,Center for Disease Control,US," (2000).)

THE ECONOMIC AND QUALITY OF LIFE IMPACT OF RHINOSINUSITIS

Since it is fairly well accepted that rhinosinusitis is one of the most common reasons for an individual seeking medical care, rhinosinusitis results in high direct medical costs. These include the costs of an office visit; any diagnostic tests performed, such as cultures, laboratory or radiologic costs; antibiotics or other pharmaceuticals; procedures or surgery; hospitalizations; and the treatment of any complications. Chronic rhinosinusitis results in 13–18 million office visits to a physician in the US each year. (Chronic Sinusitis Statistics by National Center for Health Statistics,Center for Disease Control,US," (2000).) It was estimated that Americans spent approximately $200 million on prescription cold medications for sinusitis in 1992, which was a $50 million increase over 1989. (Kennedy, D. 1995) It is also estimated that they spend more than $2 billion annually on over-the-counter medications for nasal and sinus disorders. (Agency oN health Care Policy and Research, 1999)

The direct costs of rhinosinusitis do not include other important costs to the individual, the community and society. There are losses in time away from work or school with the associated decrease in productivity. There are also the costs related to decreased productivity of individuals who do not miss work but are less effective because of their illness. If all the costs were measured, rhinosinusitis costs in the billions of

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dollars each year in the US alone. Rhinosinusitis Disability Index (RSDI) is a validated instrument that measures the physical, functional and emotional impact of rhinosinusitis on a person's quality of life. Although originally validated for rhinosinusitis, the RSDI has also been found to be valid in other acute and chronic nasal-sinus disorders including allergic and nonallergic rhinitis and anatomic obstructive disorders. Using the RSDI, we have shown that ABRS has a greater impact on the general quality of life of patients than other disorders, such as allergic and nonallergic rhinitis or anatomic obstruction. Since the RSDI measures not only the physical symptoms but also the emotional and functional impact of the disorder, it can be seen that rhinosinusitis has a broader impact than that ascribed to the local symptoms alone. (Benninger, M. S., & Senior, B. A. 1997)

THE ODDS RATIO

The **odds ratio** is a measure of effect size, describing the strength of association or non-independence between two binary data values. It is used as a descriptive statistic, and plays an important role in logistic regression. Unlike other measures of association for paired binary data such as the relative risk, the odds ratio treats the two variables being compared symmetrically, and can be estimated using some types of non-random samples. (Cornfield, J. 1951)

The odds ratio is the ratio of the odds of an event occurring in one group to the odds of it occurring in another group. an odds ratio of 1 indicates that the condition or event under study is equally likely to occur in both groups. an odds ratio greater than 1 indicates that the condition or event is more likely to occur in the first group. and an odds ratio less than 1 indicates that the condition or event is less likely to occur in the first group. (Mosteller, F. 1968)

In recent years odds ratios have become widely used in medical reports. There are three reasons for this. Firstly, they provide an estimate (with confidence interval) for the relationship between two binary ("yes or no") variables. Secondly, they enable us to examine the effects of other variables on that relationship, using logistic regression. Thirdly, they have a special and very convenient interpretation in case-control studies. (Edwards, A. W. 1963)

The odds are a way of representing probability, especially familiar for betting. For example, the odds that a single throw of a die will produce a six are 1 to 5, or 1/5. The odds is the ratio of the probability that the event of interest occurs to the probability that it does not. This is often estimated by the ratio of the number of times that the event of interest occurs to the number of times that it does not. (Edwards, A. W. 1963)

PATIENTS AND METHODS

The current prospective study included 50 patients are collected from June 2023 to July 2024, in the out- patient department of Otorhinolaryngology of Imam-Al-Hussein Medical Teaching City/Holy Karbala Directorate.

These patients are submitted to our questionnaire formula that included general historical informations.

So collectively by 2 major factors or 1 major plus 2 minor factors,we selected the patients to go on to physical examination by anterior rhinoscope using head light and Killan nasal speculm with or without topical vasoconstrictor and look for;

- discoloured nasal discharge(mucopurulent).
- polyp or polypoidal swelling. And using flexible fiber-optic nasopharyngoscope after application of decongestant (xylometazolone nasal spray Hcl 0.1%)+local anesthesia (lidocaine spray10%)to look for;
- Edema, erythema of middle meatus.
- Generalized or localized erythema, edema or granulation tissue.
- Mucopurulent discharge in middle meatus.

In general if the patients had positive findings of above history, physical examination and were refractory for medical treatment for more than 4-6 weeks duration. They had been submitted for computed tomography scanning.

Medical treatment for CRS include:

1. Nasal douching using normal saline irrigation.
2. Topical steroids inform of intranasal spray budesonide64ug or fluticasone 200ug twice daily.
3. Systemic steroids abrief course of prednisolone 20mg twice daily for 5days then 10mg twice daily for 5 days and 10mg daily for 5days(total of 15 days treatment).
4. Systemic antibiotics for acute exacerbation of CRS or persistence purulent drainage, the most appropriate antibiotics treatment ;amoxicillin-clavulanate 625mg 3 times daily while those with pencillin allergy clindamycin 300mg 4times daily(3-4 weaks duration).
5. Antihistamine in form of loratidine 10mg daily.

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All computed tomography imagings were obtained with Siemens SOMATOM Definition AS 256 (Germany) in our radiological department of Imam-al-Hussein Medical Teaching City/Holy Karbala Directorate.

Scanning parameters include;
Plane= coronal.
Slice thickness= 3.5 mm.
Window=200-2000 Hounsfeild units.
Radiation=120 Kv, 100 mAs.

Coronal computed tomography sections were performed with the patient in prone position with extended neck and the plane (tube)was angled perpendicular to infraorbitomeatal line(Reid's Line) and scanning were done from the posterior margin of sphenoid sinus to anterior wall of frontal sinus.

The photographs that generated were photographed at appropriate window width & level to detect the bony abnormalities as well as soft tissue pathologies.

Now the patients had paranasal sinus computed tomography(CT) scan analyzed for common anatomical variants; concha bullosa of middle turbinate, paradoxically bent middle turbinate, over pneumatized (giant) ethmoidal bulla, Haller cells , agger nasi cells and septal deviation(moderate to severe type that compromised the nasal passage).

Laterally bent uncinate process had been canceled in this study because it need special view and more readily seen by endosopical examination, also Onodi cells had been excluded because need axial view that prohibited by radiological department because most films come to us & requested as coronal views.

Other 25 patients that consult neurological out-patients clinic in Al-Imam Al-Hussein medical teaching city/holy Karbala directorate for the same period who complaining of headache other than sinusitis (confirm by our examination) that need brain CTscan(axial plane) request them to do reconstructed coronal plane of paranasal sinuses for the same patient at the same time.

So we analyzed these 25 patients with no complain of sinusitis for paranasal anatomical variants and consider them as control group for these variants.

For these control group we use the same questionnaire formula . By biostatistics consideration we use the Odds ratio for our case-control study to find the effect or risk of anatomical variants on CRS patients.

RESULTS

3-1 Age Distribution

The mean age for CRS patients was28 years and 31 years for controls ,the range for both groups between 15-50 years with high frequency in 15-25 year age group for both, the least frequency in group more than 45 years old; Table 3-1a &3-1b showing these data.

Table 3-1a: Age distribution of CRS patients

Sex	Age group								
	No.	15-25yr	%	26-35yr	%	36-45yr	%	>45yr	%
Male	30	14	28%	12	24%	3	4%	1	2%
Female	20	12	24%	6	12%	3	4%	1	2%
Total	50	26	52%	18	36%	6	8%	2	4%

Table 3-1b: Age distribution of controls

Sex	Age group								
	No.	15-25yr	%	26-35yr	%	36-45yr	%	>45yr	%
Male	16	7	28%	7	28%	1	4%	1	4%
Female	9	3	12%	2	8%	2	8%	2	8%
Total	25	10	40%	9	36%	3	12%	3	12%

3-2 Sex Distribution

The patients was comprised of 30 males(60%) and 20 females(40%) making men outnumbered in ratio of 1.5:1, Also the controls was comprised of 16 males (64%) and 9 females (36%) in ratio of 1.7:1as shown in figure 3-1a&3-1b also in table 3-2 a&b.

Table 3-1a: Sex distribution of CRS patients

Sex	number	Percentage
Male	30	60%

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Female	20	40%
Total	50	100%

Table 3-1b: Sex distribution of controls

Sex	Number	Percentage
Male	16	64%
Female	9	36%
Total	25	100%

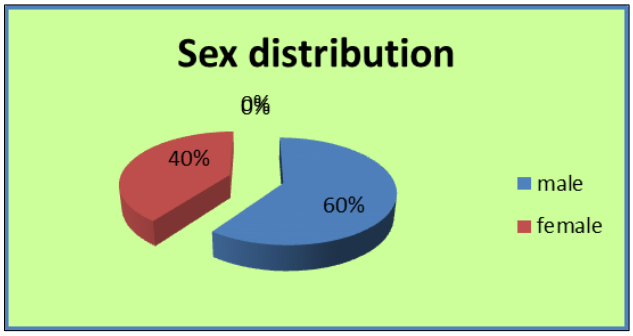


Figure 3-1a Sex distribution in CRS patients

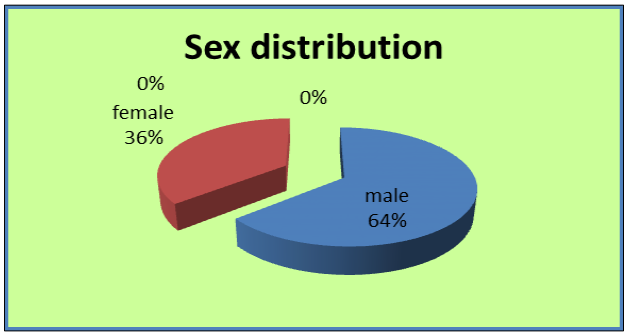


Figure 3-1b: sex distribution of Controls

3-3 Residence Distribution

Residence of the patients in our study 30/50 (60%) rural&20/50(40%)urban while for controls 17/25(68%)urban&8/25(32%)rural as shown in figure 3-2a&b and table 3-3a&b.

Table (3-3a): Residency distribution of CRS.

Residence	No.	Percentage
Rural	30	60%
Urban	20	40%

Table (3-3b): Residency distribution of controls

Residence	No.	Percentage
Rural	8	32%
Urban	16	68%

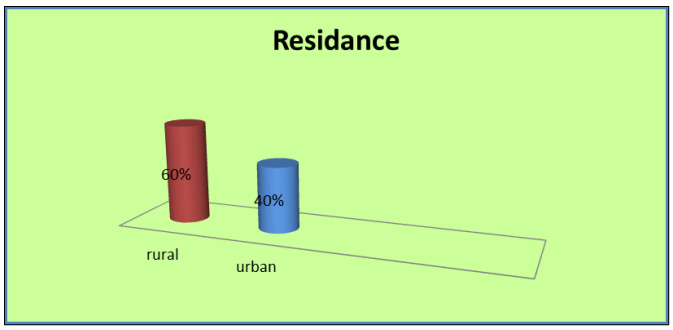


Figure (3-2a): Residency distribution of CRS.

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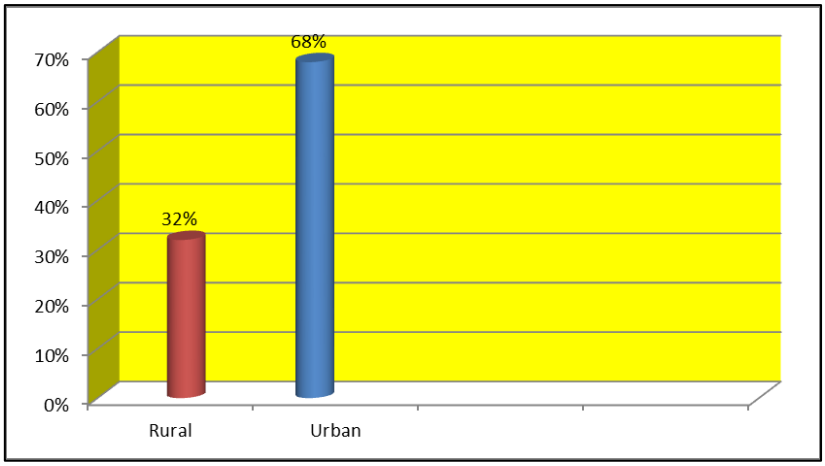


Figure (3-2b): Residency distribution of Controls

3-4 Anatomic Variations Distribution

CT scan detection of anatomic variations in CRS patients yield septal deviation was the most common variants in 34 (68%) patients followed by agger nasi cells in 18(36%) patients, other variants like concha bullosa of middle turbinate was detected in 15 (30%) patients.

The least occurring variants are giant bulla, paradoxically bent middle turbinate & haller cells in percentage of 16%, 8%, 8% respectively as demonstrated in table 3-4a.

While in control group these variants like septal deviation and agger nasi cells still common but in less frequency than CRS patients to detect in 8(32%),5(20%) patients respectively. The same thing was applied to concha bullosa in 5(20%) patients &giant bulla in 2(8%) patients with only one patient of both haller cells & paradoxically bent middle turbinate in our controls as depicted in table 3-4b.

Table 3-4a: Anatomic variation distribution in CRS patient**.**

Anatomic variations	Unilateral	Bilateral	Total	Percentage
Concha bullosa	9	6	15	30%
Paradoxically bent mid.turbinate	1	3	4	8%
Giant ethmoidal bulla	3	5	8	16%
Haller cells	3	1	4	8%
Agger nasi cells	6	12	18	36%
Septal deviation	-	-	34	68%

Table 3-4b: Anatomic variations distribution in controls.

Anatomic variations	Unilateral	Bilateral	Total	Percentage
Concha bullosa	3	2	5	20%
Paradoxically bent mid.turbinate	-	1	1	4%
Giant ethmoidal bulla	1	1	2	8%
Haller cells	1	-	1	4%
Agger nasi cells	2	3	5	20%
Septal deviation	-	-	8	32%

3-5 Odds Ratio Distribution

By data analysis of CRS-control group using odds ratio showed an association between the presence of anatomical variants and the occurrence of CRS .

Septal deviation, agger nasi cells, giant ethmoid bulla, paradoxically bent middle turbinate, haller cells & concha bullosa were variants showed significant association with CRS in step ladder fashion specially for septal deviation & agger nasi cells.

In this study, the odds of presence of septal deviation was 4.51 times as common among the individuals with CRS as in the controls, also the odds of the presence of agger nasi cells with CRS was 2.25 times more than the odds in the controls, but for concha bullosa showed the lower odds ratio in our study as1.7143[95% C.I:0.5419-5.423] we

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conclude that was in our patients the size of this anatomical variant was not large enough to exert mass effect on osteomeatal unit.

All these information data are abstracted at (table 3-5).

Table 3-5: Descriptive biostatistic of case-control study of anatomic variation inCTscan in CRS using odds ratio with 95% confidence interval*.

Anatomic variations	CRS	Control	Odds ratio[95% C.I]*
Concha bullosa	15	5	1.7143[0.5419-5.423]
Paradoxically bent mid.turbinate	4	1	2.187[0.2208-19.7265]
Giant ethmoidal bulla	8	2	2.1905[0.4288-11.1889]
Haller cells	4	1	2.187[0.2208-19.7265]
Agger nasi cells	18	5	2.25[0.7214-7.0176]
Septal deviation	34	8	4.5156[1.6134-12.6385]

DISCUSSION

The degree to which anatomical variations may predispose to recurrent and CRS is not well identified. (Rodney Jschlosser & DW. Kennedy, 2008)

Stammberger (Stammberger, H. 1991) and stammberger etal (Kopp, W. *et al*., 1988) proposed that stenosis of osteomeatal complex from either the anatomical configuration or hypertrophied mucosa can cause obstruction and stagnation of secretion that may become infected or perpetuate infection.

Agger Nasi Cells: lie just anterior to the anterosuperior attachment of the middle turbinate and frontal recess. these can invade the lacrimal bone or ascending process of maxilla. these cells were present in this study in 18/50 patients(36%) these incidence is less as compared to 98.5% by Bolger (Bolger, W. E. *et al*., 1991) and 88.5% by Maru (Maru, Y. K., & Gupta, V. 2001) but Asruddin (Asruddin, Yadav, S. S. *et al*., 1999) reported an almost a near incidence of 48%.

Haller's Cells: are ethmoidal cells that grow into the floor of orbit and may narrow the adjacent ostium of the maxillary sinus especially when they become infected. (Lioyd, GAS, Lund, V.J. *et al*., 1991)

The frequency of Haller's cells in our study was 4/50(8%) Liyod reported 15% (Lioyd, GAS, Lund, V.J. *et al*., 1991) and it was less than that reported by Bolger 45.9% (Bolger, W. E. *et al*., 1991), Maru 36% (Maru, Y. K., & Gupta, V. 2001) and Asruddin 28%.(Asruddin, Yadav, S. S. *et al*., 1999)

Concha Bullosa : of middle turbinate has been implicated as a possible aetiological factor in causation of recurrent &CRS. It is due to its negative influence on paranasal sinus ventilation and mucociliary clearance in middle meatus region as quoted by Tonai (Tonai, A., & Baba, S. 1996).the frequency of concha bullosa in our study was15/50(30%) which is less as compared to the reported incidence of 59% by Scribano (Scribano, E. *et al*., 1997) , 53.6% by Bolger *et al*(Bolger, W. E. *et al*., 1991), 42.6% by Maru *et al* (Maru, Y. K., & Gupta, V. 2001) 28% by Asruddin *et al* (Asruddin, Yadav, S. S. *et al*., 1999) and 24% by Liyod .also in swiss study by S-Nadas reported that 35% of 151 patients with CRS had concha bullosa of middle turbinate.(Nadas, S. *et al*., 1995)

Paradoxical Middle Turbinate: This may lead to impingement of middle meatus and sinusitis. It was found in 4/50 (8%)3 unilateral&1 bilateral.

the incidence is similar to that of 12% by Asruddin etal (Asruddin, Yadav, S. S. *et al*., 1999) and 15% by Liyod (Lioyd, GAS, Lund, V.J. *et al*., 1991) ,its less than reported by Bolger etal 27%. (Bolger, W. E. *et al*., 1991)

Deviated Nasal Septum(Moderate To Severe):can cause a decrease in critical area of osteomeatal complex predisposing to obstruction & its complications, it was the maximum anatomical variant in this study 34/50(68%),it was similar to 55.7% in study by Maru (Maru, Y. K., & Gupta, V. 2001) and more than that of 38%reported by Asruddin. (Asruddin, Yadav, S. S. *et al*., 1999)

Over Pneumatised Ethmoid Bulla: was found in 8/50(16%), 3unilaterally & 5 bilaterally which was similar to 18% as found by Zinreich (Zinreich, S. J. *et al*., 1988) and less as found in study by Scribano in Italy 5% of CRSpatients had giant ethmoidal bulla (Scribano, E. *et al*., 1997) . Almost all the above had been illustrated in (table 4-1).

According to our results in control group, the most fequent variant was septal deviation in 8/25(32%) and the least common was paradoxically bent

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middle turbinate & haller cells that were found in one patient from 25 making percentage of 4% for both.

Septal deviation frequency was less as compared with Lund V(80%) (Lund, V. J. 1989), the following table (Table 4-2) showing the incidence of anatomic variants in controls according to Zinreich study. (Zinreich, S. J. *et al*., 1988).

Table 4-1: The incidence of anatomical variants of CRS patientsin different studies.

Anatomic variations	Our study	Bolger	Maru	Asruddin	Liyod
Concha bullosa	30%	53.6%	42.6%	28%	24%
Paradoxically bent mid.turbinate	8%	27%	-	8%	15%
Giant ethmoidal bulla	16%	-	-	12%	-
Haller cells	8%	45.9%	36%	28%	15%
Agger nasi cells	36%	98.5%	88.5%	48%	-
Septal deviation	68%	-	55.7%	38%	-

Table 4-2: The incidence of anatomic variants of Controls in different studies.

Anatomic variations	Our study	Zinreich	LundV
Concha bullosa	20%	14%	-
Paradoxically bent mid.turbinate	4%	17%	-
Giant ethmoidal bulla	8%	17%	-
Haller cells	4%	2%	-
Agger nasi cells	20%	3%	-
Septal deviation	32%	-	80%

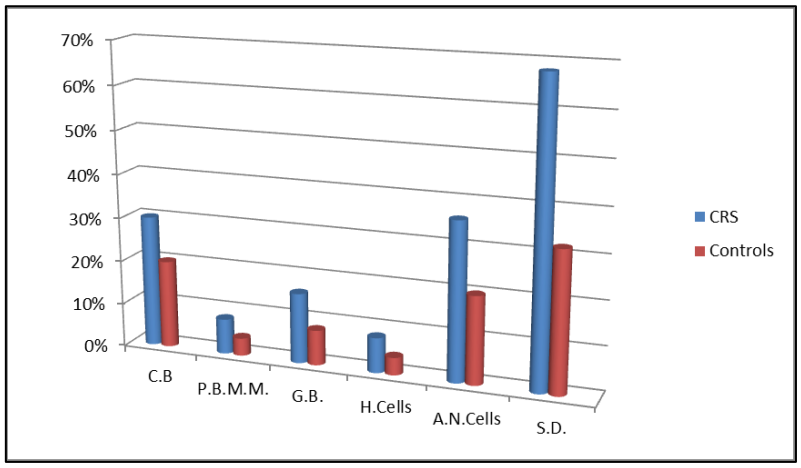


Figure 4-1: Showing the comparison of anatomical variants between CRS&Controls group.

By simple comparison the percentage of frequency of these anatomical variants between the two groups using figure 4-1 conclude these variants are more in CRS group and to proof the significant association between them by biostatic method, we select the odds ratio to calibrate the relative risk of these variants on chronicity of sinus diseases.

This current study revealed that among all the observed variants septal deviation and agger nasi cells were associated with the occurrence of CRS by measuring the odds ratio 4.51 -2.25 respectively, also there is a significant associationbetween the presence of giant ethmoidal bulla and CRS, the odds ratio is 2.19.

But for concha bullosa in this study record the least risk for CRS(1.7) because we assume in our patients the size of concha bullosa was not large enough to compress the ethmoid infandibulum, obsruct the nasal cavity or cause lateral displacemant of uncinate process causing symtoms. The remarkable difference between the frequency of these variants among CRS patients as compared with normal population lead to conclusion that these anatomic variants propably increase the risk of sinus inflammation by bringing the mucosal lining of osteomeatal complex in contact with mucosal lining of paranasal sinus compromising their drainage and subsequently causing chronic inflammation as illustrated on table 4-3.

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Table 4-3: Odds ratio of our study anatomical variants.

Anatomic variations	Odds ratio[95% C.I]*
Concha bullosa	1.7143[0.5419-5.423]
Paradoxically bent mid.turbinate	2.187[0.2208-19.7265]
Giant ethmoidal bulla	2.1905[0.4288-11.1889]
Haller cells	2.187[0.2208-19.7265]
Agger nasi cells	2.25[0.7214-7.0176]
Septal deviation	4.5156[1.6134-12.6385]

CONCLUSIONS

1- There is an increase in the frequency of these variants in patients with chronic rhinosinusitis when compared with the normal group.

2-An important relationship exists among different anatomical variants and CRS, the variants that implicated in order of higher odds ratio include septal deviations, agger nasi cells, giant ethmoidal bulla, infraorbital ethmoid cells (Haller's cells), paradoxically bent middle turbinates and concha bullosa abnormalities with95% confidence interval.

Recommendations

1-It is important to identify anatomic variations when evaluating CT scans for chronic rhinosinusitis.

2-it is important not to generically label these structures as pathologic rather than predisposing role

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Source of support: Nil; **Conflict of interest:** Nil.

Cite this article as:
Hussein, H. A., Hussein, I. A. & khashan, K. M. "Frequency of Anatomical Variations in Ctscan in Patients with Chronic Rhinosinusitis." *Sarcouncil Journal of Internal Medicine and Public Health* 5.6 (2026): pp 9-26.

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