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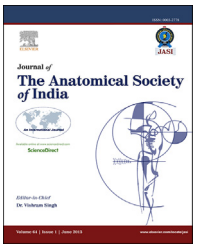

Original Article

Anatomical variations of paranasal air sinuses – A CT scan study

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ARTICLE INFO

Article history:
Received 8 April 2015
Accepted 25 April 2015
Available online 14 May 2015

Keywords:
Variation
Paranasal sinuses
CT scan

ABSTRACT

Introduction: The variations of paranasal air sinuses are not uncommon and often pose a risk during a sinus surgery therefore knowledge of these variations is of great significance to rhinologist and E.N.T surgeons. The present study deals with these variations by computerized tomography scanning (CT scan) in adult individuals.

Methods: CT scans of 100 patients were procured from Department of Radiology, Kamineni Institute of Medical Sciences, Narketpally, Andhra Pradesh. The scans were studied in both coronal and axial planes.

Results: The variations found include deviated nasal septum, concha bullosa, paradoxical middle concha, Haller cells, agger nasi cells, Onodi cells and pneumatised inferior concha. A higher incidence of agger nasi cells was found followed by Haller cells and deviated nasal septum. The least variant was inferior concha anomaly followed by Onodi cells.

Discussion: The precise details of variations of paranasal sinuses can now be visualized by CT scan imaging. These observations are of paramount significance to prevent unnecessary complications during sinus surgery.

1. Introduction

A precise knowledge of normal and variant anatomy of the paranasal air sinuses is essential for rhinologist to prevent potential hazards during an endoscopic surgery of the sinuses. This information is not possible by conventional radiography, however now possible by computerized tomography scanning (CT scan).[1–3]

In the present study the anatomical variations related to paranasal sinuses were observed in 100 adult patients (between 18 and 60 years) using CT scans in coronal plane complemented by axial plane. The population studied showed great anatomical variability with a high percentage related to nasal septum, middle concha, inferior concha, Haller cells, Onodi cells, agger nasi cells. The observations were taken, tabulated and compared with earlier studies to find the regional and ethnic variations.

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http://dx.doi.org/10.1016/j.jasi.2015.04.017

2. Materials and methods

The computerized tomography scans (CT scans) of paranasal sinuses of 100 patients, 54 females and 46 males with suspected nasal pathology (i.e., with complaints of rhinitis or sinusitis) referred to Department of Radiology in Kamineni Institute of Medical Sciences, Narketpally, Andhra Pradesh were procured for the study. The scans were of both axial and coronal planes.

These CT scan images were taken at a thickness of 3 mm which later were made to 1 mm thickness for the reconstruction models resulting in 150–300 images for each patient, for better visualization of the variants. The scans were evaluated along with the help of a radiologist. While studying the

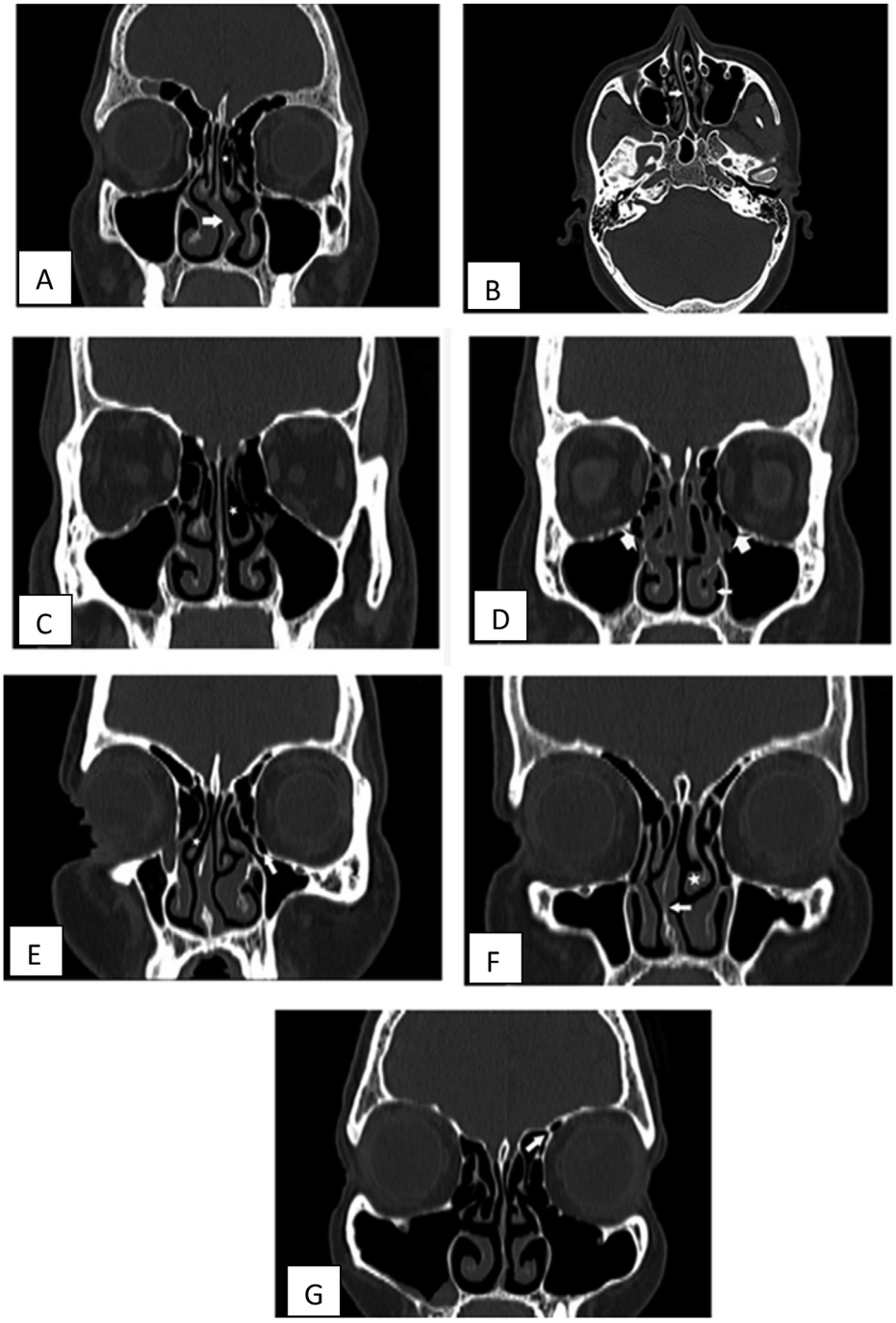

Fig. 1 – Anatomical variations of paranasal air sinuses. A: CT scan, coronal plane with deviated nasal septum (arrow) and concha bullosa (star). B: CT scan axial plane with deviated nasal septum (arrow) and concha bullosa (star). C: CT scan coronal plane with concha bullosa (star). D: CT scan coronal plane with pneumatised inferior nasal concha (small arrow) and Haller cells (larger arrow). E: CT scan coronal plane with Haller cells (arrow). F: CT scan coronal plane with paradoxical middle concha (star) and deviated nasal septum (arrow). G: CT scan coronal plane with agger nasi cells (arrow).

Table 1 – Percentage (%) variation in human paranasal air sinuses.

S. no	Septal deviation (%)		Middle concha: Concha bullosa (%)			Middle concha: Paradoxical middle turbinate (%)			Inferior turbinate (%)			Haller cells (%)			Onodi cells (%)			Agger nasi (%)		
Total variation	52%		47%			11%			2%			53%			12%			94%		
	R	L	R	L	B/L	R	L	B/L	R	L	B/L	R	L	B/L	R	L	B/L	R	L	B/L
	27%	25%	20%	17%	10%	2%	8%	1%	0%	2%	0%	17%	22%	14%	6%	4%	2%	28%	28%	38%

coronal scans antero-posteriorly, parallel to the osteomeatal unit, first the frontal sinus was visualized followed by nasal septum, inferior concha, middle concha along maxillary air sinus, anterior ethmoidal air cells. As we moved posteriorly the superior concha along with posterior ethmoidal air cells and the sphenoidal air sinuses were visualized. In this way the anatomical variations such as nasal septal deviation, middle concha variations such as concha bullosa and paradoxical concha, inferior concha, Haller cells, Onodi cells and agger nasi cells were studied.

The axial scans were studied infero-superiorly, these were parallel to the hard palate and perpendicular to the osteomeatal unit, were helpful mainly in identifying the septal deviation, concha bullosa and the sphenoidal sinus along with the Onodi cells. The variations were noted on right side, left side and bilaterally.

3. Results

The axial sections were observed from the level of C1 (corresponding to level of hard palate) and above, whereas the coronal sections were observed with osteomeatal complex as reference level. The variations of deviated nasal septum, middle nasal concha (concha bullosa & paradoxical concha), inferior nasal concha, Haller cells, agger nasi cells and Onodi cells were noted.

Nasal septum, a partition between the nasal cavities, is formed by cartilages and bones. It usually divides the nasal cavity into two asymmetrical halves because of its deviation to one side. This deviation may be either congenital or traumatic.[4,5]

In present study we observed and noted any noticeable deviation from the midline, and detected variations in 52 cases. The incidence of deviations onto the right and left side were almost identical with a slight predominance onto the right viz., a 27% variation towards the right and a 25% variation toward the left side (Fig. 1A and B).

Middle nasal concha, a shelf-like bony projection from the lateral wall of the nasal cavity is generally prone to different types of variations than that of the superior and inferior conchae. The variations of the middle nasal concha comprise the concha bullosa (pneumatised middle concha) and a paradoxical middle concha (bent middle concha).The concha bullosa is formed by the proliferation of the anterior ethmoid air cells.[6] In present study this variation was predominant after the septal deviation in 47% of cases. This variation was detected in 20% cases on the right side, 17% were on the left side and 10% bilaterally (Fig. 1C).

The paradoxical middle concha, was seen in 11% of the cases.

Inferior nasal concha, a curved shelf like projection from lateral wall of nose below the middle meatus showed pneumatisation in 2% of cases only on the left side (Fig. 1D).

Haller cells are the extramural ethmoidal air cells present in the inferomedial orbital wall hence also called as infraorbital ethmoidal air cells.[7] These cells have the significance of being in relation with the infraorbital nerve and hence important in identifying them during an endoscopic procedure.

These cells were observed in 53% of the cases out of which 24% were on the right side, 29% on the left side and 14% of the cases they were present on both the sides (Fig. 1E).

Onodi cells are the sphenoethmoidal air cells.[7,8] They lie posteriorly and sometimes superior to the sphenoidal sinus, in relation to optic nerve and sometimes in relation with internal carotid artery.

They were observed in 12% of the cases, of which 8% were on the right side, and 4% were on the left side.

Agger nasi cells are the most anterior ethmoidal air cells lying anteriorly, laterally and inferiorly to the frontoethmoidal recess and anteriorly and above the attachment of the middle concha. They are located within the lacrimal bone, hence related laterally to the orbit, lacrimal sac and nasolacrimal duct. However in some cases these cells are also seen a little posteriorly.

These cells were observed in 94% of the cases of which 28% of them on the right side, 28% of them on the left side and in 38% of the cases on both sides (Fig. 1G).

The above observed results are shown in Table 1.

Table 2 – Comparison with earlier studies.

Workers	Septal deviation	Concha bullosa	Paradoxical concha	Haller cells	Onodi cells	Agger nasi cells	Pneumatised inferior concha
Zinreich et al[12] (1987)	21%	36%	15%	10%	–	Nearly all	–
Bolger et al[6] (1991)	18.8%	53%	26%	45%	–	3%	–
Perez-Pinas et al[10] (2000)	55%	34%	27%	3%	11%	–	–
Sukalya lerdlum et al[11] (2005)	56.4%	14.3%	5.3%	9.4%	–	7.9%	–
Present (2010–2013)	52%	47%	11%	53%	12%	94%	2%

4. Discussion

The Anatomical variations in human paranasal air sinuses and lateral wall of the nose have been studied since centuries, but with advent of recent imaging techniques viz., computerized tomography scanning (CT scan) and magnetic resonance imaging (MRI) variations have been identified much more extensively and precisely. Even the extensive use of X-rays in early nineties could not provide precise detailed anatomical variations. In the present study by using CT scan we could identify the variations of nasal septum, middle nasal concha, inferior nasal concha, Haller cells, agger nasi cells, Onodi cells. These scans provided a clear view of the bony landmarks and mucosal changes at different levels.

According to Lydia Badia et al[9] plain radiographs had no place in the routine management of rhinitis and sinusitis. They emphasized that the pneumatisation of agger nasi was the most common variant with ethnic variation but did not specify whether the variant was unilateral or bilateral. These results coincided to a large extent with the results of present study.

According to Perez-Pinas et al[10] the most common variant was nasal septum deviation (55%) followed by presence of concha bullosa (34%) Onodi cells (11%). However Perez-Pinas et al did not include agger nasi cells and variation of inferior concha in their study. These findings also correspond with the results of the present study to a large extent. However pneumatisation of inferior nasal concha was found in 2% of cases in present study.

Haller cells which were discussed by Bolger et al[6] found to be in 53% of the cases, this result was close to the present work (45%), in rest of the studies this entity was not emphasized much and proper values were not specified.

Paradoxical bending of middle concha was found to be 11% in the present study, Sukalya lerdlum et al[11] found this at only 5.3% which was least variation in their study and they did not account for Onodi cells and variation of inferior concha.

The minor differences between the gross values of the variations could be attributed to the sample size, sex and ethnic variations.

The results of present study are compared with the earlier studies in Table 2.

5. Conclusion

The variations in the paranasal air sinuses are prevalent as most of the subjects showed at least one of them (vide supra). This study provides an anatomical and ethnic perspective towards the variations in paranasal air sinuses.

These variations were almost of the same frequency irrespective of sex of the patient. With this study we can say that CT scanning is a good modality in visualizing the paranasal air sinuses and their variations. Since this study was carried out in the Kamineni institute of medical sciences Narketpally, Nalgonda district, it can be used as a reference for the future studies and in the region.

This study may also be of immense value to E.N.T surgeons and radiologists in diagnosing and preventing the damage to these structures (variations) during a surgery of sinuses.

Conflicts of interest

All authors have none to declare.

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