International Journal of Biomedical and Advance Research
ISSN: 2229-3809 (Online); 2455-0558 (Print)
Journal DOI: 10.7439/ijbar
CODEN: IJBABN

Original Research Article

CT evaluation of congenital anatomical variations in paranasal sinuses

Jyoti K Tapadia*[1] and Anand Gajakos[2]

[1]Associate Professor, Department of Radiology, Ashwini Rural Medical College, Kumbhari, Solapur (MH), India
[2]Assistant Professor, Department of Radiology, Ashwini Rural Medical College, Kumbhari, Solapur (MH), India

***Correspondence Info:**
Dr. Jyoti K Tapadia,
Associate Professor,
Department of Radiology,
Ashwini Rural Medical College,
Kumbhari, Solapur (MH), India
E-mail: tawareishwari@gmail.com

Abstract

Introduction: A good knowledge of the anatomy of the paranasal sinuses is essential for the clinician to understand sinonasal diseases. Conventional radiology does not permit a detailed study of the nasal cavity and paranasal sinuses, and has now largely been replaced by computerized tomographic (CT) imaging.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.
Objective: To evaluate the congenital anatomical variations of paranasal sinus by CT scan.
Materials and Methods: Over a period of 18months, 80 patients referred for CT scan of PNS region to Al-Ameen medical college hospital were evaluated for the presence of normal variants of the paranasal region. Unenhanced CT of the PNS was performed for these patients in the coronal plane, complemented by axial views in selected cases.
Results: 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: The presence of anatomical variants does not indicate a predisposition to sinus pathology but these variations may predispose patients to increased risk of intraoperative complications. The radiologist must pay close attention to anatomical variants in the preoperative evaluation and provide a road map to the surgeon and help avoid possible complications and improve success of management strategies.
Keywords: Paranasal sinuses; Septal deviation; Concha bullosa; Agger nasi cell; Haller cell; Onodi cell; computed tomography; anatomical variations.

1. 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. 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. This gives an applied anatomical view of the region and of the anatomical variants that are very often found. The detection of these variants to prevent potential hazards is essential for the use of current endoscopic surgery on the sinuses.

1.1 Objective

To evaluate the congenital anatomical variations of paranasal sinus by CT scan examination.

2. Materials and Methods

The study was conducted at, "AL-Ameen Medical College Hospital; Bijapur and Govt District Hospital Bijapur**"** affiliated to **"**Rajiv Gandhi University of Health Science Bangalore, Karnataka". We included all patients who

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

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 method: Data was charted on a excel sheet and analysed using SPSS software.

3. 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).**

3.1 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**).

Table 1: Patients who fulfilled inclusion criteria

Gender	No. of Cases	% of Cases
Male	48	60%
Female	32	40%

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 2: Age-wise frequency

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 3: Anatomical Variants

Ariated Cristagali	3	4	7

Chi-square value for anatomyic variant is 21.4 and p-value for this is less than 0.05 indicating highly association

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**

4. 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 [1].

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 al* [2] (36%), Dua K (16%) and Peres *et al* (24.5%). Such a wide range of incidence is due to the criteria of pneumatisation adopted [3-5].

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%). The incidence of 15% in our study is less compared to the 58 10 % incidence described by Peres *et al* [3].

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 [6]. In the present study curved uncinate was found in 09 patients a total of 16%. It is higher than that of 2.5% reported by Bolger [7]. 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 [4.8,9,].

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%) –. Kenedy and Zinreich reported an almost similar incidence of 10%. It is less than that reported by Bolger (45.9%) and Asruddin (28%) [4,10,11].

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) [12].

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 [13,14]. 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 [8].

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 [3,13]

5. 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.

References

[1] Kopp W, Stammberger H, Fotter R. Special radiologic image of the paranasal sinuses. *European Journal of Radiology* 1998; 8:152-156.

[2] Zinreich J, Mattox DE, Kennedy DW, Chisholm HI, Diffey DM, Rosenbaum AE. Concha bullosa: CT evaluation. *Journal of computer assisted tomography* 1988; 12:778-784.

[3] Perez-Pinas I, Sabate J, Carmona A, Catalina H C J, Jimenez C J. Anatomical variations in the human paranasal sinus region studied by CT. *Journal of Anatomy* 2000;197(2):221–227.

[4] Driben J S, Bolger W E, Robles H A, Cable B, Zinreich S J. The reliability of computerized tomographic detection of the Onodi (sphenoethmoid) cell. *Am. J. Rhinol* 1998; 12:105–111.

[5] Dua K, Chopra H, Khurana AS, Munjal M. CT Scan variations in Chronic Sinusitis. *Ind J Radiol Imag* 2005; 15:315-320.

[6] Zinreich S. Imaging of inflammatory sinus disease. *Otolaryngol Clin North Am* 1993; 26:535-547.

[7] Rao V M and El-Noueam K I, Sinonasal imaging. Anatomy and pathology. *Radiol. Clin. North Am* 1998; 36:921–939.

[8] Mecit K, Mural K, Fatih A, Omer O, Adnan O, Adem K. Remarkable anatomic variations in paranasal sinus region and their clinical importance. *European Journal of Radiology* 2004; 50(3): 296-303.

[9] Zinreich S. Paranasal sinus imaging. *Otolaryngol Head Neck Surg* 1990; 103:863-868.

[10] Asruddin, Yadav SPS, Yadav RK, Singh J. Low dose CT in chronic sinusitis. *Indian Journal of Otolaryngology and Head Neck Surgery* 2000; 52: 17-21.

[11] Kennedy D.W. and Zinreich S.J., Functional endoscopic approach to inflammatory sinus disease: current perspectives and technique modifications. *Am. J. Rhinol* 1988; 2:89–96.

[12] Daghighi M.H., Daryani A., Chavoshi Nejad K.: Evaluation of Anatomic Variations of Paranasal Sinuses. *The Internet Journal of Otorhinolaryngology* 2007 7; 1:8-12.

[13] Bolger W E, Woodruff W and Parsons D S, CT demonstration of pneumatization of the uncinate process. *Am. J. Neuroradiol* 1990; 11:552.

[14] Delbert A B, Jocyline L M, Mutsuhisa F, Kook S O, Lionel W . Radiologic Imaging in Otorhinolaryngology. *Pediatric Clinics of North America* 1981; 28(4):16-19.