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Original Article

Role of Computed Tomography in Evaluation of Congenital Anatomical Variations in Paranasal Sinuses

Mohammed Atik Ahmed*, **Suresh Kanmadi**

[a]*Assistant Professor, Radiodiagnosis, Al-Ameen Medical College, Bijapur*
[b]*Post Graduate Student, Radiodiagnosis, Al-Ameen Medical College, Bijapur*

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ABSTRACT

Objective: To study the diagnostic accuracy and efficacy of CT scan in evaluation congenital anatomical variations of paranasal sinuses and to compare congenital anatomical variations of paranasal sinuses in male and female. Material and Methods: Over a period of 18months, 80 patients referred for CT scan of PNS region were evaluated for the presence of normal variants of the paranasal region on GE single slice spiral CT machine Results: 80 patients who fulfilled inclusion criteria were studied, out of which 48 were male and 32 were female, majority patients were in the age group of 11-20yrs [32 (40%)] Deviated nasal septum was the most common variation in 72(90%) followed by concha bullosa in 31 (38.75%) patients. Other variations found were curved uncinate process in 16 (20%), hypoplastic frontal sinus in 14 (17.5%), overpneumatized ethmoidal bulla or giant bulla 13 (16.25%), Paradoxical middle turbinate in 12 (15%), prominent Agger Nasi cells in 11 (13.75%), superior concha bullosa in 07 (8.75%), ariated cristagali in 07(8.75%), haller cells in 05 (6.25%), onodi cells in 03 (3.75%), and pneumatization of uncinate process in 03 (3.75%) patients. 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.

Introduction

Sinonasal inflammatory disease is a frequently encountered health problem. Traditionally, plain films were the modality of choice in evaluation of sinus pathology. Clinical and radiographic emphasis was directed primarily to the maxillary and frontal sinuses. In recent years, it has become evident that sinusitis is primarily a clinical diagnosis. The role of imaging is to document the extent of disease, to answer questions regarding ambiguous cases, and to provide an accurate display of the anatomy of the sinonasal system.

A precise knowledge of the normal anatomy of the paranasal sinuses is essential for the clinician and to understand the variation in the disease processes. 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.

* Corresponding Author : **Mohammed Atik Ahmed**

Assistant Professor , Dept. of Radiodiagnosis
Al-Ameen Medical College
Athani Road- Bijapur
Karnataka-India 586108
e-mail: dratik98@gmail.com

This gives an applied anatomical view of the region and of the anatomical variants that are very often found.

Anatomical variations studied on CT scan are found to block the osteomeatal complex (OMC) and cause chronic sinusitis. The detection of these variants to prevent potential hazards is essential for the use of current endoscopic surgery on the sinuses.

AIMS AND OBJECTIVES

1. To study the congenital anatomical variations of paranasal sinuses by CT scan.

2. Comparative and analytical study of congenital anatomical variations of paranasal sinuses in male and female.

MATERIALS AND METHODS

We included all patients who were referred for CT scan of PNS during a period of 18 months from June 2011through Dec.2012. Unenhanced CT scan of the PNS was performed for 80 patients in the coronal plane "GE single slice spiral CT machine".

EXAMINATION PROTOCOL

For direct coronal scanning, the patient is placed prone on the scanner table, with the chin hyperextended. The scanner gantry is angled perpendicular to the hard palate. The angulation of the scan plane is very important. Variations in scan angulation greater than 100 from the plane perpendicular to the hard palate result in significant loss of anatomic detail of the structures of the OMU. Scanning is performed as contiguous 3-mm-thick images from the anterior wall of the frontal sinus through the posterior wall of the sphenoid sinus. Contiguous 35 scans are essential to avoid loss of information through “skipped” areas. The exposure settings used are 125 kVp and 80 to 160 mAs.

Pregnant women and patients with history of RTA, sinonasal malignancy or past h/o surgery in the paranasal region were not included in this study.

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 40

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) uncinate process: deviation of the upper edge, pneumatisation; (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 , asymmetry of ethmoidal roof and incidence of aerated Crista Galli were also investigated.

Statistical data analysis was done by following methods: Chi-square test and student's t-test was used for data analysis

RESULTS

During the period of 18 months of the study 80 patients who fulfilled inclusion criteria were studied, out of which 48 were male and 32 were female (Table-1). Of the 80 cases studied, majority patients were in the age group of 11-20yrs [32 (40%)] (Table-2)

CT scan detection of anatomic variations (TABLE–3): Deviated nasal septum was the most common variation in 72(90%) followed by concha bullosa in 31 (38.75%) patients. Other variations found were curved uncinate process in 16 (20%), hypoplastic frontal sinus in 14 (17.5%), overpneumatized ethmoidal bulla or giant bulla 13 (16.25%), Paradoxical middle turbinate in 12 (15%), prominent Agger Nasi cells in 11 (13.75%), superior concha bullosa in 07 (8.75%), ariated cristagali in 07(8.75%), haller cells in 05 (6.25%), onodi cells in 03 (3.75%), and pneumatization of uncinate process in 03 (3.75%) patients. Chi-square value for anatomyic variant is 21.4 and p-value for this is less than 0.05 indicating highly association

DNS was categorized into various types in which type I was seen in 33(45.83%), type II in 10(13.89%), type III in 11(15.28%), type IV in 02 (2.78%), type V in 12 (16.66%), type VI in 02(2.78%) and type VII in 02 (2.78%) patients (Table-4).

GENDER	NO. OF CASES	% OF CASES
MALE	48	60%
FEMALE	32	40%

TABLE-2: AGE-WISE FREQUENCY

AGE GROUP	NO OF PATIENTS	PERCENTAGE
01-10	06	7.5
11-20	32	40
21-30	25	31.25
31-40	12	15
41-50	01	1.25
51-60	04	5
TOTAL	80	100

MEAN	STANDARD DEVIATION	RANGE IN YEARS
20.5	13.2	08-58

TABLE-3: ANATOMICAL VARIANTS

Anatomical Variant	Male	Female	Total
Deviated Nasal Septum	45	27	72
Concha Bullosa	14	17	31
Superior Concha Bullosa	3	4	7
Paradoxical Middle Turbinate	7	5	12
Curved Uncinate Process	11	5	16
Pneumatization of Uncinate Process	2	1	3
Overpneumatized Ethmoidal Bulla	4	9	13
Haller Cells	1	4	5
Onadi Cells	2	1	3
Prominent Agger Nasi Cells	6	5	11
Hypoplastic Frontal Sinus	9	5	14
Ariated Cristagali	3	4	7

TABLE-4: TYPES OF DNS

TYPES	NO. OF CASES	PERCENTAGE
I	33	45.83
II	10	13.89
III	11	15.28
IV	02	2.78
V	12	16.66
VI	02	2.78
VII	02	2.78
TOTAL	**72**	**100**

TABLE-5: ANATOMICAL VARIANTS (UNILATERAL AND BILATE RAL)

Anatomic Variation	Unilateral		Bilateral		Total	
	No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage
Concha Bullosa	20	25	11	13.75	31	38.75
Superior Concha Bullosa	03	3.75	04	5	07	8.75
Paradoxical Middle Turbinate	10	12.5	02	2.5	12	15
Curved Uncinate Process	09	11.25	07	8.75	16	20
Uncinate Process Pneumatization	02	2.5	01	1.25	03	3.75
Over Pneumatized Ethmoidal Bulla	07	8.75	06	7.5	13	16.25
Haller cells	04	5	01	1.25	05	6.25
Odoni cells	03	3.75	00	00	03	3.75
Prominent Agger Nasi cells	10	12.5	01	1.25	11	13.75
Hypoplastic Frontal sinus	06	7.5	08	10	14	17.5

FIGURES & LEGENDS

FIGURE- 1. CT scan PNS. Topogram and planning

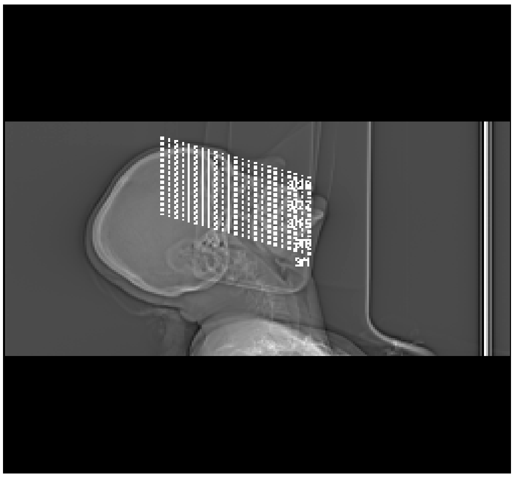


FIGURE- 2. CT scan PNS coronal section showing bilateral middle concha bullosa- right larger than left.

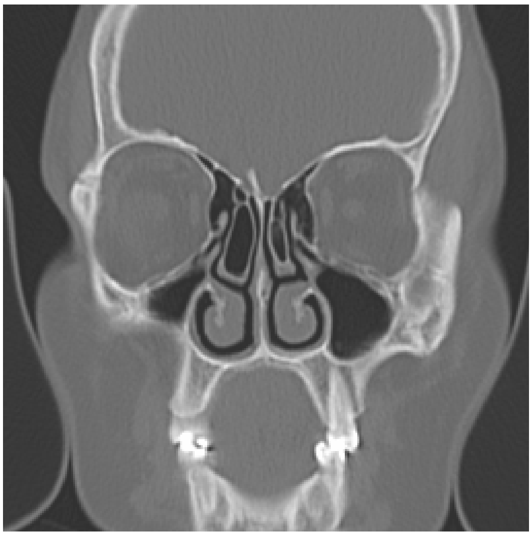


FIGURE- 3. CT scan PNS axial section showing mucocele of middle concha bullosa (arrow).

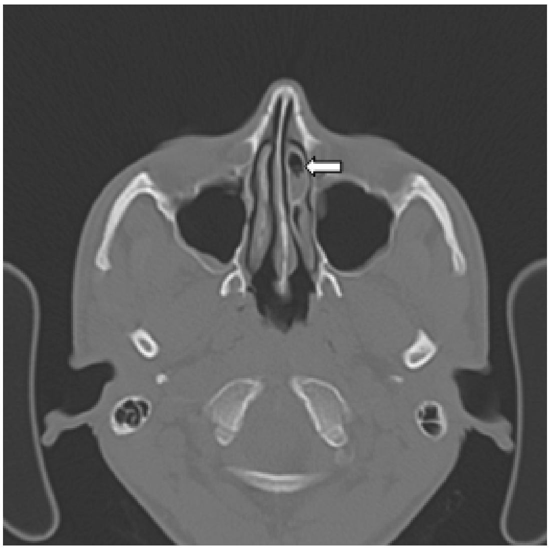


FIGURE- 4. CT scan PNS coronal section showing concha bullosa on the right side (curved arrow) and DNS to the left side (arrow).

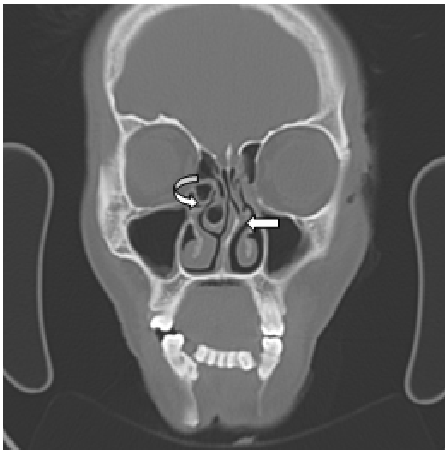


FIGURE-5. CT scan PNS coronal section. Bilateral concha bullosa (white arrow). Overexpansion of the ethmoid sinus on right side (Horizontal white arrow). Right Haller cells (curved arrow). Floors bulge downward, compressing the middle turbinate and compromising the semilunar hiatus.

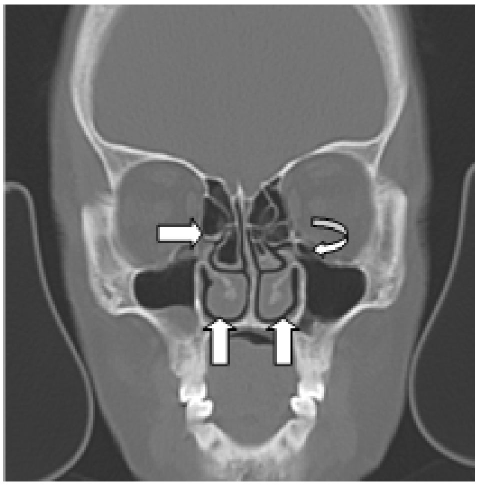


FIGURE- 6. CT scan PNS coronal section showing bilateral superior concha bullosa (arrows).

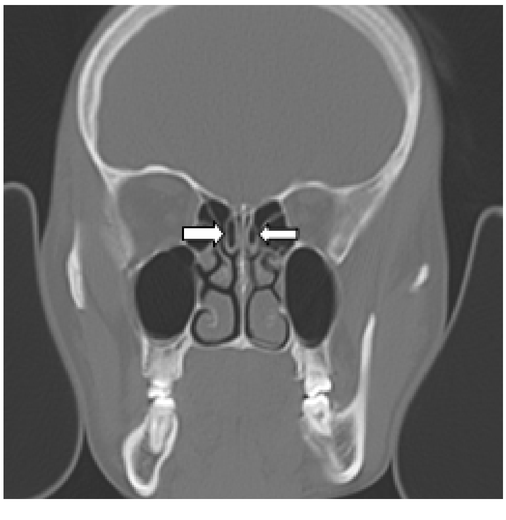


FIGURE- 7. CT scan PNS coronal section paradoxical curvature of middle turbinate on the left side (arrow) and DNS to the right side (curved arrow).

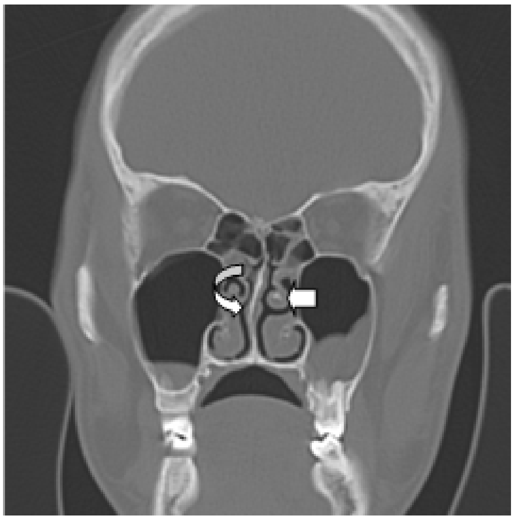


FIGURE- 8. CT scan PNS coronal section showing paradoxical curvature of right middle turbinate (curved arrow) and accessory middle turbinate on the left side (straight arrow).

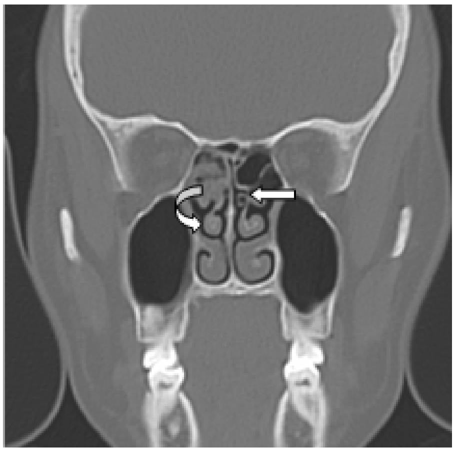


FIGURE- 9. CT scan PNS coronal section showing pneumatized uncinate process on the left side (arrow).

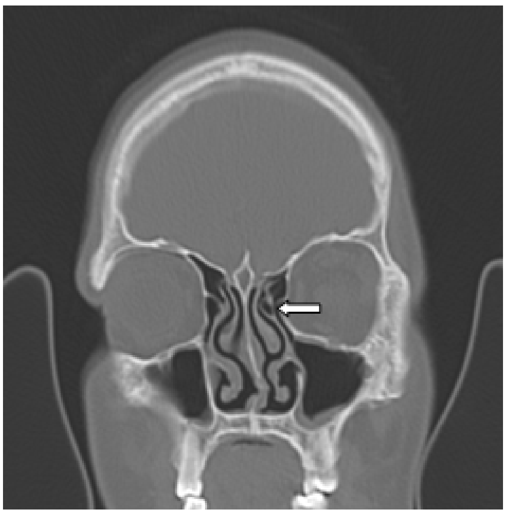


FIGURE- 10. CT scan PNS coronal section showing prominent Agger Nasi cells on the left side (arrow).

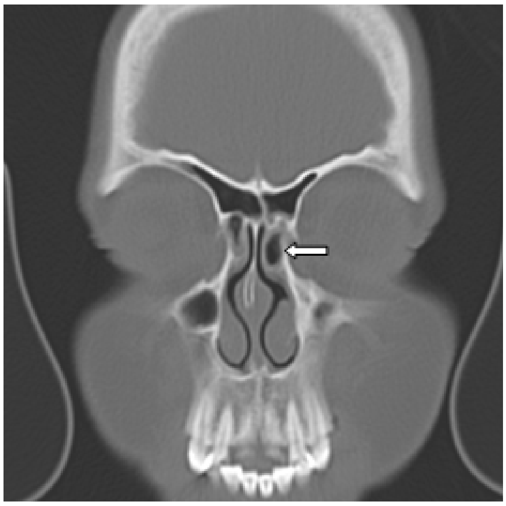


FIGURE- 11: CT scan PNS coronal section showing large Haller's cell on the left side (arrow).

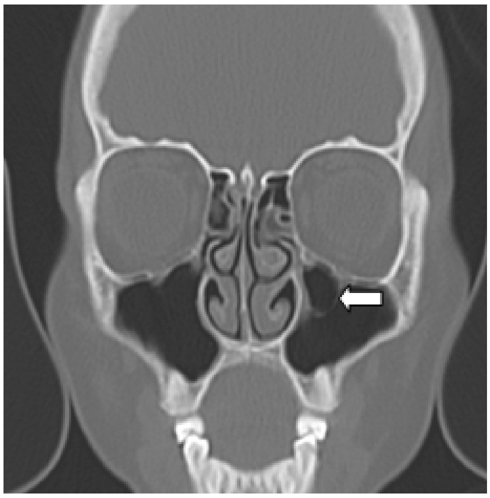


FIGURE- 12: CT scan PNS coronal section showing pneumatization of lesser wing of sphenoid bone on left side (arrow).

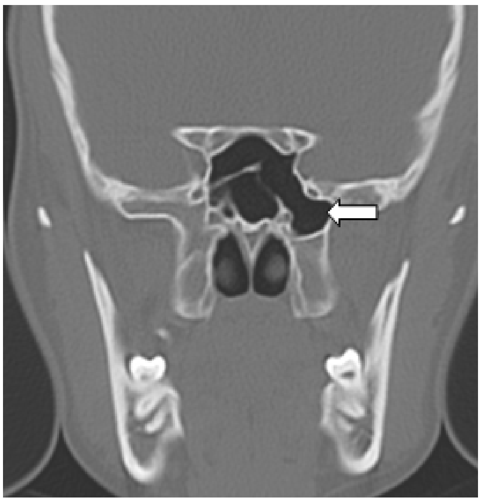
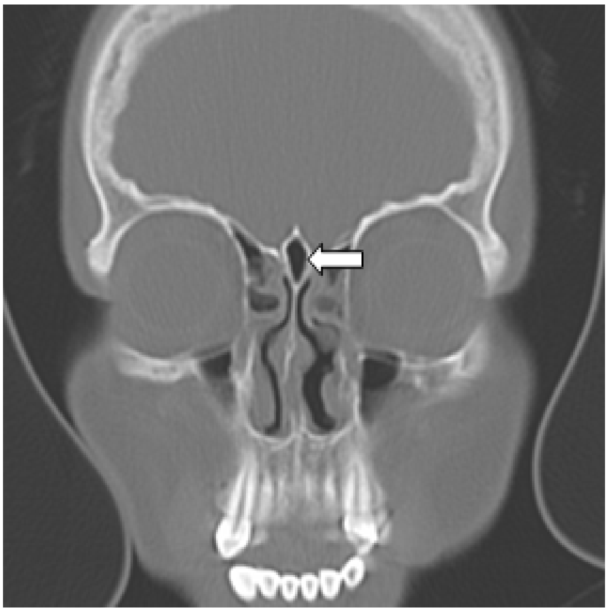


FIGURE- 13: CT scan PNS coronal section showing hypoplastic right Frontal sinus.

FIGURE-14: CT scan PNS coronal section showing pneumatisation of crista galli



DISCUSSION

The paranasal sinus region is subject to a large variety of lesions. Congenital anomalies and normal anatomical variations in this region are important as they may have pathological consequence or may be the source of difficulty/ complication during surgery. Stumberger et al proposed that stenosis of the osteomeatal complex, from either the anatomical configuration or hypertrophied mucosa, can cause obstruction and stagnation of secretions that may become infected or perpetuate infection.2

The presence of a concha bullosa has ranged between 4% and 80% in different studies; our data gave 38.75% which is less compared to 53.6% observed by Bolger and more compared to incidence reported by Zinreich S et al10 (36%), Dua K (16%) and Peres et al (24.5%). Such a wide range of incidence is due to the criteria of pneumatisation adopted.1, 7, 11

The middle turbinate may be paradoxically curved i.e. bent in the reverse direction. This may lead to impingement of the middle meatus and thus to sinusitis. In our study it was found in 12 patients (15%) – 10 unilateral, 2 bilateral. The incidence of 15% in our study is less compared to the 58 10 % incidence described by Peres et al.1

Zinreich first observed that the uncinate process may be curved or bent. It can impair sinus ventilation especially in the anterior ethmoid, frontal recess and Infundibulum regions. 5 In the present study curved uncinate was found in 09 patients unilaterally (11.25%) and 07 patient bilaterally (8.75%), a total of 16%. It is higher than that of 2.5% reported by Bolger.8 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.3, 4 , 7

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 05 (6.25%) – 4 unilateral and 1 bilateral. Kenedy and Zinreich reported an almost similar incidence of 10%. It is less than that reported by Bolger (45.9%) and Asruddin (28%).7, 12, 13

According to the results obtained in the study conducted by Mohammed Hosein Daghighi et al, the septal deviation (39% in males, 35.29% in females) was the most common normal variation and the other cases were sequentially as follows 1- Agger Nasi cell (38.22% in males, 34.3%in females), 2- Concha bullosa (14.67% in males, 17.23% in females), 3- Hypoplastic frontal sinus (3.86% in males, 8.82% in females), 4- Aerated Septum (2.79% in males, 2.52% in females), 5- Haller cell (1.16% in males, 1.68% in females), 6- Onodi cell (0.39% in males, 0.42% in females).14

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 11 patients (13.75%) in our study. The incidence is less as compared to 98.5% by Bolger and 40% by Dua K.6,9 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.3

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 peri-operative injury to optic nerve are increased when the bony canal of the nerve is lying dehiscent. Most authors have found an incidence of 8–14%, 10.9% by Pere and 11% by Bogler.1, 6 It was found unilaterally in 3 patients in our study (3.75%).

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. 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.

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