Original Research Article

Study of normal anatomical variations in paranasal sinuses using CT scan

Mahesh Kadam[1], Chandrashekhar Mundkar[2*]

[1]Associate Professor, [2]Assistant Professor, Department of Radiology, Vilasrao Deshmukh Government Institute of Medical Sciences, Latur, Maharashtra, INDIA.
Email: mahesh2kadam@gmail.com

Abstract

Background: Evaluation of anatomic variations of the paranasal air sinuses is important in patients who are undergoing CT scan evaluation for various rhinologic reasons. Knowledge of the anatomic variations does reduce the surgical complication rates during FESS, helps explain recurrence of disease and allows one to change the operative technique. 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 development and refinement of CT scans has allowed extensive assessment of patients' paranasal sinuses thus providing a guide map for FESS surgeons to operate. **Objectives:** To study normal anatomical variations in paranasal sinuses using CT. **Material and Methods:** This study was conducted at Radiodiagnosis Department for a duration of 18 months. Using the multislice(128 slice scanner) the axial paranasal sinuses cuts were taken and then coronal and sagittal reconstruction was done. **Results:** 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. **Conclusion:** According to the results, nasal septal deviation was the most common anatomic variation. Haller cell and pneumatised 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.

Keywords: paranasal sinuses.

[*]**Address for Correspondence:**
Dr Chandrashekhar Mundkar, Assistant Professor, Department of Radiology, Vilasrao Deshmukh Government Institute of Medical Sscineces, Latur. Maharashtra, INDIA.
Email: mahesh2kadam@gmail.com

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INTRODUCTION

Evaluation of anatomic variations of the paranasal air sinuses is important in patients who are undergoing CT scan evaluation for various rhinologic reasons. Knowledge of the anatomic variations does reduce the surgical complication rates during FESS, helps explain recurrence of disease and allows one to change the operative technique. 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 development and refinement of CT scans has allowed extensive assessment of patients' paranasal sinuses thus providing a guide map for FESS surgeons to operate.

Objectives

To study normal anatomical variations in paranasal sinuses using CT. To assess the frequency of occurrence of these variations.

METHODOLOGY

Study design: Cross sectional observational study. **Study setting:** Department of Radiodiagnosis, Tertiary care centre. **Study duration:** 18 months (Data collection-12 months and analysis 6 months) **Inclusion criteria:** Patients

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complains pertaining to PNS and referred from the ENT OPD and wards. Those who are willing to participate in study after written consent. **Exclusion criteria:** Sinonasal anatomy alteration or obscuration due to inflammatory diseases (When bony detail was obscured by polypoid mucosal disease). Previous sinonasal surgery (excluding nasoantral window antrostomy). Facial trauma. Paranasal sinus neoplasm. Pregnancy. Paediatric age group

ample size calculation

Formula for sample size calculation

(**Source for formula:** Lwanga SK, Lameshow S. Sample size determination in health studies. 1st Ed, 1991. WHO, Geneva)

Ref of article: Lingaiah RK *et al.*[79] Anatomical variations of paranasal sinuses on coronal CT-scan in subjects with complaints pertaining to PNS. Radiol Sec. 2016; 20169:1-7.

We considered prevalence of DNS as commonly observed anatomical variation of PNS in the above-mentioned article i.e. 62%.

P	Your guess of Population P (any value<1)	0.62
1-α	Confidence level set by you	0.95
Z	Z value associated with confidence	1.96
d	Absolute precision (Value less than P)	0.12
n	Minimum sample size	63

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**

Table 2: Distribution according to gender

		Frequency	Percent
Anatomical variation	Male	42	66.7
	Female	21	33.3
	Total	**63**	**100.0**

Table 3: Distribution according to anatomical variation number

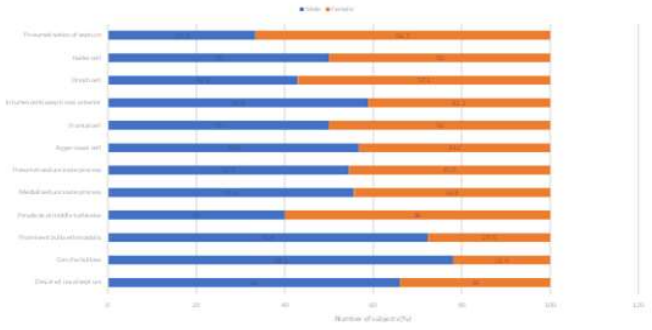
		Frequency	Percent
Anatomical variation	Single	21	33.3
	Multiple	42	66.7
	Total	**63**	**100.0**

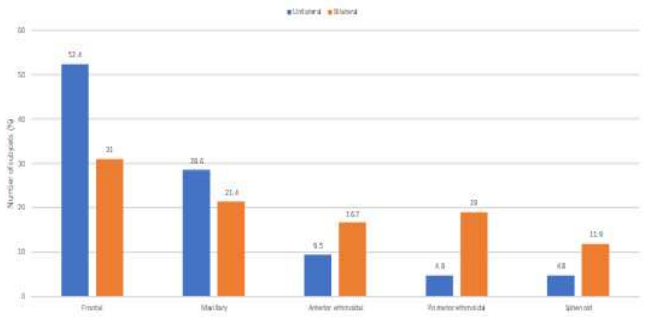
Table 4: Distribution according to CT detected anatomical variation

		Frequency	Percent
Anatomical variation	Deviated nasal sep tum	53	84.1
	Concha bullosa	32	50.8
	Prominent bulla ethmoidalis	29	46.0
	Paradoxical middle turbinate	5	7.9
	Medialised incinate process	9	14.3
	Pneumatised uncinated process	11	17.5
	Agger nasal cell	37	58.7
	Frontal cell	6	9.5
	In tum escen tia sep ti nasi an terior	17	27.0
	Onodi cell	7	11.1
	Haller cell	2	3.2
	Pneumatisation of septum	3	4.8

Table 5: Regions involved and anatomical variations associated with it

Region involved	Anatomical variations associate with it
Frontal sinus region	Aggger nasi cell
Anterior nasal cavity	Concha bullosa
Posterior nasal cavity	Septal deviation
Sphenoid sinus region	Onodi cell





Graph 1: Anatomical variation and its distribution according to gender; **Graph 2:** CT scan detected sinuses involved

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. Concha bullosa (pneumatised middle turbinate) has been implicated as a possible aetiological factor in the causation of recurrent chronic sinusitis. It is due to its negative influence on PNS ventilation and mucociliary clearance in the middle meatus region. The presence of a concha bullosa has ranged between 4% and 80% in different studies; our data gave 50.8% which is less compared to 53.6% observed by Bolger and more compared to incidence reported by Zinreich S *et al.*9 (36%), Dua K *et al.* (16%) and Peres *et al.* (24.5%). Such a wide range of incidence is due to the criteria of pneumatisation adopted. 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 9 patients (14.3%) – 6 unilateral, 3 bilateral.The incidence of 14.3% in our study is close to the 58.10 % incidence described by Peres *et al.*Zinreich S *et al.*9 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. In the present study curved uncinate was found in 5 patients unilaterally (8%) and 4 patient bilaterally (6.3%), a total of 14.3%. It is slightly higher than that of 2.5% reported by Bolger *et al.* 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 (Fig.9) in 3 (4.8%) patients, 2 unilateral and 1 bilateral. This is consistence with 5% reported by Mecit *et al.* and more compared to Zinreich S *et al.*9 (0.4%) and Bolger *et al.*60 (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 al.*9 reported incidence of 10% which is more than our incidence. It is also more than that reported by Bolger *et al.*60 (45.9%) and Asruddin *et al.*87 (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 al.*. It is more than observed by by Dua K *et al.*84 (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. 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 perioperative 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. It was found unilaterally in 7 patients in our study (11.1%). The clinical significance of

anatomical variants of the nasal sinus region is controversial. Most CT anatomical studies of the sinus region have been made in patients suspected of a clinical syndrome suggesting inflammatory sinus pathology. Zinreich S *et al.*9 found that 62% of his patients presented at least one anatomic variant, against 11% in the normal control group. These findings seem to suggest a positive correlation between anatomical variants and the appearance of inflammatory sinus pathology. However, Bolger *et al.* in a series of 202 patients studied by CT, observed 131 anatomical variants, but found the incidence in patients with sinus pathology was similar to that in persons studied for other reasons. Bolger *et al.*60 and Stammberger *et al.*6 and Wolf *et al.*88 detected the presence of anatomical variants both in patients studied for sinus problems and in those studied for other reasons. They concluded that the simple presence of variants does not mean a predisposition to sinus pathology, except when other associated factors are present. This opinion is not shared by Yousem *et al.*89, who claimed that the anatomical variants may be predisposing factors, depending on their size. In our study, 25 patients were detected with anatomical variations out of 37 who had mucosal changes. So, the prevalence was 67.6%. In our study, 18 patients were detected with anatomical variations out of 26 in whom mucosal changes were absent. So, the prevalence was 69.2% From this observation our study also reveals that the presence of anatomical variants does not mean a predisposition to sinus pathology. However, it is important for surgeon to be aware of variations that may predispose patients to increased risk of intraoperative complications. The radiologist must pay close attention to anatomical variants in the preoperative evaluation and help avoid possible complications and improve success of management strategies.

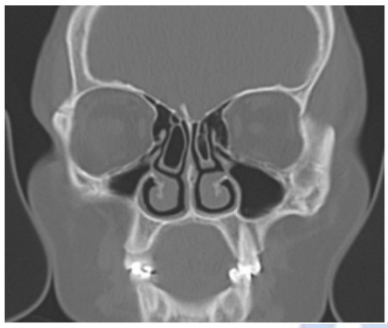
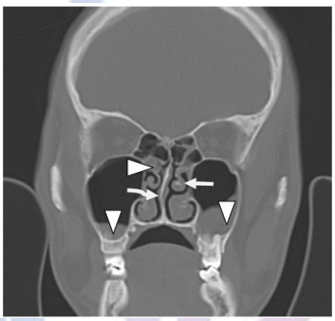


Figure 1



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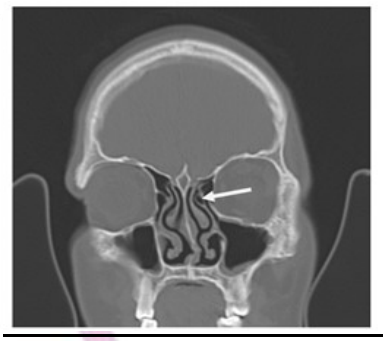

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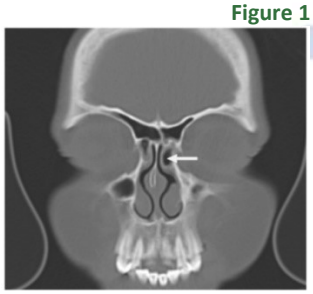
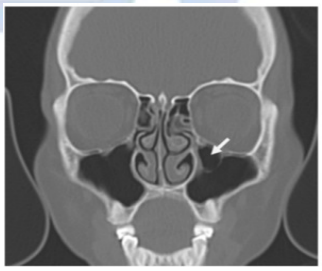


Figure 4



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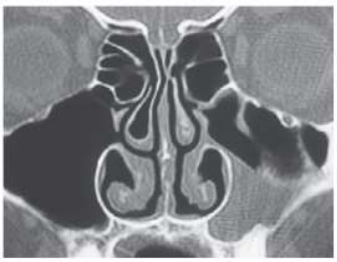

Figure 6

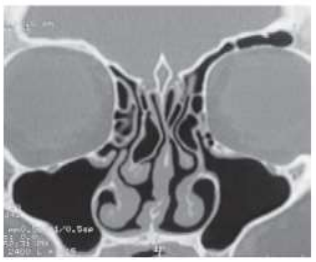

Figure 7

Figure 1: CT scan PNS coronal section showing bilateral middle concha bullosa- right larger than left; **Figure 2:** CT scan PNS coronal section showing Bilateral maxillary and right anterior ethmoidal sinusitis, paradoxical curvature of middle turbinate on the left side (arrow) and DNS to the right side (curved arrow); **Figure 3:** CT scan PNS coronal section showing pneumatized uncinate process on the left side (arrow); **Figure 4:** CT scan PNS coronal section showing prominent Agger Nasi cells on the left side (arrow); **Figure 5:** CT scan PNS coronal section showing large Haller's cell on the left side (arrow); **Figure 6:** Prominent bulla ethmoidalis and concha bullosa; **Figure 7:** Concha bullosa and pneumatized uncinate process

CONCLUSION

According to the results, nasal septal deviation was the most common anatomic variation. Haller cell and pneumatised 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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