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Tomographic Evaluation of Structural Variations of Nasal Cavity in Various Nasal Pathologies

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ABSTRACT

Objective: The aim of the present study was to evaluate the structural variations of nasal cavity in reference to frequency and types at the key area *i.e*. the ostiomeatal complex. **Materials and Methods:** Computed tomography of Paranasal sinuses of 50 patients was studied for clinical suspicion of various sinonasal pathologies. **Results:** The most commonly encountered anatomical variations in this study were Deviated Nasal Septum in 78% (39 patients), followed by Concha Bullosa in 36% (18 patients), Agger Nasi cell in 18% (nine patients), Pneumatised septum in 12% (six patients), Paradoxical Middle Turbinate and Septated Maxillary Sinus in 10% (five patients each) and Pneumatised Uncinate Process 6% (three patients). In quite a few patients we witnessed more than one variation. **Conclusion:** The anatomical variations in the nose and ostiomeatal complex are not uncommon, with the most frequent ones involving the nasal septum and the middle turbinate.

Keywords: Structural Variations of Nasal Cavity; CT PNS; Concha Bullosa; Paradoxical Middle Turbinate

1. Introduction

There are various sinonasal pathologies encountered in day to day clinical practice by otorhinolaryngologists. These pathologies sometimes do not respond to medical therapy. Computed tomography (CT) is the method of choice for evaluating these cases, particularly in patients, requiring surgical intervention [1]. Endoscopic surgery demands a meticulous assessment and a detailed description of both nasal and paranasal cavities structures [2]. In the last few years the anatomical CT variations and pathological findings were registered and supposed as a possible element which is favoring development of sinus pathology and shows symptoms usually connected with sinusitis [3]. Considering that the main objective of this type of surgery is to reopen the natural ways of drainage of paranasal cavities, it is very relevant that the radiologist is aware of the ostiomeatal complex variants, by describing them in a comprehensible way for the otorhinolaryngologist [4,5].

The present study was aimed at evaluating the frequency and types of anatomical variants of the nasal cavity and ostiomeatal complex.

2. Materials and Methods

This prospective study spanning over a period of 2 years (August 2010 to August 2012), comprised of CT evaluation of 50 patients with clinical suspicion of sinonasal pathologies who were part of OPD or IPD care of department of ENT of AVBRH, Wardha. Patients with Rhinosinusitis, Septal Pathologies like deviated nasal septum (DNS), Nasal Polyp, Symptom of Nasal Obstruction with different causes, Headache due to Nasal Pathologies, Anosmia/Hyposmia due to structural pathologies etc were included in this study. Those patients included in the study where analysed using parameters like age, sex, signs, symptoms, nasal endoscopic and CT scan findings like DNS, Agger cells, pneumatised septum, paradoxical middle turbinate, septated maxillary sinus, Haller cell and conha bullosa. Patients with Septal Pathologies like haematoma, abscess, perforation, fracture nasal bone, nasal trauma, sinonasal malignancies and patients with previous nasal surgery were excluded from the analysis.

Patients were scanned on "Philips 16 slides CT machine". The protocol consisted of coronal and axial slices, respectively, perpendicular and parallel to the palate,

with 2 - 3 mm in thickness. Scanning parameters included 120 kV and 250 mA. For patients who could not tolerate the prone position (hyperextended neck) required for coronal images acquisition, helical acquisition was performed with 2 - 3 mm collimation and computer-generated reconstructed coronal views. In all of the cases, soft tissue and bone algorithm were utilized for documentation.

A radiologist and an otorhinolaryngologist who were unaware of patients' symptoms analyzed CT scans independently. Only those patients in whom both specialists concurred on the anatomical and/or pathological changes were finally included in study.

3. Results

Out of 50 patients, 26 (52%) patients were male and 24 (48%) were female, ranging in the age of six to 70 years (mean age 31.66 years).

The structural variants commonly involved nasal septum and middle turbinates. The most commonly encountered anatomical variation in this study was Deviated Nasal Septum (**Figure 1**) in 78% (39 patients) followed by Concha Bullosa (**Figure 1**) in 36% (18 patients), Agger Nasi cell in 18% (nine patients), Pneumatised septum (**Figure 2**) in 12% (six patients), Paradoxical Middle Turbinate (**Figure 3**) and septated Maxillary Sinus (**Figure 1**) in 10% (five patients each). In 8% (four patients) infraorbital (Haller) cells and three patients (6%) Pneumatised Uncinate process (**Figure 4**) was observed. In 34 out of 50 patients more than one anatomical variants were present. Of this 36 patients one variation in 16 (32%) patients, two variations in 25 (50%) patients, three variations in seven (14%) and four variations in 1 (2%) patient were seen.

Figure 1. Shows bilateral concha bullosa, DNS & septated right maxillary sinus.

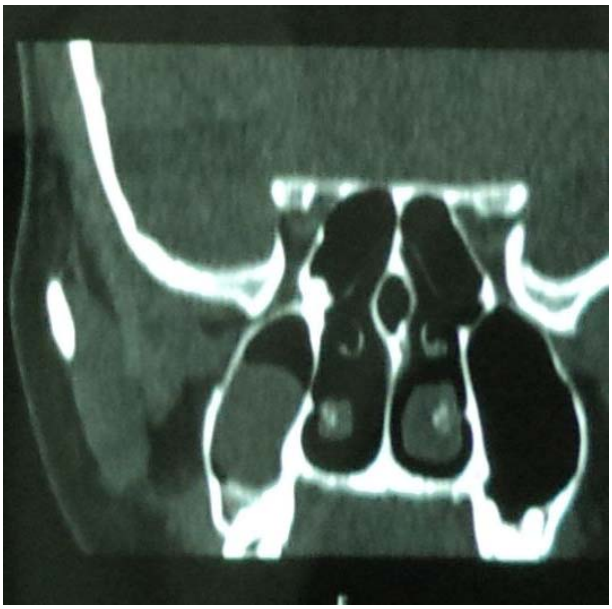

Figure 2. Pneumatised septum.

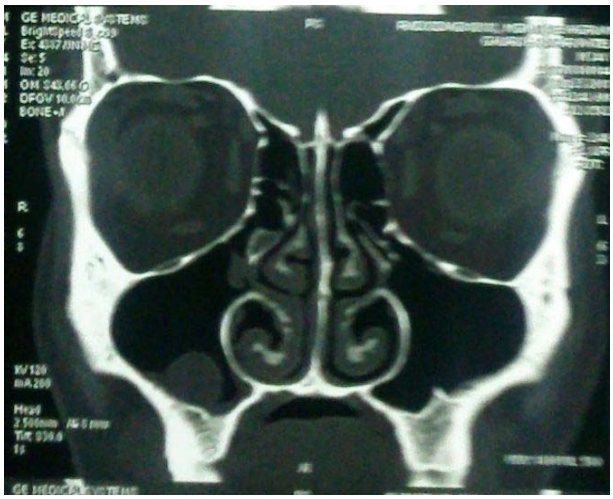

Figure 3. Paradoxical middle turbinate.

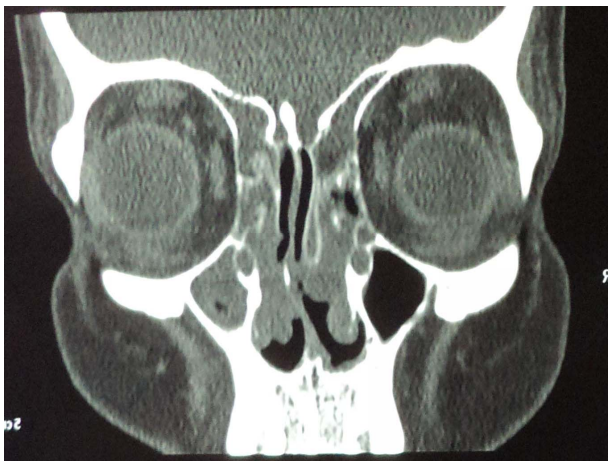

Figure 4. Pneumatised uncinate process.

Disease spectrum in these 50 patients was studied and we came across Maxillary sinusitis in 44% (22 patients), AC polyp in 22% (11 patients), Pansinusitis in 18% (nine patients), Headache (no cause found after extensive investigations) in 12% (six patients) and Ethmoidal polyp in 4% (two patients).

Maxillary sinusitis was the most common associated disease predominantly on the left side (11). Followed by right side (in seven patients) and bi-lateral (in four patients).

Antrochoanal polyp was the next common disease, which was seen in right side in six (54.5%) patients and in left side five (45.5%) patients.

Out of the total nine patients with sinusitis, most of them (eight) had bilateral disease.

4. Discussion

Instructive role of CT scan in guiding surgeons intra-operatively cannot be over-emphasized. It is like a road map, which is very handy for nasal endoscopic surgeons, not only for uneventful surgery but for avoiding possible complications.

In various studies since decades, subtle bony anatomical variations of nose, paranasal sinus and oeteomeatal complex are being detected. Data regarding "background" prevalence of these findings are needed to determine their clinical relevance. Current understanding of the localization and extent of the pathophysiology of sinus and skull base disease is based on detailed knowledge of anatomic structure [6].

The prevalence of anatomic variations of nose causing diseases has been variously described, ranging from pure anatomic descriptions to descriptions based on computed tomography examinations [7]. Prevalence of structural variations of nasal cavity and paranasal sinuses around 67% has been reported previously [5].

In the present study of 50 patients, a in-depth analysis of CT scans of PNS, specially coronal plane, coupled with endoscopic instrumentation was done with special attention to bony anatomical variations. Anatomical variants were identified in all but one patient evaluated (98%). One patient with nasal polyp, did not have any noticeable structural bony variation.

In our study, we encountered anatomical variations like deviated nasal septum, Concha Bullosa (pneumatised middle turbinate), Agger Nasi cell, Pneumatised septum, Paradoxical middle turbinate (medially curved middle turbinate), Haller cell (infra-orbital cell), Pneumatised Uncinate process and Septated maxillary sinus.

Two anatomical variations were observed in almost half of these patients (50%), followed by single variation (32%), three variations in 14% and as many as four variations in 2% cases. Here is an account of individual variations.

4.1. Deviated Nasal Septum

Nasal septal deviation has an important role in causing sinusitis. Asymmetric nasal septum can force nasal turbinates laterally and result in narrowing of the middle meatus and ultimately blocking drainage of the ipsilateral Maxillary, anterior ethmoid and frontal sinuses [8]. We included any visually detectable nasal deviation from the midline in this group.

In current study, DNS was the most common anatomical variation with prevalence rate of 78%. Prevalence of this particular anatomical variation ranging from 13% - 80% has been reported. Badia *et al*. (2005) [9], considered notable DNS, only when it was more than 4 mm deviation and found its prevalence to be only 13% - 20%. On the other hand, Perez-Pinas *et al*. (2000) [5] considered DNS, when any visually detectable nasal deviation from the midline was seen and observed prevalence of it to be 80%. Different criteria applied to diagnose and consider septum to be deviated in different studies, accounted for variation in prevalence.

Majority of the studies showed DNS as the most common anatomical variations, as does the present study. Talaiepour *et al*. (2005) [8], K. Dua *et al*. (2005) [10], S. Lerdlum *et al*. (2005) [11], Fikret K. *et al*. (2009) [12], H. Mamatha *et al*. (2010) [13] and recently A. K. Gupta *et al*. (2012) [14] had prevalence rate of DNS as an anatomical variation 65%, 44%, 56.4%, 41.9%, 65% and 65.2% in their respective studies.

4.2. Concha Bullosa

The middle nasal concha is normally a flat bone. When it is pneumatised by extension of anterior ethmoid cells or less frequently, posterior ones, it is referred to as Concha Bullosa [15]. The true concha bullosa is produced following pneumatisation of both portions (vertical lamina and inferior bulb) of the middle nasal concha [5]. Lamellar pneumatisation and conchal Pneumatization, both were included in Concha Bullosa in our study and with this criteria, it's prevalence rate was 36%.

As per Stammberger *et al*. the concha bullosa must be distinguished from an interlamellar cell, which arises from pneumatization of the vertical lamella of the middle turbinate from the superior meatus [6]. Perhaps due to this, prevalence of Concha Bullosa varied from 11.5% (A. K. Gupta *et al*., 2012 [14]) to 53% (Bolger *et al*., 1991 [15]).

Talaiepour *et al*. (2005) [8] had seen Concha Bullosa in 35% subjects, which nearly corresponds to our study-data.

4.3. Agger Nasi Cell

The most anterior cells of the anterior ethmoid group, the prevalence of Agger Nasi cell ranges widely in different studies which can be attributed to loose anatomic definitions or due to technical miss-match. Herein the Agger

Nasi cells are defined as those lying anterior to the upper end of the nasolacrimal duct [7]. The frequency of Agger nasi cell (AN cell) in our study population was 18%.

Bolger *et al*. (1991) [15] reported very high prevalence (98.5%) of Agger Nasi cell. A. K. Gupta *et al*. (2012) [14] observed a prevalence rate of 68.8%; Tonai and Baba's (1996) [16] and Talaiepour *et al*.'s (2005) [8] found prevalence of 56.7%.

Study by Badia L. *et al.*'s (2005) [9] study revealed presence of AN cell in 44% - 57% of British population. Lower prevalence of AN cell has been reported by Perez-Pinas *et al*. (2000) [5] 2.7%, S. Lerdlum *et al*. (2005) [11] 7.9% and Fikret K. *et al*. (2009) [12] 4.7%. Reason may lie in not so fixed criteria for diagnosis.

4.4. Pneumatised Septum

Pneumatised septum, an important anatomical variation, can compress the osteomeatal complex and has a potential to induce sinonasal mucosal diseases. The prevalence rate of Pneumatised septum in our study was 12%. This matches closely to prevalence reported by A. K. Gupta *et al*. (2012) [14], which is 13.04%. K. Dua *et al.* (2005) [10] reported prevalence of 2% for pneumatised septum (pneumatisation of Vomer).

4.5. Paradoxical Middle Turbinate

It is an anatomical variation of middle turbinate, where in it's convexity is reversed to face laterally. However it is not associated with any change in the normal middle turbinate attachments. This may lead to impingement of the middle meatus and thus sinusitis or other mucosal diseases of sinus, specially the large ones [7].

In present study, prevalence of Paradoxical Middle Turbinate was 10%, which is similar to the study of K. Dua *et al*. (2005) [10]. But, Bolger *et al*.'s (1991) [15], Tonai and Baba's (1996) [16] and Fikret K. *et al*.'s (2009) [12] noted greater prevalence rate of 26.1%, 25.3% and 16.3% respectively. S. Lerdlum *et al*. (2005) [11] reported lower prevalence rate (5.3% only).

4.6. Septated Maxillary Sinus

Maxillary sinus was septated in this study in 10% of patients. Relatively lower prevalence rate of 6% and 2.1% were observed by K. Dua *et al*.'s (2005) [10] and A. K. Gupta *et al*.'s (2012) [14] respectively.

4.7. Haller Cell

The potential pathophysiologic importance of a Haller's cell is clear, but not the anatomic definition. As described by Albert von Haller in 1765, these cells grow into the bony orbital floor that constitutes the roof of the maxillary sinus [6]. The definition of ethmoid cells given by Haller in eighteenth century is now controversial. Some authors (Kennedy and Zinreich, 1988) considered Haller cell as ethmoid cells which are the air cavities projecting below the ethmoid bulla within the orbital floor in the region of the opening of the maxillary sinus [5]. However, Bolger *et al*. (1991) broadened the term to include any cell located between the ethmoidal bulla, the orbital lamina of the ethmoid bone and the orbital floor [15].

Considering the criteria laid down by Haller, our study showed a prevalence of 8%. It is nearly similar to the prevalence reported by S. Lerdum *et al*. (2005) [11] (9.4%) and Fikret K. *et al*. (2009) [12] (9.3%). High prevalence was noted by Bolger *et al*. (1991) [15] (45.1%), Tonai and Baba (1996) [16] (36%), Badia L. *et al* (2005) [9] (10% - 15%), K Dua *et al.* (2005) [10] (16%), H. Mamatha *et al*. (2010) [13] (17.5%) and Talaiepour *et al*. (2005) [8] (3.5%) (see **Table 1**).

4.8. Pneumatised Uncinate Process

Pneumatised uncinate process as an anatomical variation was seen in 6% of patients, in the present study. This is quite comparable to the prevalence of 4.7% and 4.34%, reported by Fikret *et al*. (2009) [12] and A. K. Gupta *et al*. (2012) [14] respectively. Bolger *et al*. (1991) [15] found it in only 2.5% cases.

4.9. Sinonasal Pathologies

The diagnosis of nasal or inflammatory sinus diseases is often difficult clinically, as the nasal symptoms are neither sensitive nor specific in predicting the underlying pathology [17]. Various investigations, like CT scan, helps to establish diagnosis.

In this study, Maxillary sinusitis (22, 44%), Antrochoanal polyp (11, 22%) Pansinusitis (9, 18%) were the various sinonasal diseases, Headache and Ethmoidal polyp were found in 6 (12%) and 2 (4%) cases respectively.

Van der Veken P. *et al*. (1989) who studied 196 patients, showed Maxillary sinusitis as the most common sinus disease (63%) [18].

Neena Chaudhary *et al*. (1999), in her study of 69 patients, observed sinusitis in 61%, Ethmoidal Polyp in 26% patients and Antrochoanal Polyp in 13% patients [19].

Marcio M. Kinsui *et al*. (2002) in the study of 150 patients found that most affected paranasal sinus was Maxillary sinus (52.7%) in terms of mucosal abnormalities [20].

While agreeing with other studies, present study also points that Maxillary sinusitis is the commonest diagnosis. In other word, maxillary sinus is the most frequent involved sinus.

In the present study, Antrochoanal polyp on the Rt.

Table 1. Comparison of prevalence of anatomical variations (n = number of patients).

	DNS	CB	AN Cell	Pneumatised Septum	Paradoxical MT	Septated MS	HC	Pneumatised UP
Present Study	78%	36%	18%	12%	10%	10%	8%	6%
Bolger *et al*. (1991) [15] (n = 202)	-	53%	98.5%	-	26.1%	-	45.1%	2.5%
Tonai and Baba (1996) [16] (n = 75)	-	28%	86.7%	-	25.3%	-	36%	-
Perez-Pinas *et al*. (2000) [5] (n = 110)	80%	24.5%	2.7%	-	-	-	-	-
Talaiepour *et al*. (2005) [8] (n = 143)	63%	35%	56.7%	-	-	-	3.5%	-
Badia L. *et al*. (2005) (for UK population) [9] (n = 200)	13% - 20%	12% - 31%	44% - 57%	-	10% - 22%	-	10% - 15%	2%
K. Dua *et al*. (2005) [10] (n = 50)	44%	16%	40%	2%	10%	6%	16%	-
S. Lerdlum *et al*. (2005) [11] (n = 148)	56.4%	14.3%	7.9%	-	5.3%	-	9.4%	-
Fikret K. *et al*. (2009) [12] (n = 43)	41.9%	16.3%	4.7%	-	16.3%	-	9.3%	4.7%
H. Mamatha *et al*. (2010) [13] (n = 40)	65%	15%	50%	-	-	-	17.5%	-
A. K. Gupta *et al*. (2012) [14] (n = 69)	65.2%	11.5%	68.8%	13.04%	-	2.1%	-	4.34%

side was seen in 54.5% and on Lt. Side in 45.5% patients. No left or right bias with Antrochoanal polyp has been found in previous studies. It is also supported by P. Frosini *et al*.'s study (2009, in which, AC Polyp was in Rt. side for 48.5% and in Lt. side for 50% patients [21].

4% of our patients has Ethmoidal polyp while 22% patients are diagnosed to have Antrochoanal polyp. In contrast to our study, Neena Chaudhary *et al*.'s (1999) [19] found Ethmoidal polyp out numbering AC polyp (18 of 27 patients with nasal polyp had Ethmoidal polyp).

5. Conclusions

Thus, with the pitfall of less sample size, this study has re-emphasized the concept that positions of the nasal septum and Osteomeatal complex are the key factors in the causation of various sinonasal pathologies like sinusitis or polyp. Different and frequent anatomical variants may be found in the anterior ostiomeatal complex, and a single individual may present with different variants.

In the present study, the most frequent variants involved the nasal septum (deviation or pneumatization), the middle turbinate, particularly their pneumatization and paradoxical curvature, pneumatized agger nasi cells, infraorbital ethmoid cells and uncinate process. Removal of disease from Osteomeatal complex region is the basic principle of FESS which is best appreciated on CT Scan. Before the suggestion of a casual relation between the anatomical variants and the sinusopathy in the tomographic analysis of a patient, these conditions should be considered in conjunction with the clinical picture.

REFERENCES

[1] A. P. de Freitas Linhares Riello and E. M. Boasquevisque, "Anatomical Variants of the Ostiomeatal Complex: Tomographic Findings in 200 Patients," *Radiologia Brasileira*, Vol. 41, No. 3, 2008, pp. 149-154.

[2] J. J. Ludwick, K. H. Taber, S. Manolidis, *et al*., "A Computed Tomographic Guide to Endoscopic Sinus Surgery: Axial and Coronal Views," *Journal of Computer Assisted Tomography*, Vol. 26, No. 2, 2002, pp. 317-322. doi:10.1097/00004728-200203000-00026

[3] A. Lactic, D. Milicic, K. Radmilovic, M. Delibegovic and J. Samardzic, "Paranasal Sinus CT Scan Findings in Patients with Chronic Sinonasal Symptoms," *Acta Informatica Medica*, Vol. 18, No. 4, 2010, pp. 196-198.

[4] L. D. Dutra and E. Marchiori, "Tomografia Computadorizada Helicoidal dos Seios Paranasais na Criança: Avaliação das Sinusopatias Inflamatórias," *Radiologia Brasileira*, Vol. 35, No. 3, 2002, pp. 161-169. doi:10.1590/S0100-39842002000300007

[5] I. Pérez-Piñas, J. Sabaté, A. Carmona, *et al*., "Anatomical Variations in the Human Paranasal Sinus Region Studied by CT," *Journal of Anatomy*, Vol. 197, No. 2, 2000, pp. 221-227. doi:10.1017/S0021878299006500

[6] H. R. Stammberger and D. W. Kennedy, "Paranasal Sinuses: Anatomic Terminology and Nomenclature," *Annals of Otology, Rhinology and Laryngology Supplement*, Vol. 167, No. 104, 1995, pp. 7-16.

[7] J. Earwaker, "Anatomic Variants in Sinonasal CT," *RadioGraphics*, Vol. 13, No. 2, 1993, pp. 381-415.

[8] A. R. Talaiepour, A. A. Sazgar and A. Bagheri, "Anatomic Variations of the Paranasal Sinuses on CT Scan Images," *Journal of Dentistry, Tehran University of Medical Sciences*, Vol. 2, No. 4, 2005, pp. 142-146.

[9] L. Badia, V. J. Lund, W. Wei and W. K. Ho, "Ethnic Variation in Sinonasal Anatomy on CT-Scanning," *Rhinology*, Vol. 43, 2005, pp. 210-214.

[10] K. Dua, H. Chopra, A. S. Khurana and M. Munjal, "CT Scan Variations in Chronic Sinusitis," *Indian Journal of Radiology and Imaging*, Vol. 15, No. 3, 2005, pp. 315-320. doi:10.4103/0971-3026.29144

[11] S. Lerdlum and B. Vachiranubhap, "Prevalence of Anatomic Variation Demonstrated on Screening Sinus Com-

puted Tomography and Clinical Correlation," *Journal of the Medical Association of Thailand*, Vol. 88, Suppl. 4, 2005, pp. S110-S115.

[12] F. Kasapoglu, S. Onart and O. Basut, "Preoperative Evaluation of Chronic Rhinosinusitis Patients by Conventional Radiographics, Computed Tomography and Nasal Endoscopy," *Kulak Burun Boğaz İhtisas Dergisi*, Vol. 19, No. 4, 2009, pp. 184-191.

[13] H. Mamatha, N. M. Shamasundar, M. B. Bharathi and L. C. Prasanna, "Variations of Osteomeatal Complex and Its Applied Anatomy: A CT Scan Study," *Indian Journal of Science and Technology*, Vol. 3, No. 8, 2010, pp. 904-907.

[14] A. K. Gupta, B. Gupta, N. Gupta and N. Gupta, "Computerized Tomography of Paranasal Sinuses: A Roadmap to Endoscopic Surgery," *Clinical Rhinology*: *An International Journal*, Vol. 5, No. 1, 2012, pp. 1-10.

[15] W. E. Bolger, C. A. Butzin and D. S. Parsons, "Paranasal Sinus Bony Anatomic Variations and Mucosal Abnormalities: CT Analysis for Endoscopic Sinus Surgery," *Laryngoscope*, Vol. 101, No. 1, 1991, pp. 56-64. doi:10.1288/00005537-199101000-00010

[16] A. Tonai and S. Baba, "Anatomic Variations of the Bone in Sinonasal CT," *Acta Otolaryngologica Supplement*, Vol. 525, 1996, pp. 9-13.

[17] D. Sheetal, P. P. Devan, P. Manjunath, P. Martin, K. Satish Kumar, Sreekantha, T. G. Satisha and B. K. Manjunatha Goud, "CT PNS—Do We Really Require before FESS?" *Journal of Clinical & Diagnostic Research*, Vol. 5, No. 2, 2011, pp. 179-181.

[18] P. Van der Veken, P. A. Clement, T. Buisseret, B. Desprechins, L. Kaufman and M. P. Derde, "CAT-Scan Study of the Prevalence of Sinus Disorders and Anatomical Variations in 196 Children," *Acta Othorhinolaryngologica Belgica*, Vol. 43, No. 1, 1989, pp. 51-58 .

[19] N. Chaudhary, R. Kapoor, G. Motwani and S. C. Gandotra, "Functional Endoscopic Sinus Surgery Results in 69 Patients," *Indian Journal of Otolaryngology and Head & Neck Surgery*, Vol. 52, No. 1, 1999, pp. 5-8.

[20] M. M. Kinsui, A. Guilherme and H. K. Yamashita, "Anatomical Variations and Sinusitis: A Computed Tomographic Study," *Revista Brasileira de Otorrinolaringologia*, Vol. 68, No. 5, 2002, pp. 642-652.

[21] P. Frosini, G. Picarella and E. De Campora, "Antrochoanal Polyp: Analysis of 200 Cases," *Acta Otorhinolaryngologica Italica*, Vol. 29, No. 1, 2009, pp. 21-26.

