

## Anatomical variations of nose and para-nasal sinuses; CT scan review

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### Abstract

**Objective:** To determine the frequency of anatomic variations on computed tomography scan of para-nasal sinuses.

**Methods:** The retrospective study was conducted at the Aga Khan University Hospital, Karachi, and comprised computed tomography scans of 77 patients who had presented between October 2007 and March 2011. All the scans were reviewed using Picture Archiving Communication System computer software. The scans were reviewed for the presence of deviated nasal septum, paradoxical middle turbinate, Haller cell, Onodi cell, and pneumatization of the middle turbinate and unciniate process.

**Results:** The mean age of the patients was  $31 \pm 13.15$  years. One or more types of anatomical variants were observed in 40 (51.9%) of the patients; the most frequent being the deviated nasal septum 20 (26%) and the Concha bullosa 14 (18.2%).

**Conclusion:** Considering the wide range of variations in the anatomy, each and every para-nasal sinus case should be planned individually and carefully to avoid dreadful complications and maximise patients' benefit.

**Keywords:** Anatomic variations, Para-nasal sinuses, Deviated nasal septum, Concha bullosa. (JPMA 63: 317; 2013)

### Introduction

Computed tomography (CT) of the para-nasal sinuses (PNS) has nowadays become the investigation of choice for the radiological diagnosis of nasal and sinus diseases.<sup>1</sup> Unlike plain radiography, sinus CT shows an excellent anatomical soft tissue and bony details, helps in the diagnosis, and gives detail of sinonasal anatomy for safe surgery.

Endoscopic sinus surgery (ESS) is a common procedure which requires a meticulous assessment of patient and a detailed radiological description of the anatomy and its anatomical variations in nose and PNS.<sup>2</sup> Although the role of anatomical variations of osteomeatal complex in the etiology of sinonasal disease is controversial<sup>3</sup> but knowledge of these variations in every patient is important before surgery is planned to avoid damage to surrounding vital structures like the orbit and the brain. The frequency of these variations may differ among the different ethnic groups.<sup>4</sup> In review of literature, there is no data on anatomical variations of nose and PNS in our population. The aim of this study was to report the frequency of these variations in patients with sinonasal symptoms who underwent CT scan in the hospital.

### Patients and Methods

The retrospective review of CT scans PNS was done at the Aga Khan University Hospital, Karachi, and comprised

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data of 87 patients who had visited the hospital from October 2007 to March 2011. All patients had CT scan done for sinonasal symptoms. CT scans of patients who either had previous surgery or had invasive disease were excluded. All the 87 patients underwent CT scans using a Toshiba's Aquilion 64-slice CT System. The study reviewed coronal and axial views in bony windows of all CT scan films using Picture Archiving Communication System (PACS) software, and reported the results in a data sheet. Results were analysed on SPSS 18. The study included CT scans of all patients referred from the Ear Nose Throat (ENT) clinic after the installation of PACS in October 2007. Each scan was reviewed for the presence of haller cell, onodi cell, paradoxical middle turbinate, deviated nasal septum (DNS), pneumatization in the nasal septum, superior and middle turbinate, and unciniate process. A septum was termed DNS when it was obstructing at least half of the nasal cavity.

### Results

Of the initial 87 scans, 10 (11.5%) were excluded for not meeting the inclusion criteria. The final sample size, as such, was 77 (88.5%). The mean age of the patients was  $31 \pm 13.15$  years. One-third 26 (33%) of the scans were of females, and two-third 51 (66%) of males. There was no anatomical variation identified in 37 (48.1%) images. Single variation was seen in 16 (20.7%), two variations in 18 (23.3%), and in 6 (7.7%) scans more than three variations were present. DNS was the most common variation, 20 (26%); Concha bullosa (CB), 14 (18.2%); paradoxical middle turbinate (PMT), 11 (14.3%); Haller's cell, 7 (9.1%); Onodi cells, 6 (7.8%); and pneumatization of

Table-1: Main anatomical variants found.

Variable	Number	Percent
DNS	20	26%
Septal Pneumatisation	0	0
Concha bullosa	14	18.2%
Paradoxical MT	11	14.3%
UP Pneumatisation	4	5.2%
Onodi cells	6	7.8%
Haller cells	7	9.1%

UP: Uncinate process. MT: Middle turbinate. DNS: Deviated nasal septum.

Uncinate process (UP), 4 (5.2%) (Table-1). Septal pneumatisation was not identified in any case.

## Discussion

The surgical management of sinonasal disease has evolved over the years. Extensive external approaches and prolonged hospital stays have been replaced by a minimally invasive procedure called endoscopic sinus surgery (ESS). This involves opening the obstructed ostia to provide normal ventilation with preservation of adjacent mucosa and removal of disease.<sup>5</sup> Literature has reported excellent results with ESS.<sup>5,6</sup> However, due to close proximity of PNS to important structures such as the orbit and the skull base, if complications occur in surgery, they are usually dangerous and harmful.

Sinonasal region have many different anatomical variations. Although their role in the development of sinusitis remains unclear, but complete knowledge of these variations is important before the surgical procedure to avoid dreadful complications.

An anatomic variation study reviewing the CT scans of 100 Caucasian and 100 Chinese patients found statistically significant difference in the occurrence of CB, PMT and Haller and Onodi cells between the two groups. Pneumatisation of the agger nasi cell was the most common variant in both the groups i.e 44-57% (maximum range, either unilateral or bilateral) in the Caucasian group and 47-53% in the Chinese group. There was no statistical

difference in the incidence between the two groups. The results of that study may explain in part the wide variations in sinonasal anatomy reported in literature.

In our study, we noted different frequency of these variations compared to previous reports of Caucasian, Asian, Japanese and Indian races (Table-2). Genetic and environmental factors seem to be the best explanation for these variations.

DNS (Figure-a) has a number of definitions. Our study defined it as any deviation that blocked at least half of the nasal cavity. It may be cartilaginous, osteocartilaginous or osseous. Severe DNS may result in compression of the inferior or middle turbinate, causing obstruction of the normal mucous flow and, consequently, secondary inflammation and infection.<sup>7</sup>

DNS was found in 20 (26%) cases in our study. In other studies, this finding ranged from 14.1% to 80%.<sup>6,8-10</sup>

Air cells in the nasal septum are commonly found within the posterior portion of the septum and communicate with the sphenoid sinus, allowing PNS infection to spread to these cells.<sup>11</sup> Additionally, if these cells are prominent, they may block the drainage of the middle meatus. In our study no septal pneumatisation was seen.

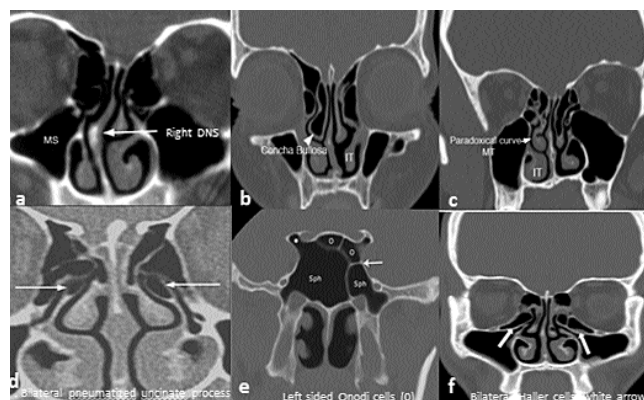


Figure: (a,b,c,d,e,f) Different anatomical variations.

Table-2: Reported incidence of sinonasal anatomical variations in different ethnic population.

Author & Country	n	DNS	Concha bullosa	Paradoxical MT	UP pneumatization	Haller cells	Onodi cells
Tonai etal (Japan) <sup>11</sup>	75	-	(28%)	(25%)	-	(36%)	
Pérez etal (Spain) <sup>10</sup>	110	(58.2%)	(24.5%)	(10%)	Nil	(45%)	(10.9%)
H. Mamatha (India) <sup>6</sup>	40	(65%)	(15%)	-	-	(17.5%)	-
Dutra etal (Brazil) <sup>8</sup>	71	(14.1%)	(4.2%)	-	-	(1.4%)	-
Mazza D etal (Italy) <sup>12</sup>	100	-	(29%)	(11%)	(5%)	(5%)	(9%)
AR Talaiepour etal (Iran) <sup>9</sup>	143	(63%)	(35%)	-	-	(3.5%)	(7%)
Current study	77	20 (26%)	14 (18.2%)	11 (14.3%)	4 (5.2%)	7 (9.1%)	6 (7.8%)

CB (Figure-b) is referred to as pneumatization of the turbinate. The reported prevalence of CB varies widely from 14-80%,<sup>3</sup> with some authors only considering pneumatization of the vertical lamina and the inferior bulb of the middle turbinate as true concha. We considered aeration in either site as CB. Presence of CB not only limits the exposure of surgical field, but may also block ostiomeatal complex (OMC) and, hence, sinus disease.

Middle turbinate aeration was found in 14 (18.2%) of patients in the present study. Other studies have found prevalence<sup>6,8,9,11,12</sup> ranging between 4% and 73%.

PMT is a laterally projected curvature of the middle turbinate, which may lead to the narrowing of the middle meatus (Figure-c). One study reported PMT as an etiologic factor for chronic rhinosinusitis because it may cause impaired ventilation of the OMC.<sup>13</sup>

In our study PMT was seen in 11 (14.3%) scans. Other studies found it from 11-25%.<sup>10-12</sup>

Pneumatized uncinate process also has been associated with poor sinus ventilation, specifically of the anterior ethmoid, frontal recess and of the infundibulum region. In the present study, pneumatization of the uncinate process was found in 4 (5.2%) cases (Figure-d), whereas other authors have reported prevalence rates of 6.3%<sup>10</sup> and 5%.<sup>12</sup>

Onodi cell is the most posterior ethmoid air cell that extends laterally (Figure-e). This extension is near the carotid canal and close to the optic nerve, which emphasizes the clinical importance of considering this anatomic variation prior to any attempt for invasive intervention. The surgeon must pay close attention to the occasional Onodi cell in pre-operative evaluation to avoid potential complications of ESS.

Onodi cell was found in 6 (7.8%) patients in the current study. Other studies have reported Onodi cell presence from 0% to 9%.<sup>9,12,14</sup>

Haller's cells (Infraorbital ethmoid cell) are the anterior ethmoid cells that project along the medial roof of the maxillary sinus and the most inferior portion of the lamina papyracea (Figure-f). They are closely related to the infundibulum. Due to their proximity to the natural ostium of the maxillary sinus, one study demonstrated a significant increase in maxillary sinus mucosal disease in patients with medium or large Haller's cells (45.8%) versus those with small cells (28.9%;  $p < 0.05$ ).<sup>15</sup> Other studies, however, found no significant correlation between

Haller's cell and chronic sinus disease.<sup>16,17</sup>

In our study, the prevalence of Haller's cell was 7 (9.1%). In other studies, this finding ranged from 1% to 36%.<sup>6,8-10,12</sup>

## Conclusion

Different anatomical variants may be found frequently in PNS. Since all variations have an anatomic and surgical significance, each and every case should be individually studied in detail before surgery to maximise patient benefit and avoid serious complications.

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