Original Research Article

A review of common anatomical variants of paranasal sinuses and nasal cavity and its frequency of occurrence as evidenced on multi-detector computed tomography

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Abstract

This study was carried out to know the frequency of occurrence of common anatomic variants in computed tomography of paranasal sinuses and nasal cavity. Non contrast Computed tomography (CT) of paranasal sinuses of 100 patients referred to Department Of Radiology, Saveetha Medical College were retrospectively studied. The Multi-detector computed tomography (MDCT) scans were evaluated for various anatomical variants of paranasal sinuses and nasal cavity. The frequency of occurrence was calculated in percentage. We found out that deviated nasal septum (DNS) was the most common variant in this study, seen in 86% of cases, followed by Agger nasi cells which was seen in 56% and the third most common was supra-orbital ethmoidal cells seen in 42% of the study population. All the cases included in the study, had minimum of one variant. Most of the study population showed multiple anatomical variations of paranasal sinus and nasal cavity. In conclusion,
multidetector Computed tomography plays an important role in the assessment of various anatomical variants of the paranasal sinuses and nasal cavity. Pre-operative MDCT of Paranasal sinuses, gives the surgeons most if not all of the anatomical information they need to tailor surgeries. Considering the relatively high frequency of occurrence of these variants, it is essential for the radiologists to have a precise knowledge of imaging features of normal anatomy and anatomical variants of Paranasal sinuses.

Key words
CT-PNS, MDCT, Agger nasi, Onodi Cells, DNS, Sphenoid Sinus, Kero’s, Delanos, Concha Bullosa.

Introduction
Paranasal sinuses are paired air-filled spaces in the skull whose function is, to lighten the skull, humidification of air and it also acts as a resonant chamber to voice. They include maxillary sinus, ethmoid sinus, frontal sinus and sphenoid sinuses [1].

A number of anatomic variants of paranasal sinus are known to occur [2]. With wide availability of MDCT and development of minimally invasive functional endoscopic sinus surgery (FESS), pre-operative imaging of paranasal nasal sinuses has increased [3].

MDCT provides accurate information regarding the normal anatomy, anatomic variants, drainage pathways and the extent of associated sinonasal diseases [2]. It has the potential to provide accurate information for preoperative mapping of paranasal sinuses and nasal cavity and helps the surgeon to tailor the surgery appropriately for the patient.

Computed Tomography scan is the best investigation of choice for paranasal sinuses. Modern multi-slice CT scanner acquires thin axial plane slices, reconstruction of sagittal and coronal planes can be done from it. The coronal plane is best to evaluate the osteomeatal complex. The axial plane helps in identifying the basal lamella of the middle turbinate which divides anterior and posterior ethmoid sinuses [4].

Conventional radiography gives useful information regarding maxillary sinus and frontal sinus pathology. But its role in the evaluation of osteomeatal complexes, nasal cavity, sphenoid sinus and ethmoid sinus is limited [3].

MDCT not only provides detailed information of the anatomy, its variants, extent of the diseases involving paranasal sinuses but also provides useful information regarding the adjacent bones and soft tissues as well, thereby making MDCT the imaging modality of choice for evaluating paranasal sinus and its variants [1, 3].

Normal anatomy
Maxillary sinus is within the body of maxilla. Bounded superiorly by floor of orbit, medially by lateral wall of nasal cavity, inferiorly by alveolar process of maxilla and posterior to it is the pterygopalatine fossa. Maxillary ostium (3 mm to 10 mm) is located along its medial wall [5].

Frontal sinus is separated from the anterior cranial fossa by its superior and posterior wall and are located superior to orbit and ethmoid sinus [6] and between the inner and outer table of frontal bone [7].

Ethmoid sinus consists of group of cells divided into anterior and posterior by the basal lamella. It is located inferior to frontal sinus, medial to orbit and anterior to sphenoid sinus [8]. Roof is formed by fovea ethmoidalis which separates it from anterior cranial fossa [9].

Anterior ethmoidal air cells are anteriorly bounded by the ethmoid infundibulum,
posteriorly by the basal lamella, base of the skull bounds it superiorly and lamina papyracea laterally [8].

Anterior boundary of posterior ethmoidal air cells is the basal lamella, posterior boundary is anterior sphenoidal wall, medial is superior turbinate, lateral is the lamina papyracea and superiorly the base of the skull [10].

Sphenoid sinus is within the sphenoid bone, located posterior to ethmoidal air cells. Posterior wall of the ethmoid sinus forms the anterior wall of the sphenoid sinuses. The most reliable landmark is the ostium that lies 1 cm superior to the superior turbinate. As sphenoid sinus is in close proximity with the vital structures like internal carotid artery and optic nerve, assessment of its pneumatization is very essential [11].

The final drainage pathway of maxillary, frontal and anterior ethmoidal sinuses is the osteomeatal complex which consists of maxillary ostium, infundibulum and hiatus semilunaris and its bony margins are formed by uncinate process, lateral margin of the middle turbinate and infero-medial wall of the orbit [12].

An additional sinus drainage pathway draining frontal sinuses are the frontal recess which drains into the middle meatus or infundibulum depending on the anterior attachment site of the uncinate process and it is best evaluated on sagittal reconstructed CT images and located along the posterior margin of the agger nasi cell [12].

The posterior ethmoidal air cells and sphenoid sinus drain through sphen-ethmoidal recess.

**Anatomical variants of paranasal sinus**

Several studies have shown that there is no significant difference in the prevalence of any paranasal sinus and nasal cavity variants among patients with minimal and those with clinically significant radiologic evidence of sinonasal disease [2].

Few studies state that the anatomical variants can affect the OMC and frontal recess and predispose to recurrent and refractory rhino-sinusitis by narrowing or obstructing the drainage pathway and altering the sinus ventilation and mucociliary clearance [2]. It can also alter the surgical landmarks in the region of the sinus drainage tracts [13].

The anatomic variants affecting the osteomeatal complex are concha bullosa, Haller cells, paradoxical rotation of the middle turbinate and nasal septal deviation. Prominent or variant frontal recess cells can affect the frontal recess [13].

Perez P, et al. and Stammberger, et al. proved that coronal CT is more informative than axial CT in identifying anatomical variations and also for better visualization of the sinuses along with adjacent structures by the surgeons [14, 15].

**Concha bullosa**

Pneumatization of the middle turbinate is called Concha bullosa. It is the extension of normal pneumatization of ethmoidal air cells (Figure - 4) [14]. Concha bullosa can cause narrowing of the middle meatus, lateral deviation of uncinate process which can obstruct infundibulum [13] and thereby can be implicated in the pathogenesis of rhino-sinusitis. However, some studies have shown that the prevalence of concha bullosa is the same in patients with and without sinus disease [16].

**KERAO’S classification**

Olfactory fossa is classified based on its depth and the length of lateral lamella of the cribiform plate.

**Type I:** Distance between cribiform plate and fovea ethmoidalis is 1-3 mm.

**Type II:** Distance between cribiform plate and fovea ethmoidalis is 4-7 mm.
Type III: Distance between cribriform plate and fovea ethmoidalis is 8-16 mm [17].

In most of the cases, the cribriform plate is symmetrical, when asymmetric, it is an anatomical variant [14]. In case of asymmetrically positioned cribriform plate, the more inferiorly placed lateral lamella is at a greater risk of injury during FESS [7]. Assessing the asymmetry is very important to avoid inadvertent injury during surgery.

Deviated nasal septum
Deviated nasal septum with bony spur can affect the sinus outflow pathways by laterally displacing middle turbinate and narrowing the middle meatus. (Figure - 12). Shpilberg, et al. defined it on coronal MDCT scans as any bending of the septal contour [2]. Pressure is put on the nasal turbinates by asymmetrical nasal septal positions [18].

Haller cells
Kennedy, et al. defined Haller cells as pneumatized ethmoidal cells seen projecting below the ethmoidal bullae within the orbital floor adjacent to the opening of the maxillary sinus [20] (Figure - 2). A Haller cell is an ethmoidal air cell which can cause narrowing of the maxillary antrum and proximal infundibulum, as it is situated lateral to the maxillo-ethmoidal suture in the medial orbital floor [13]. It was Identified first by Albrecht von Haller in the year 1765 [21]. Larger Haller cell can narrow the infundibulum and can cause sinusitis [20]. Haller cells are air cells that are located between the ethmoid bullae, orbital lamina of the ethmoid bone and orbital floor as defined by Bolger, et al. [22].

During procedures like functional endoscopic sinus surgery (FESS), increased risk of injury to orbit is associated with presence of infra-orbital air cell [23].

Agger nasi cells
Agger nasi cell is the anterior most ethmoid air cell, located below the frontal sinus forming significant part of the anterior wall of the frontal recess (Figure - 1). Agger nasi cells may impinge upon the frontal sinus drainage tract, extending infero-laterally to lacrimal fossa and located antero-superior to the hiatus semilunaris. Recognition of this relationship is important in management of chronic frontal sinusitis [24, 25].

Paradoxical rotation of the middle turbinates
In paradoxical rotation, middle turbinate is rotated inwards, which may in turn cause middle meatus narrowing, lateral deviation of uncinate process with infundibular narrowing (Figure - 5) and obstruction of the drainage pathway [13].

Frontal recess cells
The agger nasi cell which represents the anterior most ethmoid air cell is a named frontal recess cell. It is seen pneumatized in majority of cases and forms a part of anterior boundary of the frontal recess [13].

Kuhn classification - frontal cells - associated with frontal recess
Frontal cells are additional subsets of frontal recess cells, which form portion of anterior margin of frontal recess.
Type 1 - Single cell seen above the agger nasi cell.
Type 2 - Two or more small cells seen above the agger nasi cell.
Type 3 – A large cell seen above the agger nasi cell with extension into the frontal sinus.
Type 4 - Rare, fronto-ethmoidal cells, entirely contained within the frontal sinus [13].

Onodi cells
Posterior most ethmoidal cells are Onodi cells, seen extending posterior, lateral and superior to the sphenoid sinus, medial to the optic nerve (Figure - 3). First described by Adolf Onodi in 1903. Extensive pneumatization can expose the circumference of optic nerve, surrounded by air spaces [26]. Onodi cells are also known as spheno-ethmoidal cells and its identification on
imaging is significant to surgeon during functional endoscopic sinus surgery. When Onodi cells are present, both optic nerve and carotid artery may be exposed within the posterior ethmoidal cells [19]. The best orientation is seen on axial cuts as the course of optic nerve can be followed as a relation [27].

Maxillary sinus hypoplasia
An uncommon condition, often diagnosed incorrectly as chronic sinusitis [14]. When severe, it impedes mucociliary clearance and more prone to retention of mucus. Finding maxillary sinus ostium may be difficult in case of hypoplasia [28]. Failure in recognizing maxillary sinus hypoplasia, can cause injury to medial orbital wall intra-operatively [29].

Maxillary sinus hypoplasia classification
Type 1: Mild - Normally developed uncinate process and well-developed infundibular passage with affected sinus showing varying degree of mucosal thickening.
Type 2: Significant – Uncinate process is hypoplastic or absent with ill-defined or absent infundibular passage and affected sinus show total opacification.
Type 3: Profound - Absent uncinate process with the sinus represented by shallow cleft in lateral nasal wall of the nose [2].

Sphenoid sinus pneumatization
Pattern of sphenoid sinus pneumatization is divided into 3 types - (i) Conchal (ii) Pre-Sellar (iii) Sellar.
Conchal: Area below the Sella is solid block of bone without pneumatization.
Pre-Sellar: Sphenoid sinus pneumatized to the level of frontal plane of the Sella and not extending beyond.
Sellar: Most common type, in which pneumatization extends into the body of the sphenoid, can also extend beyond the floor of Sella and can reach clivus [11].

Pterygoid process pneumatization
It is recognized, if it extends beyond horizontal plane crossing vidian canal, providing route for endoscopic repair of cerebrospinal fluid leakage and endoscopic biopsy of skull base lesions [30] (Figure - 13).

Anterior clinoid process pneumatization
Optico-carotid recess is a small space in lateral wall of sphenoid sinus, between carotid prominence inferiorly and optic canal superiorly (Figure - 10). The optico-carotid recess concurs with the ipsilateral optic nerve or the internal carotid artery protrusion into sphenoid sinus [31]. If the clinoid process is pneumatized, a deep recess might be there in the upper part of lateral wall of sphenoid sinus [23].

Materials and methods
Study population of 100 patients who underwent MDCT study of Paranasal sinus and nasal cavity from January 2021 to April 2021 were retrospectively studied for anatomical variants. Study was conducted in Saveetha medical college and hospital, Chennai, India.

All patients referred for MDCT Paranasal sinuses and nasal cavity above 18 years were included in the study. Patients with previous sino-nasal disease, head and neck malignancy, facial trauma and those younger than 18 years were excluded from the study.

The images were acquired on PHILIPS INGUNITY 128 slice CT machine with tube potential of 120 KV, helical scan with Rot value of 0.6 sec/HE and 39.4 mm/rot scan and CT paranasal sinuses examined using multiple reconstruction techniques. The axial plane was inferior orbital mental plane (anthropologic plane), coronal and sagittal reconstructions were post processed.

The data was manually analyzed for the presence of anatomical variants in paranasal sinuses and frequency of occurrence was documented and calculated in percentage.
Results
Out of 100 patients, 55 were male and 45 were female. Maximum variants (39%) were noted in age group 21-30 years seen. Deviated nasal septum was the most common in our study (86%) followed by agger nasi cells (56%), supraorbital cells (42%), concha bullosa (26%), frontal sinus hypoplasia (22%), pterygoid plate pneumatization (21%), Haller cells (19%), Onodi cells (19%), anterior clinoid pneumatization (18%), crista galli pneumatization (18%), paradoxical middle turbinate (9%), maxillary sinus septations (8%), maxillary sinus hypoplasia (5%), frontal sinus hyper-pneumatization (4%), maxillary sinus hyper-pneumatization (2%). A minimum of one anatomical variant was seen in all the case included in the study. We also observed that most of the cases in our study population showed more than one anatomical variant (Table 1 to 8).

Table – 1: Gender distribution.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>55</td>
<td>55%</td>
</tr>
<tr>
<td>Female</td>
<td>45</td>
<td>45%</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100%</td>
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</table>

Table – 2: Age distribution.

<table>
<thead>
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<th>Age in years</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
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<tr>
<td>≤ 20</td>
<td>10</td>
<td>10%</td>
</tr>
<tr>
<td>21-30</td>
<td>39</td>
<td>39%</td>
</tr>
<tr>
<td>31-40</td>
<td>26</td>
<td>26%</td>
</tr>
<tr>
<td>41-50</td>
<td>10</td>
<td>10%</td>
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<tr>
<td>51-60</td>
<td>12</td>
<td>12%</td>
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<tr>
<td>&gt;60</td>
<td>03</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table – 3: Pattern of sphenoid sinus pneumatisation.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concha</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Pre sellar</td>
<td>14</td>
<td>14%</td>
</tr>
<tr>
<td>Sellar</td>
<td>82</td>
<td>82%</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100%</td>
</tr>
</tbody>
</table>

Discussion

Deviated Nasal Septum
According to various studies, nasal septum deviation varies from 18% to 80%. Study by Tiwari, et al. reported 88.2% of study population with deviated nasal septum [33] and 85% as reported by Farhan, et al. [33].

In our study of 100 patients, most common variant was deviated nasal septum, reported in 86% of study population, which is very close to other studies (Figure - 12).

Frontal Sinus Variants
In our study, 22% of patient showed Frontal sinus hypoplasia (Figure - 6), which was slightly

higher to 15% seen in study by Devareddy, et al. [34].

Frontal sinus hyper-pneumatization (Figure - 7) is seen in 4% of study population in our study.

Table - 8: overall frequency of paranasal sinus anatomical variants.

<table>
<thead>
<tr>
<th>Anatomical variants in CT</th>
<th>Bilateral involvement</th>
<th>Right side involvement</th>
<th>Left side involvement</th>
<th>Total No. of cases</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal septum deviation</td>
<td>‘s’ shaped - 15</td>
<td>31</td>
<td>40</td>
<td>86</td>
<td>86%</td>
</tr>
<tr>
<td>Agger nasi cells</td>
<td>49</td>
<td>2</td>
<td>5</td>
<td>56</td>
<td>56%</td>
</tr>
<tr>
<td>Supraorbital cells</td>
<td>34</td>
<td>4</td>
<td>4</td>
<td>42</td>
<td>42%</td>
</tr>
<tr>
<td>Concha bullosa</td>
<td>14</td>
<td>3</td>
<td>9</td>
<td>26</td>
<td>26%</td>
</tr>
<tr>
<td>Frontal sinus hypoplasia</td>
<td>11</td>
<td>8</td>
<td>3</td>
<td>22</td>
<td>22%</td>
</tr>
<tr>
<td>Pterygoid plate pneumatisation</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>21</td>
<td>21%</td>
</tr>
<tr>
<td>Haller cells</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>19</td>
<td>19%</td>
</tr>
<tr>
<td>Onodi cells</td>
<td>7</td>
<td>7</td>
<td>5</td>
<td>19</td>
<td>19%</td>
</tr>
<tr>
<td>Anterior clinoid process pneumatation</td>
<td>8</td>
<td>8</td>
<td>2</td>
<td>18</td>
<td>18%</td>
</tr>
<tr>
<td>Crista galli pneumatisation</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>18</td>
<td>18%</td>
</tr>
<tr>
<td>Paradoxical middle turbinate</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>9%</td>
</tr>
<tr>
<td>Maxillary sinus septation</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>8</td>
<td>8%</td>
</tr>
<tr>
<td>Maxillary sinus hypoplasia</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Frontal sinus hyperplasia</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4%</td>
</tr>
<tr>
<td>Maxillary sinus hyperplasia</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2%</td>
</tr>
</tbody>
</table>

Figure - 1: CT Coronal image showing bilateral agger nasi cells.

Concha Bullosa
In a study by Mazza, et al., concha bullosa was reported in 29% (35) and 33% was observed by Farhan, et al. [33] which is slightly higher than our study, in which we report, 26% of the study population show concha bullosa of which 14% reported bilateral variant.

Figure - 2: CT Coronal image showing bilateral Haller cells.
Figure - 3: CT Coronal image showing left Onodi cell.

Figure - 4: CT Axial image showing right concha bullosa.

Paradoxical Rotation of Middle Turbinate
Our study reported 9% of the study population with this variant, 5% seen bilaterally and 2% right and left, which is very close to 8% reported by Dua, et al. But little lower than few other studies which reported 14% - 25% cases showing paradoxical rotation of middle turbinate [18, 37, 38, 39].

Agger Nasi Cells
Review of literature, shows prevalence of Agger nasi cells vary from 10 to 98.5%. Study by Talaiepour AR, et al., showed Agger nasi cell in 56.7% of cases [40] and another study by Devareddy et al. reported Agger nasi cells in 26% of study population [34].

Figure - 5: CT Coronal image showing bilateral paradoxical middle turbinates.

Figure - 6: CT Coronal image showing bilateral frontal sinus hypoplasia.

In our study we report 56% of study population showing agger nasi cells, which is similar to study by Devareddy, et al., of which 49% was seen bilaterally.

Onodi Cells
Study by John Earwaker, et al. showed 24% of Onodi cells [41] and study by Dua, et al. showed occurrence of Onodi cells in 6% of cases [36]. While in our study we report 19% of cases with Onodi cells, of which 7% seen bilaterally.

**Figure - 7:** CT Axial image showing bilateral frontal sinus hyper-pneumatization.

**Figure - 8:** CT Coronal image showing bilateral maxillary sinus hypoplasia.

**Figure - 9:** CT Axial image showing bilateral maxillary sinus septations.

**Figure - 10:** CT Axial image showing bilateral anterior clinoid process pneumatization.

### Anterior Clinoid Process Pneumatisation
Nouraei, et al. and Shpilberg, et al. reported 18% and 16.7% anterior clinoid process pneumatization in their study respectively. Which is similar to 18% reported in our study, with 8% seen bilaterally (**Figure - 10**).

### Kero’s Classification of Olfactory Fossa

In a study in Indian population, Murthy et al. reported Kero’s Type I in 19.5%, type II in 71.5% and type III in 9% [45].

**Figure - 11:** CT Coronal image showing pneumatized crista galli.

**Figure - 12:** CT Coronal image showing ‘S’ shaped deviated nasal septum.

Another study by Farhan, et al. reported 25.7% of type II, 62.3%, and 11.9% of type III [33].

In this study, we report, Kero’s type I in 7%, type II in 68% and type III in 17%. Kero’s Type II is the most common type of olfactory fossa reported in this study, as seen in other studies.

**Figure - 13:** CT Coronal image showing bilateral pterygoid process pneumatisation.

**Delanos Classification of Optic Nerve**

Study by Delano et al. reported 76%, 15%, 6%, and 3% of types I, II, III, IV respectively [46]. Type I was the most common.

In our study, most common type is also type I seen in 74% and 16% of type II, 0% of type III and 10% of type IV was seen.

**Maxillary Sinus Septation**

Study by Aliu Abdul Hameed, et al. reported 24.6% of maxillary sinus septum [47].

In our study, 8% of the study population showed maxillary sinus septa of which 2% seen bilaterally, 5% in right and 1% in left maxillary sinus and all seen on the anterior wall of sinus (**Figure - 9**). This is lower than the study by Aliu Abdul Hameed, at al.

**Maxillary Sinus Hypoplasia**

In our study, 5% of study population show maxillary sinus hypoplasia, of which 2% seen bilaterally (**Figure - 8**).

Study by Devareddy, et al. showed maxillary sinus hypoplasia 3% bilaterally which is similar to our study [34].
Maxillary sinus hyper-pneumatization is seen bilaterally in 2% of our study population.

Supraorbital Ethmoidal Cells
Souza, et al. reported 35% of study population with supraorbital ethmoidal cells which is lower than 42% as reported in our study. In our study 34% was seen bilaterally.

Carlos, et al. reported much higher occurrence of supraorbital ethmoidal cells of 69.1% in his study [49].

Crista Galli Pneumatisation
In our study we report 18% of cases with Crista galli pneumatization (Figure - 11) which is higher to 9.9% reported by Shpilberg et al. and 8.3% in another study by Amita Kumari, et al. [2, 50].

Variations In Sphenoid Sinus Septa
Study by Battal, et al. in Turkish population reported single intersphenoidal septum in 64.3% and multiple intersphenoidal septa in 32.1% [51].

Another study by Farhan, et al. show single intersphenoidal septum in 72.3% and multiple or accessory intersphenoidal septa in 24.5% of cases [33].

We found single intersphenoidal septa in 54% and multiple intersphenoidal septa seen in 46% of cases.

In our study, sphenoid sinus septa attached to ICA was seen in 20%, of which 6% found on the right and 8% found on the left and 6% bilaterally. Our data is higher than results by Farhan, et al. who reported sphenoid sinus septa attached to the ICA in 13.1% subjects, of which 3.8% on the right, 4.6 % on the left, and 4.6% present bilaterally [33].

Sphenoid Sinus Pneumatization Pattern
Most common in our study is Sellar variant as reported in study by O’Brien WT Sr, et al. seen in 82%, presellar variant in 14% and concha variant in 4% [52].

Pterygoid Process Pneumatization
In our study, we report 21% of study population show pterygoid process pneumatization. This is in accordance with 27.1% as reported by Shpilberg, et al. [2].

In our study, 7% show right sided pneumatization, 7% show left sided pneumatization and 7% showed bilateral pneumatization (Figure - 13).

Conclusion
MDCT plays a crucial role in the assessing the anatomical variants of the paranasal sinuses and nasal cavity. Considering the relatively high frequency of occurrence of these variants, a precise knowledge of imaging features of normal anatomy and anatomical variation of Paranasal sinuses and its location is of utmost importance for surgeons, especially in patients with recurrent and refractory sinusitis who may require surgical treatment.

Pre-operative MDCT PNS, plays a very important part in helping the surgeons get all the required anatomical information they need to appropriately plan the surgery for any particular patient and to avoid fatal and life threatening intra-operative complications. Hence, it is essential for the radiologists to have clear understanding of these common anatomic variants, its incidence and its imaging features.

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