

A Cross-Sectional Study to Assess Normal Anatomical Variations in Paranasal Sinuses Using CT: Our Experience from Jaipur, India.

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Abstract

A precise knowledge of the anatomy of the paranasal sinuses is essential for the clinician. With the advent of functional endoscopic sinus surgery (FESS) and coronal computed tomography (CT) imaging, considerable attention has been directed toward paranasal region anatomy. Conventional radiology does not permit a detailed study of the nasal cavity and paranasal sinuses, and has now largely been replaced by computerized tomographic (CT) imaging.

Objectives: To study normal anatomical variations in paranasal sinuses using CT.

Methodology: The present cross-sectional observational study was carried out in Department of Radiodiagnosis at Department of Radio-diagnosis, NIMS Medical College & Hospital, NIMS University, Jaipur during December 2013 to February 2014. **Results:** Mean age of study population was observed to be 44.2 ± 11.9 years. Majority of them were males i.e. 42 (66.7%) and females were 21 (33.3%). CT evaluation of study subjects revealed total 211 anatomical variations in our study. In 21 patients it was single and in remaining 42 patients, it was multiple variations reported. Out of 21 unilateral sinuses, commonly involved sinus is frontal in 11(52.4%) patients, followed by maxillary in 6(28.6%), anterior ethmoidal in 2(9.5%) and 1 i.e. 4.8% each in posterior ethmoidal and sphenoid sinuses. **Conclusion:** Among the anatomical variations of the osteomeatal complex in patients with chronic sinusitis not responding to medical therapy, a combination of anatomical variations is more commonly found. Of the anatomical variations in patients with chronic sinusitis, nasal septal deviation is the commonest abnormality noted.

Key words: *normal anatomical variations, paranasal sinuses, CT*

Introduction

The anatomical variations of lateral nasal wall and Para nasal sinuses are surgically and patho-physiologically important because they narrow the drainage pathway of the para nasal sinuses, which in turn lead on to stagnation of secretions, then infection and inflammation of the mucosa lining the sinuses.¹ Diseases in extensively pneumatized sinuses lead on to exposure of important structures like Optic nerve and Internal Carotid artery, to infection and inflammation, and also increases risk during surgical procedure. Hence, Endoscopic evaluation and CT Scan evaluation of nose and Para nasal sinuses is mandatory in chronic sinusitis patients, to evaluate the detailed anatomy (normal anatomy, anatomical variation and the extent of the disease process) that are commonly encountered in the osteomeatal complex and lateral nasal wall per se. This will help the endoscopic surgeon in pre-operative assessment and planning of the surgery, in complete eradication of the disease and to reduce the intra operative and post-operative complications.²

Computer Tomography scan is a mandatory radiological investigation for patients undergoing FESS. CT scan helps identify these anatomic variations. Many centers use the three-millimeter cuts for all views – coronal, sagittal and axial to assess the different anatomical structures of the lateral nasal wall and the paranasal sinuses. The coronal views are best for the sphenoid and the ethmoid cell variants such as the onodi or sphenothmoidal cell.³

A precise knowledge of the anatomy of the paranasal sinuses is essential for the clinician. With the advent of functional endoscopic sinus surgery (FESS) and coronal computed tomography (CT) imaging, considerable attention has been directed toward paranasal region anatomy. Conventional radiology does not permit a detailed study of the nasal cavity and paranasal sinuses, and has now largely been replaced by computerized tomographic (CT) imaging. Currently, CT scanning is the standard imaging in the evaluation of the paranasal sinuses.⁴ This gives an applied anatomical view of the region and of the anatomical variants that are very often found. The development and refinement of CT scans has allowed extensive assessment of patients' paranasal sinuses thus providing a guide map for FESS surgeons to operate.⁵

Hence the present study was undertaken to know the normal anatomical variations in paranasal sinuses using CT in a tertiary care centre.

Objectives: To study normal anatomical variations in paranasal sinuses using CT.

Materials and Methods

Study design: Cross sectional observational study

Study setting: Department of Radiodiagnosis at Department of Radio-diagnosis, NIMS Medical College & Hospital, NIMS University, Jaipur during December 2013 to February 2014

Study duration: December 2013 to February 2014

Inclusion criteria:

1. Patients complain pertaining to PNS and referred from the ENT OPD and wards.
2. Those who are willing to participate in study after written consent

Exclusion criteria:

1. Sinonasal anatomy alteration or obscuration due to inflammatory diseases (When bony detail was obscured by polypoid mucosal disease).
2. Previous sinonasal surgery (excluding naso antral window antrostomy).
3. Facial trauma.
4. Paranasal sinus neoplasm.
5. Pregnancy.
6. Paediatric age group

In all cases, systematic studies of the nasal sinus region were performed in coronal complemented by axial views in selected cases.

Analysis of anatomical variants was performed both using a soft parts window and a bone density window. In all cases, the existence of the following variants was investigated: (1) nasal septum: septal deviation, septal bony spur; (2) turbinates: superior concha bullosa, middle concha bullosa, paradoxical (false) middle concha, hypoplasia, and secondary middle concha; (3) uncinat process: deviation of the upper edge, pneumatization; (4) ethmoid air

cells: agger nasi cells, Haller's cells, great ethmoid bulla, Onodi cells (extramural sphenoid cells); (5) other variants: hypoplasia of the maxillary sinus, maxillary septa, hypoplastic frontal sinus and asymmetry of both cavities of the sphenoid sinus. Associated anatomy of the paranasal regions such as the course of optic nerve, asymmetry of ethmoidal roof and incidence of aerated Crista Galli were also investigated.

The images was reviewed in both bone and soft tissue algorithms for the following variations

1. Septum deviation.
2. Agger nasi pneumatized
3. Bulla ethmoidalis
4. Uncinate process
5. Middle turbinate pneumatization
6. Maxillary sinus septations
7. Pneumitized superior turbinate
8. Haller cells
9. Onodi cells
10. Frontal sinus
11. Cribriform plate
12. Extramural sphenoid pneumatization

Statistical analysis and methods:

Data was collected by using a structure proforma. Data entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA. Qualitative data was expressed in terms of percentages and proportions. Association between two qualitative variables was found out by using Chi square/ Fischer's exact test. A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

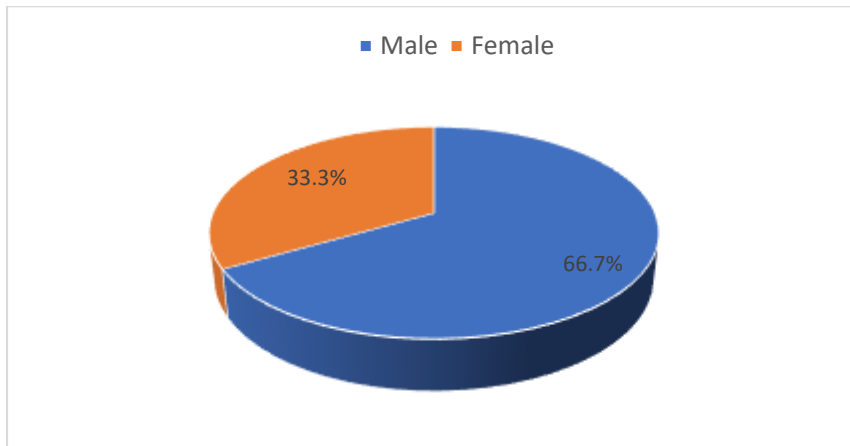
Results**Table 1: Distribution according to age**

		Frequency	Percent
Age group in years	20-30	15	23.8
	31-40	19	30.2
	41-50	8	12.7
	51-60	11	17.5
	> 60	10	15.9
	Total	63	100.0

Total 63 patients included in our study having complains pertaining to PNS, majority of them were from 31-40 years i.e. 19 (30.2%). This is followed by 15 (23.8%) from 20-30 years age, 11(17.5%) from 51-60 years, 10 i.e. 15.9% from above 60 years age group. Mean age of study population was observed to be 44.2±11.9 years.

Figure 2: Distribution according to gender

Majority of them were males i.e. 42 (66.7%) and females were 21 (33.3%)

**Table 2: Distribution according to CT detected anatomical variation**

		Frequency	Percent
Anatomical variation	Deviated nasal septum	53	84.1
	Concha bullosa	32	50.8
	Prominent bulla ethmoidalis	29	46.0
	Paradoxical middle turbinate	5	7.9
	Medialised uncinate process	9	14.3
	Pneumatised uncinate process	11	17.5
	Agger nasai cell	37	58.7
	Frontal cell	6	9.5
	Intumescencia septi nasi anterior	17	27.0
	Onodi cell	7	11.1
	Haller cell	2	3.2
	Pneumatisation of septum	3	4.8

CT evaluation of study subjects revealed total 211 anatomical variations in our study. In 21 patients it was single and in remaining 42 patients, it was multiple variations reported. In our study, most commonly observed CT findings was-deviated nasal septum in 53 patients i.e.84.1%. It is followed by agger nasai cell in 37 i.e. 58.7%, concha bullosa in 32 i.e. 50.8%, prominent bulla ethmoidalis in 29 i.e. 46%, intumescencia septi nasi anterior in 17 i.e. 27%, pneumatised uncinate process in 11 i.e 17.5%, medialised uncinate process in 9 (14.3%) onodi cells in 7 i.e. 11.1%, frontal cells in 6 (9.5%), haller cells in 2(3.2%).

Table 3: CT scan detected sinuses involved

		Unilateral (21)		Bilateral (42)		Total
		Frequency	Percent	Frequency	Percent	
Sinuses involved	Frontal	11	52.4	13	31.0	24
	Maxillary	6	28.6	9	21.4	15
	Anterior ethmoidal	2	9.5	7	16.7	9
	Posterior ethmoidal	1	4.8	8	19.0	9
	Sphenoid	1	4.8	5	11.9	6

Out of 21 unilateral sinuses, commonly involved sinus is frontal in 11(52.4%) patients, followed by maxillary in 6(28.6%), anterior ethmoidal in 2(9.5%) and 1 i.e. 4.8% each in posterior ethmoidal and sphenoid sinuses.

Discussion

In the present study curved uncinate was found in 5 patients unilaterally (8%) and 4 patients bilaterally (6.3%), a total of 14.3%. It is slightly higher than that of 2.5% reported by Bolger et al.⁶ A markedly medially bent or pneumatized uncinate process with a corresponding area of extensive contact with the middle turbinate can cause sinusitis. Combination of some anatomic variations such as uncinate bulla and Haller's cell may increase pathogenic effect compared to the effect of single variant.

We encountered uncinate bulla in 3 (4.8%) patients, 2 unilateral and 1 bilateral. This is consistence with 5% reported by Mecit et al⁶ and more compared to Zinreich S. et al⁷ (0.4%) and Bolger et al⁷ (2.5%).

Haller's cells are ethmoid air cells that project beyond the limits of the ethmoid labyrinth into the maxillary sinus. They are considered as ethmoid cells that grow into the floor of orbit and may narrow the adjacent ostium. The incidence of Haller's cells in our study was 2 (3.2%) – 1 unilateral and 1 bilateral. Kenedy and Zinreich et al⁷ reported incidence of 10% which is more than our incidence. It is also more than that reported by Bolger et al⁶ (45.9%) and Asruddin et al⁸ (28%).

Agger nasi cells lie just anterior to the anterosuperior attachment of the middle turbinate and frontal recess. These can invade the lacrimal bone or the ascending process of maxilla. These cells were present in 37 patients (58.7%) in our study. The incidence is less as compared to 98.5% by Bolger et al⁶. It is more than observed by by Dua K et al⁹ (40%).

In anatomic dissections, Messerklinger encountered the Agger nasi cells in 10-15% of the specimens, Davis in 65% of specimens and Mosher in 40% of specimens.¹⁰

Out of 21 unilateral sinuses, commonly involved sinus is frontal in 11(52.4%) patients, followed by maxillary in 6(28.6%), anterior ethmoidal in 2(9.5%) and 1 i.e. 4.8% each in posterior ethmoidal and sphenoid sinuses.

The extent of involvement reported by other authors was also in the same range. Zinreich S. et al⁷ published maxillary sinus involvement in 65%, posterior ethmoids in 40%, frontal in 34%

and sphenoid sinus involvement in 29%. Bolger et al⁶⁰ reported maxillary sinus involvement in 77.7%, posterior ethmoids in 38.6%, frontal sinus in 36.6% and sphenoid sinus in 25.4%.

Conclusion:

- Computed Tomography of the paranasal sinus has improved the visualization of paranasal sinus anatomy and has allowed greater accuracy in evaluating paranasal sinus disease. It evaluates the osteomeatal complex anatomy which is not possible with plain radiographs. Improvement in FESS and CT technology has concurrently increased interest in the paranasal region anatomy and its variations. Anatomical variations studied of PNS were found along with sinusitis. The radiologist must pay close attention to anatomical variants in the preoperative evaluation. It is important for surgeon to be aware of variations that may predispose patients to increased risk of intraoperative complications and help avoid possible complications and improve success of management strategies.
- Among the anatomical variations of the osteomeatal complex in patients with chronic sinusitis not responding to medical therapy, a combination of anatomical variations is more commonly found. Of the anatomical variations in patients with chronic sinusitis, nasal septal deviation is the commonest abnormality noted.
- According to the results, nasal septal deviation was the most common anatomic variation and the Haller cell and pneumatized septum are the rarest ones noted in our study. Also, there was a strong correlation between the unilateral Concha bullosa and contra lateral septal deviation, which was evident based on the studies.

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Conflict of interest: Nil

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