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The study on Anatomical Variations in the Maxillary air sinuses in patients with Chronic Rhinosinusitis

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Abstract

INTRODUCTION: Rhinosinusitis (CRS) is chronic inflammation of nose and paranasal sinuses. Its pathophysiology is poorly described and seems to be multifactorial. With the arrival of Functional Endoscopic Sinus Surgery, the approach to the patient with CRS has been changed. Certain anatomical variations of lateral wall of nose are important as they contribute in blockage of osteomeatal complex, ventilation and drainage of paranasal sinuses. Preoperative evaluation of these variants is also important being a part of surgical safety.

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. The most common anatomic variation in all patients (study group and control group) was detected as SD (68.0 %). AN was noted in 55 (55.0 %) patients. In the present study, maximum number of patients i.e. 48(48.00%) had Lund & Mackay CT-scoring between 1 to 5. This was followed by 28(28.00%) patients who had CT-score between 6 to 10. 11 patients (11.00%) had score between 11 to 15, 8 patients (8.00%) had score between 16 to 20 and rest of 5 patients (5.0%) had score between 21 to The mean Lund & Mackay CT score in the study was 8.67.

Conclusion: 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.

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

INTRODUCTION

Rhinosinusitis (CRS) is chronic inflammation of nose and paranasal sinuses. Its pathophysiology is poorly described and seems to be multifactorial. With the arrival of Functional Endoscopic Sinus Surgery, the approach to the patient with CRS has been changed. Certain anatomical variations of lateral wall of nose are important as they contribute in blockage of osteomeatal complex, ventilation and drainage of paranasal sinuses. Preoperative evaluation of these variants is also important being a part of surgical safety.

Anterior rhinos copy reveals little information with regard to middle meatus. Diagnostic Nasal Endoscopy and Computed tomography play a vital role in accurate assessment of osteomeatal complex and anatomical variations at this area. CT scan has the ability to delineate mucosal disease of sinuses, to detect primary obstructive pathology and to image the distal structures like posterior ethmoid and sphenoid sinuses, which cannot be visualized by endoscopy. Nasal Endoscopy has the ability to detect small localized disease in the nasal cavity, which can be missed even by Computed Tomography.

Several studies have been carried out to find out the relationship between anatomical variations and chronic rhinosinusitis on CT scan. But very few studies have been found reported comparing Diagnostic Nasal Endoscopy and CT scan in diagnosing anatomical variations of nose and paranasal sinuses in chronic rhinosinusitis.

The most common disease encountered of paranasal air sinus is sinusitis. It may show acute or chronic presentation, do not require diagnostic imaging; but when the symptoms are recurrent or refractory, research with imaging is needed for a better diagnosis (21). In acute sinusitis the fluid level increases whereas in chronic sinusitis there is thickening of sinus wall of the maxillary air sinus (22). The odontogenic maxillary sinusitis differs from rhinogenic for its pathophysiology, microbiology, and treatment. The odontogenic maxillary sinusitis is 10% to 40% of all maxillary sinusitis, and its incidence may be increasing (23).

Mucosal cysts are a common incidental finding on imaging studies, with an incidence between 12.4% and 35.6% (24). They are typically spherical opacities on CT scanning, and are not associated with symptoms of chronic rhinosinusitis (17). Mucocele are pseudocysts expansive formations of the paranasal sinuses, whose wall consists of a modified sinus mucosa and the presence of cystic aseptic liquid inside, generally thick and viscous, and may be infected and became a mucopyocele (25). The accumulation of fluid increases intrasinusal pressure, resulting in expansion and bone destruction. Nasal polyps develop from the thickening of chronically inflamed mucosa, causing irregular mucosal folds. The polyposis can develop singly or in multiple forms within the maxillary sinus (18).

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.
- ✓ $(P1-p2)^2$ 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.
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 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]
Total	100/100 .0	100/100 .0	100/100 .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 1.

Table-2: Pattern of sinus involvement in CRS based on CT scan

Pattern of sinus involvement	**No. of patients (n=100)**	**%**
Maxillary alone (M)	40	40.0 %
Maxillary + frontal (M+F)	24	24.0 %
Maxillary + Ethmoids (M + E)	15	15.0 %
Pansinusitis	10	10.0 %
Ethmoids alone (E)	4	4.0 %
Maxillary + Ethmoids + Frontal (M + E + F)	3	3.0 %
Maxillary + sphenoid (M + S)	2	2.0 %
Ethmoid + frontal + sphenoid (E + F + S)	1	1.0 %
Ethmoid + sphenoid (E + S)	1	1.0 %
n= number of patients, M-maxillary, F E-ethmoid, S-sphenoid.		

Lund and Mackay CT-Scoring

In the present study, maximum number of patients i.e. 48(48.00%) had Lund & Mackay CT-scoring between 1 to 5. This was followed by 28(28.00%) patients who had CT-score between 6 to 10. 11 patients (11.00%) had score between 11 to 15, 8 patients (8.00%) had score between 16 to 20 and rest of 5 patients (5.0%) had score between 21 to The mean Lund & Mackay CT score in the study was 8.67 (Table 2).

Table-3: Distribution of patients according Lund and Mackay CT-Scoring

L & M Scoring	No. of patients (percentage)
1 to 5	48(48.00%)
6 to 10	28(28.00%)
11 to 15	11(11.00%)
16 to 20	8(8.00%)
21 to 25	5(5.00%)
Total	100
Mean L & M score	8.67
L & M scoring- Lund and Mackay scoring	

Anatomical variations in CRS seen in CT Paranasal Sinus (n=100)

In this study, most common anatomical variation was deviated nasal septum (DNS) which was seen in 70(70.0 %) patients. On Cottle's grading for DNS, 22(31.4 %) had Cottle's grade I deviation i.e. only mild deviation with no obstruction, 38(54.2%) had grade II deviation i.e. septum was touching the lateral nasal wall but after vasoconstriction there was a gap between the two. There were 4(5.7%) subjects who had grade III deviation i.e. septum was impacted over the lateral nasal wall. There were 6 (8.5%) patients who had S-shaped DNS.

The second most common anatomical variation was concha bullosa which was seen in 28 (29.7%) patients. The unilateral concha bullosa seen in 17 (60.7 %), and bilateral concha bullosa seen in 11 (39.2 %) patients.

The agger nasi cells seen in 12(12.0 %), paradoxical middle turbinate in 5(5.0 %), pneumatised vomer in 4(4.0 %), onodi cells in 4(4.0%), Enlarged ethmoidal bulla in 2(2.0%), Haller cells in 2(2.0%), septate maxillary sinus in 1(1.0 %).

Depth of Olfactory fossa was also calculated according to Kero's classification (Keros P, 1962) after CTscan. It was found that 41(41.0%) patients had depth in range of 1-3mm i.e Grade I, 52 (52.0%) had depth from 4-7mm i.e. Grade II and 7 (7.0%) patients had depth ≥ 8mm i.e. Grade III. (Table IIIa and IIIb).

Table 4: Anatomical variations in CRS seen in CT Paranasal Sinus (n=100)

Anatomical variations	No. of subjects	Percentage (%)
1.DNS	70	70.00 %
	Grade I – 22	31.4 %

	Grade II – 38 Grade III – 4 S-shaped DNS -6	54.2 % 5.7 % 8.5 %
2.concha bullosa	30	30.00 %
	Unilateral – 18 Bilateral – 12	60.0% 40.0 %
3.Agger nasi cells	12	12.00 %
4.Paradoxical middle turbinate (PMT)	5	5.00 %
5.Pneumatised vomer	4	4.00 %
6.Onodi cells	4	4.00 %
7.Enlarged ethmoidal bulla	2	2.00 %
8.Haller cells	2	2.00 %
9.Septate maxillary sinus	1	1.00 %

Table-5: Distribution of patients according to Olfactory fossa depth in mm seen in CT Paranasal Sinus (n=100)

Olfactory Fossa depth (mm)	**No of patients (n=100)**	**Percentage (%)**
Grade I (1-3mm)	41	41.0 %
Grade II (4-7 mm)	52	52.0 %
Grade III (8 mm & more)	7	7.0 %
Total	100	100 %
mm-millimeter		

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]

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]

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

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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