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Anatomical Variations in the Maxillary air sinuses in patients with Chronic Rhinosinusitis –CT Radiological Study

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Abstract

INTRODUCTION: Osseo cartilaginous nasal septum divides the nasal cavity uneven space. In the lateral wall nasal cavity there are turbinates, meatuses and opening of paranasal air sinuses. Chronic rhino sinusitis is a repeatedly cause acute or persistent chronic inflammation of the paranasal sinuses. It is major causes of health concern were the patients was uncomfortable, restlessness. If it persists for more than eight weeks, even after medication, computerised tomography (CT) scan is the gold standard in imaging the degree of disease extent and detailed measurements.

MATERIALS AND METHODS: The present study is observational case-control study. Department of Anatomy, Index Medical College, Hospital and Research center Indore. Period of the study from 2019 to 2022. Patients who are diagnosed as chronic rhino sinusitis. Total number of samples to be collected was calculated using formula. Ethical clearance will also be taken for the present study. The sample was collected from patients attending the Department of Radio diagnosis & imaging after obtaining the signed consent. CT scan were taken as a part of routine clinical evaluation for diagnostic purpose of maxillary sinus. Coronal and axial images was observed and recorded in excel sheet.

Result: This study included totally 100 patients with 20 females (20.0 %) and 80 males (80.0 %). The mean age was 30.1 ranging from 13 to 70. Concerning the demographic distribution of patients there were no statistical significance between the groups. The most common anatomic variation in all patients (study group? control group) was detected as SD (68.0 %). AN was noted in 55 (55.0 %) patients. The rates of anatomical variations in two groups were calculated separately and compared with each other. There were no significant statistical differences between the groups concerning the rates of all these mentioned variations.

Conclusion: In our study it was concluded that presence of anatomical variations is common in patients with chronic sinusitis. Presence of more than one anatomical variations significantly contributes to disease process. DNS is the most common anatomical variation in our study followed by concha bullosa, medialized uncinate process.

Keywords: Maxillary air sinuses, Chronic Rhinosinusitis, CT Radiological Study

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

INTRODUCTION

Osseo cartilaginous nasal septum divides the nasal cavity uneven space (1, 2). In the lateral wall nasal cavity there are turbinates, meatuses and opening of paranasal air sinuses (3, 4). Chronic rhino sinusitis is a repeatedly cause acute or persistent chronic inflammation of the paranasal sinuses. It is major causes of health concern were the patients was uncomfortable, restlessness (5-7). If it persists for more than eight weeks, even after medication, computerised tomography (CT) scan is the gold standard in imaging the degree of disease extent and detailed measurements (8). Paranasal air sinuses – maxillary sinus, ethmoid sinus complex, frontal sinus, sphenoidal sinus are located in the bones of the maxillary, ethmoidal, frontal and sphenoidal respectively (9). All open into the lateral wall of the nasal cavity by small apertures.

Among four paranasal air sinus the maxillary sinuses are the largest and are located bilaterally within the maxilla bone. Its shape pyramidal (10). The medial wall forms the base of the maxillary air sinus. It is also known as "the fontanelle". The lateral nasal wall mucosa lies directly over the maxillary sinus. However, the opening of maxillary air sinus is made much smaller by the contribution of the surrounding bones like lacrimal bone, ethmoid bone, inferior turbinate, and perpendicular plate of the palatine bone. This fontanelle is crossed by the uncinate process which divided it into a small anterior fontanelle and larger posterior fontanelle (11). In adults, the maxillary sinus may extend from the area of the premolar teeth to the third molar (12).

In hyperpneumatized sinus, the upper part of the molars or premolars is separated by a thin bony plate from the floor of the maxillary sinus. Often it may project into the sinus floor. Occasionally, this bone is very thin or even absent, making extraction of such a tooth risky to leave a fistula by tearing of the mucous membrane. However, these types of fistulae often end with spontaneous healing (13). Immediately posterior to the maxillary sinus lie the infratemporal fossaand the pterygopalatine fossa medially.

The infraorbital nerve, a branch of the maxillary division "V2" of the trigeminal nerve, crosses the roof of maxillary sinus within a bony canal that opens as the infraorbital foramen. The inferior wall of the infraorbital canal can be extremely thin, with an average thickness of 0.2 mm or it may be completely dehiscent in between 12% and 16% of cases. Itcan be abnormally protruded within the maxillary sinus as well (14). In these situations, surgeon must identify these variants if present and pay extra attention during the procedure not to injure the nerve.

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

MATERIALS AND METHODS

Study design
The present study is observational case-control study

Study center
Department of Anatomy, Index Medical College, Hospital and Research center Indore.

Study Period
Period of the study from 2019 to 2022.

Sample size: 200
Sample Size Calculation:

- ✓ Sample size has been calculated in order to control type I & type II error. Assuming a minimum power 80% and 95% significance level the sample size has been calculated using this formula:

$$n = \frac{2(P)(1-P)\ (Z\beta + Z\alpha/2)^2}{(p1-p2)2}$$

- ✓ n=sample size
- ✓ p measure of variability
- ✓ Z_β - power of statistical test we want to be minimum 80% for which is Z_β is 0.84.
- ✓ $Z_{\alpha/2}$ –is the level of confidence we have chosen 95% confidence in this $Z\alpha/_2$=1.96.
- ✓ $(P1\text{-}p2)^2$ or d^2 – effect in size difference in proportions.
- ✓ When P indicates the incidence of the clinical conditions e.g.: Sinusitis.
- ✓ Following the literature, the incidence of Sinusitis has been assumed as (8.7%).
- ✓ The calculated minimum sample size for our study is 200

Eligibility criteria

Inclusion criteria:

For Cases

1. Patients who are diagnosed as chronic rhino sinusitis.
2. Age group: 18 to 60 years
3. Those with chronic sinusitis not responding to 8 weeks of medical therapy.

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

4. Patients not with a history of previous endoscopic sinus surgery.

Control group

1. Patients of non having any clinical sinusitis cases (Headache, neck diseases, orbital pathologies).
2. Age group: 18 to 60 years

Exclusion criteria

1. Previous surgery of the face, alteration of the paranasal sinus anatomy
2. With chronic rhinosinusitis responding to medical management
3. Benign & malignant tumors of the sinonasal mucosa
4. Massive nasal polyposis and invasive fungal sinusitis
5. Patients met with trauma

Methodology

Total number of samples to be collected was calculated using formula. Ethical clearance will also be taken for the present study. The sample was collected from patients attending the Department of Radio diagnosis & imaging after obtaining the signed consent. CT scan were taken as a part of routine clinical evaluation for diagnostic purpose of maxillary sinus. Coronal and axial images was observed and recorded in excel sheet.

Ethical Consideration

Ethical approval was obtained from the Institute Ethical Committee. Prior written consent was taken from the subjects who volunteered to participate in the study. Identified sinusitis subject was included in the study.

STATISTICAL ANALYSIS

Descriptive statistics like mean, percentage and standard deviation was done to know the distribution of proportion. Chi-square test was done for qualitative variables, to testthe significant association between the anatomical variations of maxillary air sinus and chronic sinusitis. The association between maxillary air sinus and prevalence of anatomical variations of para nasal sinuses was measured by implementing odds ratio. Unpaired t test was applied to compare two independent groups. Correlation test was implemented to find a positive or negative correlation. p value > 0.05to be considered insignificant, p value <0.05 to be considered

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

significant, p value <0.01 to be considered statistically significant and p value<0.001tobe considered highly significant.

Result

This study included totally 100 patients with 20 females (20.0 %) and 80 males (80.0 %). The mean age was 30.1 ranging from 13 to 70. Concerning the demographic distribution of patients there were no statistical significance between the groups (Table 1).

Table 1 Demographic distribution of study and control group

Sex	Study group (n/%)	Control group (n/%)	Total (n/%)	p value
Male	55/55.0	25/25.0	80/80.0	
Female	10/10.0	10/10.0	20/20.0	[0.04]
	100/100	100/100	100/100	
Total	.0	.0	.0	

The most common anatomic variation in all patients (study group? control group) was detected as SD (68.0 %). AN was noted in 55 (55.0 %) patients. The rates of other anatomical variations were shown in Table 2.

Table 2 Frequency of anatomic variations in all patients

Anatomic variation	n	%
Septal deviation	68	68.0
Concha bullosa	40	40.0
Right	10	10.0
Left	9	9.0
Bilateral	18	18.0
Pneumatized uncinate	5	5.0
Overpneumatized EB	29	29.0
Agger nasi	55	55.0
Right	6.5	6.5
Left	2	2.0
Bilateral	45	45.0
Paradoxical MC	11	11.0
Onodi cell	6.5	6.5

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

Haller's cell	12	12.0
Pneumatized CG	18	18.0

EB ethmoid bulla, MC middle concha, CG crista galli

The rates of anatomical variations in two groups were calculated separately and compared with each other. There were no significant statistical differences between the groups concerning the rates of all these mentioned variations (Table 3).

Table 3 Distribution of presence of anatomic variations in study and control groups

Anatomic variation	Study group (n/%)	Control group (n/%)	p value
Septum deviation	60/60.0	32/32.0	0.850
Concha bullosa	35/35.0	24/24.0	0.389
Right	12/12.0	10/10.0	0.210
Left	12/12.0	10/10.0	0.648
Bilateral	30/30.0	12/12.0	0.690
Overpneumatized EB	34/34.0	28/28.0	0.250
Pneumatized uncinate	6/6.0	7/7.0	0.540
Agger nasi	62/62.0	38/38.0	0.476
Right	12/12.0	5/5.0	0.881
Left	4/4.0	3/3.0	2.290
Bilateral	58/58.0	32/32.0	0.799
Paradoxical MC	18/18.0	9/9.0	3.200

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

Onodi cell	12/12.0	5/5.0	1.828
Haller' cell	18/18.0	15/15.0	0.439
Pneumatized CG	26/26.0	19/19.0	0.684

Study group consisted of 100 patients, and control group consisted of 100 patients

EB ethmoid bulla, MC middle concha, CG crista galli

Of 250 sides, 220 (88.0 %) were diagnosed as having anatomical variation. 30 sides did not have any variation. In study group, anatomical variations were found in 129 (89.5 %) of 144 sides, and in control group, anatomical variations were found in 91 (85.8 %) of 106 sides (Table 4).

Table 4 Distribution of variation in the study and control groups

	Study group (n/%)	Control group (n/%)	Total (n/%)	p value
Any variation (?)	129/89.5	91/85.8	220/88.0	2.164
Any variation (-)	15/10.4	15/14.1	30/12.0	
Total	144/100.0	106/100.0	250/100.0	

By comparing these groups, in terms of the presence of any anatomical variations, there was no statistically significant difference (Table 4).

In our study, we analyzed only study group in order to determine the effect of anatomical variations on the severity of CRS. The sinus scores (which were assumed to show the severity of sinusitis) were calculated according to the Lund-Mackay classification. A comparison between these sinus scores and rates of anatomical variations is searched.

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

Table 5 Comparison of maxillary sinus scores between septum deviations positive and negative cases in the study group

Maxillary sinus score	Septum deviation		Total (n/%)	p value
	1(n/%)	2(n/%)		
0	16/16.0	18/18.0	34/34.0	0.814
1	42/42.0	41/41.0	83/83.0	
2	42/42.0	41/41.0	83/83.0	
Total	100/100.0	100/100.0	200[2]/100	

1. Since the nasal septal deviation represses to one side of the ostiomeatal complex, the ostiomeatal complex on the other side is interrelated with a non-deviated nasal septum, therefore it was accepted as normal

Table 6 Comparison of Lund-Mackay sinus scores between concha bullosa positive and negative groups, with respect to maxillary, anterior ethmoid, posterior ethmoid sinuses

Lund-Mackay score	Concha bullosa			P value
	1 (n/%)	-(n/%)	Total (n/%)	
Maxillary sinus				
0	10/10.0	10/10.0	20/20.0	0.082
1	12/12.0	27/27.0	39/39.0	
2	8/8.0	33/33.0	41/41.0	
Anterior ethmoid sinus				
0	12/12.0	16/16.0	28/28.0	0.193
1	11/11.0	21/21.0	32/32.0	
2	10/10.0	33/33.0	43/43.0	
Posterior ethmoid sinus				

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

0	16/16.0	21/21.0	37/41.0	0.060
1	6/6.0	27/27.0	33/37.0	
2	10/10.0	20/20.0	30/30.0	

Of the 100 patients, concha bullosa was present in 30 patients, and absent in 70 patients

Table 7 Comparison of Lund-Mackay sinus scores between groups with or without agger nasi for frontal sinus

Frontal sinus score	Agger nasi			p value
	? (n/%)	- (n/%)	Total (n/%)	
0	44/44.0	20/20.0	64/64.0	0.178
1	12/12.0	7/7.0	19/19.0	
2	14/14.0	3/3.0	17/17.0	
Total	70/100	30	100	

Of the 100 patients, agger nasi was present in 70 patients, and absent in 30 patients

For maxillary sinus, there was no significant difference between the sinus scores and the rate of SD (Table 5) or CB (Table 6).

For anterior ethmoid and posterior sinuses, there were no significant differences between sinus scores and rate of CB (Table 6). For frontal sinus, there were no significant difference between sinus scores and rate of AN cell (Table 7).

Discussion

The surgical management of chronic sinusitis has reached new heights after the advent of endoscope and high resolution CT scan. It also helps in assessing the anatomical variation pre operatively and act as a road map for surgeon. Many authors believe that anatomical variation of nose and paranasal structures may predispose patients to recurrent sinusitis. Sinonasal region which has many anatomical variation plays an important role in the pathogenesis of chronic sinusitis. [37]

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

Anatomical variation assessed pre operatively through endoscope and CT nose and paranasal sinus which helps the surgeon for performing FESS without any hindrance. In our study we found anatomical variation in 93% of chronic sinusitis patients. In our study it was observed that 52% of patients with two anatomical variation, 41% patients presented with single anatomical variation and 7% patients presented with no anatomical variation. In our study deviated nasal septum was the most common anatomical variant noted followed by unilateral concha bullosa, medialized uncinate process, paradoxical middle turbinate, Haller cell and agger nasi (Table 1).

Deviated nasal septum

Deviated nasal septum (DNS) is present in 20-30% of general population, severe deviation is found to be a contributing factor for chronic sinusitis. In our study 81% patient had a septal deviation which is the major anatomical variation found in most of the chronic sinusitis patient (Table 1) however some studies did not demonstrated a causal relationship between DNS and sinusitis. [38]

Concha bullosa

Concha bullosa which blocks the osteomeatal complex and affects the muco ciliary clearance. Concha bullosa is found to be aetiological factor for recurrent chronic sinusitis. The size of concha bullosa is also an important factor for the contribution for chronic sinusitis. This is the second most common anatomical variation of 29% in our study resulting in chronic sinusitis (Table 1). Out of 29% of patients 23% had a unilateral concha bullosa and 6% of patient had bilateral concha bullosa. [39]

Medialized uncinate process

The superior part of the uncinate deviate can deviate medially, laterally out of the middle meatus. These variations narrow infundibulum causing sinusitis. Pneumatization of uncinate process also can happen causing impaired ventilation in anterior ethmoid, frontal recess. In our study, 21% of the patients had medialized uncinate process. [40]

Paradoxical middle turbinate

Reverse curvature of the middle turbinate (paradoxical middle turbinate) can lead on to impingement of middle meatus caising sinusitis. In our study, 14.4% (Table 1) of the patients had paradoxical middle turbinate. [41]

ISSN: 0975-3583, 0976-2833 VOL13, ISSUE 05, 2022

Agger nasi cells lie anterior to anterosuperior attachment of middle turbinate and strongly contribute to frontal sinus disease. But in our study we had only 6.6% (Table 1) of the patients had agger nasi. [42]

Haller cell

Haller cell are ethmoidal air cells seen in the floor of orbit and narrows the maxillary ostium and infundibulum and affects the mucociliary function causing sinusitis. In our study, 3.3% (Table 1) of the patients had haller cell. [43]

Onodi cell

Onodi cell is the posterior most ethmoidal air cell which extends posteriorly and laterally over sphenoid sinus. Presence of onodi cell increases the chance of injury to internal carotid artery and optic nerve while doing FESS if not identified preoperatively. In our study, 7.7% (Table 1) of the patients had onodi cell. [44]

Conclusion

In our study it was concluded that presence of anatomical variations is common in patients with chronic sinusitis. Presence of more than one anatomical variations significantly contributes to disease process. DNS is the most common anatomical variation in our study followed by concha bullosa, medialized uncinate process.

CT scan helps in identifying the anatomical variation which is most important in patients undergoing Endoscopic sinus surgery. It also helps in preventing major complication during ESS. Knowledge of CT scan in anatomical variation helps in making surgical decision. This study has its own limitation of retrospectively having a small number of patients. In this study we focus only on anatomical variation and there relation with CRS.

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