Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL13,ISSUE05,2022

"ASSOCIATION OF ANATOMICAL VARIATIONS OF NOSE AND PARANASAL SINUSES WITH CHRONIC RHINOSINUSITIS"- AN INSTITUTIONAL STUDY

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Abstract- AIM OF STUDY : To study the association of anatomical variations of nose and paranasal sinuses with chronic rhinosinusitis

OBJECTIVES: To study the **variations in CT-PNS**

- To study the incidence of these variations in our hospital
- To describe these anatomical variations
- To understand the link between anatomical variations and chronic rhinosinusitis

Results : The most common anatomical variation leading to Osteo-meatal obstruction in our study was a deviated nasal septum, followed by concha bullosa. There was a statistically significant association between the presence

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of a septal deviation, concha bullosa and paradoxical turbinate with the occurrence of sinusitis. Most of the patients had presence of more than one anatomical obstruction and maxillary sinus followed by ethmoid sinus were the most commonly involved sinuses. There was significant symptomatic improvement following the endoscopic nasal surgery along with correction of the anatomical obstruction, but many a time postoperative medical therapy also needed to help the patient relieved of symptoms.

Conclusion:

Our present prospective study of anatomical variation of Osteo-meatal complex reveals many parameters. Almost all of the anatomical variations noted in this study had the prevalence rates that were comparable with the literature. Deviated Nasal septum and Concha Bullosa are the two significant anatomical variations that were encountered, and both were found to have an association with maxillary sinus opacification in chronic rhinosinusitis patients.

Key words: Anatomical variations ,Osteomeatal complex, Computer tomograph of Paranasal Siinuses

Introduction : Chronic Rhino-siniusitis is an entity which exists as a group of Disorders which can include Rhinitis ,sinusitis ,Rhinosinusitis and may be associated with a lot of other Anatomical variations like Deviated Nasal septum , Concha bullosa , Spur , Mucosal abnormalities like Allergic Rhinitis etc. All these may be present in one patient or may be presenting as individual entities. This makes us to study the patient in detailed by utilizing the various Investigations like CT scan and Diagnostic Nasal Endoscopy. We should have a proper idea about the patient condition by studying the same .Our current study is intended to see the relationships between many conditions of the Nose.

AIMS AND OBJECTIVES OF THE STUDY

AIM: To study the association of anatomical variations of nose and paranasal sinuses with chronic rhinosinusitis

OBJECTIVES:

- To know the **incidence** of **anatomical variations** of Nose like Deviated Nasal

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Septum, Concha Bullosa, Hypertrophied Inferior Turbinate, of Para nasal sinuses like Pneumatised Bulla Ethmoidalis, Uncinate Process Abnormalities, Paradoxically Curved Middle Turbinate and Pneumatised Septum

- To know the **association between** Anatomical Variations of nose and paranasal sinuses and Chronic Rhinosinusitis.
- To know the **incidence** of chronic rhinosinusitis with reference to **age and sex**
- To know the **incidence** of various major and minor **symptoms** of chronic rhinosinusitis
- To study the **variations in CT-PNS**
- To study the incidence of these variations in our hospital
- To describe these anatomical variations
- To understand the link between anatomical variations and chronic rhinosinusitis

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METHODOLOGY

Study Period

This was a prospective, correlational, cross sectional study, conducted from September 2019 to March 2021 in the Department of Otorhinolaryngology, Head and Neck Surgery, Bhaskar General Hospital, Moinabad

Inclusion Criteria:

1. Patients with major symptoms of chronic sinusitis
2. Symptoms present for more than 3 months
3. Age 18-65 years
4. Coronal CT scan of paranasal sinuses showing features of chronic sinusitis
5. Coronal CT scan of paranasal sinuses shows anatomical variation at OMC leading to obstruction and sinusitis.
6. No history of previous nasal surgeries.
7. No evidence of local sepsis from oral cavity and oropharynx.
8. No history suggestive of allergic rhinitis.
9. Uncomplicated sinusitis cases.

Exclusion Criteria:

1. Patients with acute sinusitis.
2. Patient with visible mass or polyp obstructing the nasal cavity.
3. Patients who were previously operated.
4. Patient with facial anomalies.
5. Patients age less than 18 years.
6. Complicated cases of chronic rhinosinusitis
7. Patients not willing to participate in the study.

MATERIALS AND METHODS

Diagnostic Nasal Endoscopy:

After taking complete history and doing examination, Patient screened for HIV, HbSAg.

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For conducting a proper diagnostic nasal endoscopy, the nasal mucosa is prepared by using mixture of local anaesthetic and decongestant to facilitate surface anaesthesia and decongestion within a few minutes. Moffetting followed by packing was done. Ideally the nasal endoscopy is done using a 4mm, 0 and 30-degree endoscope, and also using 2.7 mm scope in narrow passages. It helps in adequate visualization of the nasal meatus and the entire nasopharynx.
The procedure is done in three steps as follows

First pass: Examination of the septum, floor of the nose, nasopharynx, inferior meatus and inferior turbinate

Second pass: Evaluation of the sphenoethmoid recess and superior meatus.

Third pass: Examination of the Osteomeatal unit

CT Scan of Paranasal Sinuses

CT is currently the modality of choice in the evaluation of theparanasal sinuses and adjacent structures. Its ability to optimally displaythe bone and airprovidean accurate picture of both the anatomy and the extend of disease in and around the paranasal sinuses. In contrast to standard radiographs, CT clearly shows the fine bony anatomy of the Osteo meatal channels.

Since the Osteo meatal unit is best represented in the coronal plane, it is the primary imaging orientation for evaluation of the Sino nasal tract. Coronal view hence also known as Surgeon‘s view. When direct coronal study becomes difficult due to patient‘s positioning, spiral scanning or thin section, contiguous axial CT images with coronal reconstructions are performed. Axial images complement the coronal study, particularly when there is severe disease (opacification) of any of the paranasal sinuses and surgical treatment is contemplated. The axial studies are needed, as the posterior walls of the various sinuses are not well seen, if at all, in the coronal plane. Axial images are particularly important in visualizing the fronto-ethmoid junction and spheno-ethmoid recess.

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CT scan has also been used for staging of the disease by the **Lund-Mackay system** proposed by the task force on rhinosinusitis of the **American Academy of Otorhinolaryngology -Head and Neck Surgery (AAO-HNS)** A maximum score of 12 per side can be achieved. Each side is graded separately. A combined score of up to 24 is possible. Of note, an aplastic (absent) frontal sinus receives a score of 0.

The method is intentionally simplistic, for the sake of minimizing interobserver variability and expediting its application. Thus, it lends itself to application by non-radiologists and in clinical studies. Despite its simplicity, it correlates well with disease severity, extent of surgery, and complication rates, even independent of the extent of surgery.

Lund-Mackay Computed Tomography Staging system

Sinus	**Right**	**Left**
Frontal	/2	/2
Maxillary	/2	/2
Anterior ethmoid	/2	/2
Posterior ethmoid	/2	/2
Sphenoid	/2	/2
Osteomeatal complex	/2	/2
Total	/2	/2

Each individual sinus is scored □

0 □ clear

1 □ partial opacification 2 □ total opacification

Scoring of OMC □ 0 □ clear

2 □ occluded

Surgeries performed:

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Anatomical variations seen	Surgery performed
Deviated nasal septum	Septoplasty
DNS + inferior turbinate hypertrophy	Septoplasty + IT sub mucosal diathermy
Concha bullosa	Conchoplasty
DNS + sinusitis	Septoplasty + FESS
Sinusitis	FESS

RESULTS AND ANALYSIS

This study is a prospective analysis of the anatomical variations of the Osteomeatal complex that were commonly encountered in 100 chronic sinusitis patients. These patients were subjected to septoplasty and Functional Endoscopic Sinus Surgery in our hospital, with the help of Diagnostic Nasal Endoscopy and Computed Tomography of nose and paranasal sinuses.

The results are tabulated as follows**:**

Age distribution of patients with chronic sinusitis:

Age group	No. of patients (male)	No. of patients (female)	Total no patients	Percentage
18 – 25 years	24	8	32	32%
26 – 35 years	20	11	31	31%
36 – 45 years	8	7	15	15%
>45 years	12	10	22	22%

Table 1: Shows the age distribution of patients with chronic sinusitis

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The demographic profile showed the most common age group to be between 18 - 35yrs

Sex	No of patients
Male	64 (64%)
Female	36 (36%)

Table 2: Showing the sex distribution of cases

Chief complaints of the patients with sinusitis

Complaints	No of patients	Percentage
Nasal obstruction	34	34%
Nasal discharge	21	21%
Headache	20	20%
Facial pain/ pressure	12	12%
Post nasal drip/ hawking	9	9%
Hyposmia / Anosmia	2	2%
Fever	2	2%

***Table 3*:** Showing the frequency of chief complaints of the patients.

In our study, most of the patients presented with more than 1 symptom. The most common symptom was nasal obstruction in 34 (34%) out of 100 patients followed by nasal discharge in 21 (21%) and headache in 20 (20%) patients

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Anatomical variations studied:

In our study most of the patients had more than one anatomical variation. Only minor group of patients presented with one anatomical variation.

Anatomical variation	Male	Female	Total
DNS	45	22	67
Concha bullosa (CB)	10	12	22
Pneumatised septum	8	9	17
Uncinate process abnormalities	10	4	14
Pneumatised bulla ethmoidalis	3	2	5
Paradoxically curved middle turbinate	3	1	4
Onodi cell	4	1	5
Haller cell	3	1	4

Table 4: Showing frequency of different anatomical variations

The most common anatomical variation found in our study was deviated nasal septum in 67 (67%) out of 100 patients followed by concha bullosa in 22 (22%) and
pneumatised septum in 17 (17%)

Side	No of patients
Unilateral	61 (61%)
Bilateral	39 (39%)

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Table 5: Unilateral v/s bilateral disease

Anatomical variations may present unilaterally or bilaterally. In our study, 39 (39%) patients out of 100 patients had bilateral anatomical variation. 61 (61%) patients had unilateral disease.

Diagnostic Nasal Endoscopy findings:

In our study, the diagnostic nasal endoscopy findings are as follows:

Anatomical abnormality	**No of patients**
Deviated nasal septum	67
Hypertrophied inferior turbinate	22
Hypertrophied middle turbinate	23
Paradoxically curved middle turbinate	4
Uncinate process abnormalities	14

Table 6: DNE findings

Sinus involved:

Sinus involved	**No. of patients**
Maxillary	26
Ethmoid	13
Frontal	9
Maxillary & ethmoid	32
All sinuses	20

Table 7: Showing the sinuses affected in patients with sinusitis

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In our study, maxillary and ethmoid sinuses were the most commonly involved sinuses in 32 (32%) out of 100 patients followed by maxillary sinus in 26 (26%) and all sinuses is 20 (20%) out of 100 patients

Lund -Mackay CT staging:

The Lund – Mackay CT score for opacification of the sinuses is as follows

Maxillary sinus:

Maxillary sinus opacification	**No of patients**
Clear	25
Partial opacified	58
Total opacified	17

Table 8: Maxillary sinus opacification

In our study, 3/4th of the patients (75%) had involvement of the maxillary sinus of which most of the patients (58%) had partial opacification of the sinus

Ethmoid sinus:

Ethmoid sinus opacification	**No of patients**
Clear	35
Partial opacified	44

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Complete opacified	21

***Table 9*:** Ethmoid sinus opacification

In our study almost half of the patients (44%) had ethmoid sinus involvement in which 21% had complete opacification of the ethmoid sinus

Frontal sinus:

Frontal sinus opacification	**No of patients**
Clear	71
Partial opacified	18
Complete opacified	11

***Table 10*:** Frontal sinus opacification

In our study, frontal sinus was clear in most of the patients (71%)

DISCUSSION

Stammberger et al[1] stated that narrowing of the Osteomeatal complex either due to anatomical configuration or due to hypertrophied mucosa, may cause obstruction and hence stagnation of the sinus secretions that may there by, become infected or perpetuate the infection.

Mackay and Lund [2] proposed that the Osteomeatal complex acts as a drainage pathway for the maxillary, anterior ethmoid and frontal sinuses they considered the posterior Osteo-meatal unit to be a part of the sphenoid sinus. In various regions of the Osteo-meatal complex, overcrowding due to anatomical variation occurs, and thus, two mucosal layers come in to contact with each other, thus creating the likelihood of obstruction to muco-ciliary clearance. Secretions then may be retained at these sites, producing increased potential for infection, even without the closure of the ostium. The most likely areas of mucosal contact automatically are in the narrow mucosa lined pathways of the middle meatus and the ethmoid infundibulum.

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Cottle classified nasal septal deviation in to three types.

1) Simple deviation: It is the most common type. Here there is only a mild deviation with no obstruction.

2) Obstructive type: The deviated nasal septum touches the lateral nasal wall or, but on decongestion with vasoconstrictors the obstruction is relieved due to shrinking of the turbinate

3) Impaction: There will be a septal spur with gross angulation of the septum leading to severe obstruction, even after decongestion.

As a deviated nasal septum is a normal occurrence in the population rather than an abnormal variation, we considered only gross septal deflections which may hamper the mucociliary drainage leading to infection, i.e., Cottle‘s type 2 & type 3.

There was statistically significant difference between the two groups of having a septal deviation and occurrence of sinusitis. Different studies worldwide have found different results regarding the occurrence of a deviated nasal septum in the population

Study	**Sample size**	**DNS**
Perez et al (Spain)	110	58.2%
H.Mamtha (India)	40	65%
Dutra et al (Brazil)	71	14.1%
AR Talaiepour et al (Iran)	143	63%
Yahya et al (India)	50	74%
Kartikeyan et al (India)	100	73%
Current study	100	67%

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The wide difference in the studies may be because of the difference in the selection criteria i.e the exact definition of a septal deviation to be included in the study.

In our study we included patients with gross septal deviation according to the Cottle‘s classification.

Concha bullosa (pneumatised middle turbinate) has been implicated as a possible aetiological factor in the causation of recurrent chronic sinusitis. Itis due to its negative influence on paranasal sinus ventilation and muco-ciliary clearance in the middle meatus region as quoted by Tonai[3]

When concha bullosa was studied, we included bulbous and extensive type of concha bullosa, according to the Bolger et al classification in our study.

The frequency of concha bullosa was 22% in our study, compared to the reported incidence of 28% by Azruddin et al[6], 24% by Llyod[20] and 42.6% by Maru et al[5]and 53.6% by Bolger et al[4].

Study	**Incidence of Concha bullosa**
Bolger et al	53.6%
Maru et al	42.6%
Azruddin et al	28%
Lloyd et al	24%
Kartikeyan et al	60%
Current study	22%

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The middle turbinate may be paradoxically curved i.e.bent in the reverse direction. This may lead to impingement of the middle meatus andthus to sinusitis. It was found in 4% in our study. The incidence is lowerto that of 12% by Asruddin et al[6], 15% by Llyod[7] and Bolger et al[4] (27%)

Study	**Incidence of paradoxically curved MT**
Bolger et al	27%
Lloyd et al	15%
Asruddin et al	12%
Kartikeyan et al	40%
Current study	4%

Zinreich first observed that the uncinate process may be curved orbent. It can impair sinus ventilation especially in the anterior ethmoid, frontal recess and infundibulum regions. The medialised uncinate was found in 14 % patients in our study. It is higher than that of 2.5% reported byBolger[4] ,2% by Asruddin[19] and 9.8% by Maru et al[5]

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Study	Uncinate process abnormalities
Asruddin et al	2%
Bolger et al	2.5%
Maru et al	9.8%
Kartikeyan et al	21%
Current study	14%

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 5 % patients in our study. A similar incidence was found by Arslan in 12/200 patients, kartikeyan in 6/100 patients and higher than the study by Jones[8] in 8/ 200 patients

Study	Onodi cell
Arslan et al	12%
Jones et al	8%
Kartikeyan et al	6%
Current study	5%

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Haller cells are ethmoid air cells that project beyond the limits of theethmoid labyrinth into the maxillary sinus. They are considered as ethmoidcells that grow into the floor of orbit and may narrow the adjacent ostium ofthe maxillary sinus especially if they become infected[4]. The incidence ofHaller cells in our study was 4 %. It was less than that reported by Bolger [4] 45.9%, Llyod [7] 15%, Maru[5] 36% and Asruddin[6] 28%

Study	**Haller cell**
Bolger et al	45.9%
Maru et al	36%
Asruddin et al	28%
Lloyd et al	15%
Kartikeyan et al	4%
Current study	4%

The anatomical variations like DNS, concha bullosa, Haller Cell, Onodi Cell had been studied in detail by various authors with the inclusion of participants from across the globe. Our results were within the reported rangein the literature for all of these factors. On the other hand, only a few studies have discussed the pneumatization statusof nasal septum , and the prevalence rates of this in our study was considerably more than the several previous reports. However, studies by Mladina et al.respectively showed pneumatization in the perpendicular plate of ethmoid in 34.4%.Contrary to pneumatized nasal septum seen in 2%of the cases reported by Dua et al[9] that were

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involvingvomer bone of septum, we identified 17% our cases to havenasal septal pneumatization, and all were seen involving theperpendicular plate of the ethmoid, similar to findings ofMladina and group[10]

The osteomeatal unit was found to be involved in all the patients inour study. Maxillary sinus is the most common sinus involved in chronic sinusitis in our study. Zinreich et al found middle meatus opacification in72% of the patients with chronic sinusitis, and of these 65% had maxillarysinus mucoperiosteal sinus thickening. Yousem et al[12]found that when themiddle meatus was opacified, the maxillary and ethmoid sinuses showedinflammatory changes in 84% and 82% respectively. Another study foundfrontal or maxillary sinus disease in 84% patients who had OMCOpacification[12]. Thusthese findings support the contention that the anatomical variation in osteo-meatal complex will lead to obstruction of the narrow drainage pathways, which in turn lead to subsequent sinus inflammation.
Most of the patients in our study had the chief complaint as nasalobstruction (34%), followed by nasal discharge (21%),headache (20%) and facial pain/pressure (12%). These complaints were in correlation with other major studies.

Contrary to other major studies, the incidence of chronic rhinosinusitis was more in males (64%) than females (36%) in our study.

The most common sinus involved was maxillary sinus (26%), followed by ethmoid(13%) and frontal sinus (9%). But majority of the patients had involvement of both maxillary and ethmoid sinus (32%) and 20% had involvement of all the sinuses

CONCLUSION

Our present prospective study of anatomical variation of Osteo-meatal complex reveals many parameters. Almost all of the anatomical variations noted in this study had the prevalence rates that were comparable with the literature. DNS, CB are the two significant anatomical variations that were encountered, and both were found to have an association with maxillary sinus opacification in chronic rhinosinusitis patients. The associations between most of the anatomical changes were not significant statistically. Similar to previous reports in the literature, the asymmetry between the sides in the same patient is quite commonly seen in our

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study. Overall, considering the gross variability in the critical neurovascular and bony anatomy of paranasal sinuses, it is imperative that these variations be studied thoroughly before any interventions involving the sinuses

Visualization of paranasal sinus anatomy has improved by the use of computerized tomography of the sinuses. It helps in evaluating the exact anatomy and find out the abnormal anatomical variation which will help the surgeons to avoid intra operative complications as well as to give the best results for the patients.

Among the anatomical variations of the osteo-meatal complex in patients with chronic sinusitis not responding to medical therapy, a combination of anatomical variations is more commonly found

The most common anatomical variation leading to Osteo-meatal obstruction in our study was a deviated nasal septum, followed by concha bullosa. There was a statistically significant association between the presence of a septal deviation, concha bullosa and paradoxical turbinate with the occurrence of sinusitis. Most of the patientshad presence of more than one anatomical obstruction and maxillary sinus followed by ethmoid sinus were the most commonly involved sinuses. There was significant symptomatic improvement following the endoscopic nasal surgery along with correction of the anatomical obstruction, but many a time postoperative medical therapy also needed to help the patient relieved of symptoms.

Anatomical obstruction at the Osteo-meatal complex is one of the major etiological factors leading to the development of chronic sinusitis. Proper evaluation with computerized tomogram of paranasal sinuses along with diagnostic nasal endoscopy helps to identify the problem and aids in deciding the treatment protocol.

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