International Journal of Otorhinolaryngology and Head and Neck Surgery
Handi PS et al. Int J Otorhinolaryngol Head Neck Surg. 2017 Oct;3(4):898-903
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

DOI: http://dx.doi.org/10.18203/issn.2454-5929.ijohns20174204

Original Research Article

Evaluation of nose and paranasal sinus disease, anatomical variations by computerized tomography

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Received: 21 August 2017
Accepted: 14 September 2017

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ABSTRACT

Background: The anatomy of paranasal sinuses is very complicated. Evaluation of the location, extent of sino nasal diseases and anatomical variations by preoperative radiologic evaluation of the paranasal sinuses is essential in planning surgical intervention. Meticulous radiographic delineation of the small structures in this region, coupled with endoscopic evaluation, provides detailed preoperative information regarding morphology and pathology.
Methods: Patients with sinonasal symptoms indicating requirement of CT scan evaluation and aged more than 10 years were included in the study. Each CT scan was interpreted by an otolaryngologist and a radiologist and interpretation was by consensus. The data collected was evaluated and results are reported as rates and proportions.
Results: Sinusitis (single or multiple sinus involvement), nasal polyposis, frontal mucocele and ethmoidal carcinoma with destruction of medial wall of maxilla were the pathologies observed in these CT scans with sinusitis [22 (43.1%)] being the most common pathology observed. Deviated nasal septum [21 (41.2%)] was the most common anatomical variation observed. All patients who had concha bullosa [5 (9.8%)] were observed to have sinusitis involving multiple bilateral PNS. Based on Keros' classification, olfactory fossa depth type I was most commonly observed followed by type II and type III.
Conclusions: CT scan is important in patients undergoing endoscopic sinus surgery for sinonasal diseases where it acts as a road map in identifying the presence, extent of disease and any anatomical variations. This pre-operative CT scan evaluation improves planning and helps in significantly reducing morbidity and possible complications during surgery.

Keywords: CT scan, Paranasal sinus, Sinusitis, Anatomical variations

INTRODUCTION

The paranasal sinuses are a group of air filled spaces surrounding the nasal cavity; which start developing from the primitive choana at 25–28 weeks of gestation.[1] The anatomy of paranasal sinuses is very complicated.[2] Evaluation of the location, extent of sino nasal diseases by radiologic evaluation of the paranasal sinuses is essential in planning surgical intervention. Plain radiography, computed tomography and magnetic resonance imaging are applied in evaluating the sinuses. Computed tomography is considered the radiologic method of choice in completely delineating the normal anatomy and anatomical variants of the paranasal sinuses and it is extremely useful in the pre-operative planning of endonasal surgeries.[1] Coronal images can be directly acquired, preferentially with the patient in prone position, or otherwise being reconstructed from axial images. Multislice spiral CT allow multiplanar image reconstruction with a quality similar to the images directly acquired in the coronal plane, while eliminating artifacts originated by eventual dental restorations.

Sagittal reconstructions supplement the anatomical detailing of paranasal cavities provided by coronal images, especially of frontal sinuses and frontal recess. The advantage of this approach for endoscopic sinus surgery is, it can provide anatomical and pathological image with the same perspective to the surgeon.[3]

Sinonasal region that possess frequently anatomic variations, plays an important role in the pathogenesis of paranasal sinus diseases.[2] Earlier studies have demonstrated the very high rate of anatomical variations in the sinonasal area especially the osteomeatal complex-a small area located in the region between the middle turbinate and lateral nasal wall in the middle meatus representing the area of drainage of anterior ethmoid, maxillary and frontal sinuses and the importance of careful assessment of CT scan in patients with chronic rhinosinusitis, especially in the pre-operative planning prior to endoscopic surgery.[4-7] Meticulous radiographic delineation of the small structures in this region, coupled with endoscopic evaluation, provides detailed preoperative information regarding morphology and pathology. This information has led to more focused endoscopic surgical procedures, which have dramatically reduced patient morbidity.[4] In view of this, the aim of this study was to evaluate the anatomy of the nose and paranasal sinuses as delineated by computed tomography and to describe the clinical significance of the observed anatomical variants, nasal and paranasal sinus pathology.

METHODS

The CT scan of fifty one patients attending the outpatient department of otorhinolaryngology in a tertiary care centre between April 2015 to September 2016 were evaluated in this study. Patients with sinonasal symptoms indicating requirement of CT scan evaluation and aged more than 10 years were included in the study. Patients who were previously operated and patients with facial anomalies were excluded.

CT scan was performed with a Philips CT scanner. Direct axial sections were done in all the patients with the patients in supine position; with coronal reconstruction. Axial and coronal views in bone and soft tissue windows of all the CT scan films were reviewed using Philips Dicom Viewer software. All the CT scans evaluated in this study were performed without contrast. The study parameters evaluated were age, sex, and radiographic findings of disease and anatomical variations. Each CT scan was interpreted by an otolaryngologist and a radiologist and interpretation was by consensus. Each scan was reviewed for the presence of haller cell, onodi cell, concha bullosa, paradoxically curved middle turbinate, deviated nasal septum (DNS), pneumatisation in the nasal septum, superior and middle turbinate, uncinate process, osteomeatal complex, type of olfactory fossa, lamina papyracea, the presence of frontal sinus, sinonasal soft tissue and site of sinus infection. The data on concha bullosa and Haller's cell were also analyzed for their contribution to maxillary sinusitis. If the septum was obstructing at least half of the nasal cavity, it was termed as deviated nasal septum. The data collected was evaluated and results are reported as rates and proportions (%).

RESULTS

The study evaluated CT scan of 51 patients of which 34 were male patients and 17 were female patients with age ranging from 15 years to 65 years. Most [15 (29.4%)] of these patients belonged to the 21-30 age group (Table 1).

Table 1: Distribution of cases based on age and sex.

Age group (years)	Males	Females	Total number (%)
11-20	3	4	7 (13.7)
21-30	10	5	15 (29.4)
31-40	10	1	11 (21.6)
41-50	5	4	9 (17.6)
51-60	5	2	7 (13.7)
61-70	1	1	2 (3.9)
TOTAL	34	17	51

Table 2: Classification of cases based on sites of paranasal sinus (PNS) disease.

Site of PNS disease	Number n (%) N=51	Pattern of involvement	
		Unilateral	Bilateral
Frontal sinus	26 (51.0)	4	22
Maxillary sinus	38 (74.5)	9	29
Ethmoid sinus	32 (62.7)	5	27
Sphenoid sinus	22 (43.1)	5	17

N= total number evaluated; n= number in each group; % = n/N×100.

Table 3: Classification of cases based on types of olfactory fossa (Keros' classification).

Type of olfactory fossa	Number evaluated, n (%) N=51
Type I (1-3 mm in depth)	29 (56.9)
Type II (4-7 mm in depth)	20 (39.2)
Type III (> 8 mm in depth)	2 (3.9)

N= total number evaluated; n= number in each group.

Sinusitis (single or multiple sinus involvement), nasal polyposis, frontal mucocele and ethmoidal carcinoma with destruction of medial wall of maxilla were the pathologies observed in these CT scans with sinusitis [22 (43.1%)] being the most common pathology observed. Orbital wall erosion was observed in 2 cases: one lamina papyracea erosion and one with erosion of floor of orbit.

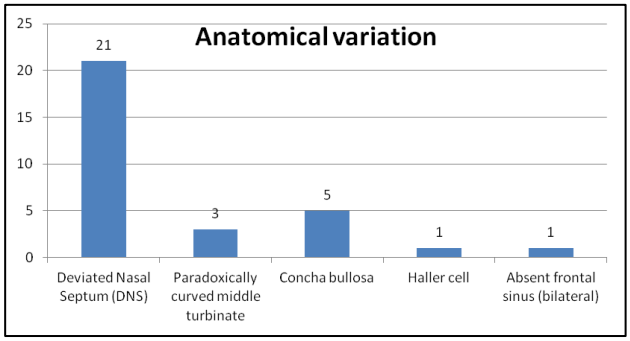

Figure 1: Classification of cases based on anatomical variations observed.

Deviated nasal septum [21 (41.2%)] was the most common anatomical variation observed (Figure 1). All patients who had concha bullosa [5 (9.8%)] were observed to have sinusitis involving multiple bilateral PNS. Maxillary sinus [38 (74.5%)] was the most common site of paranasal sinus disease (Table 2).

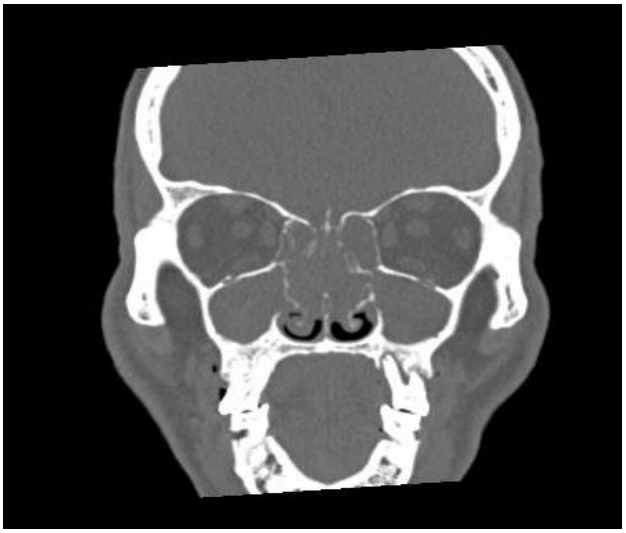

Figure 2: Bilateral maxillary ethmoid sinusitis with polyposis with OMC block.

Based on Keros' classification, olfactory fossa depth type I was most common followed by type II and type III (Table 3).

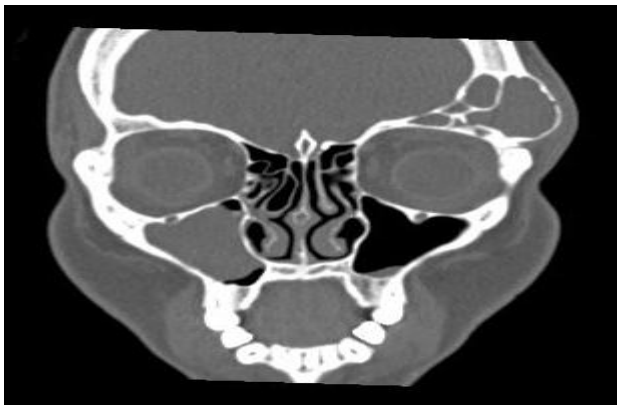

Figure 3: Concha bullosa with maxillary sinusitis.

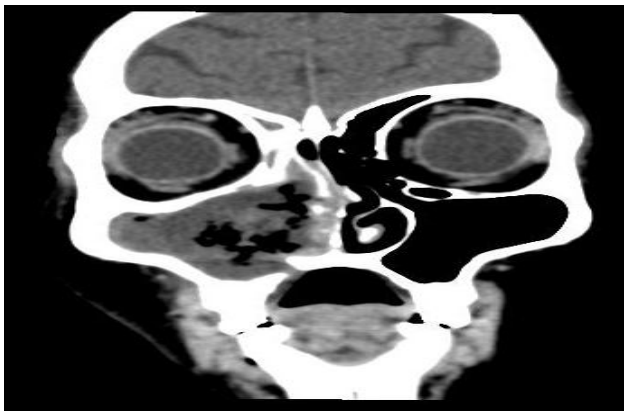

Figure 4: Destruction of medial wall of maxillary Sinus.

Figure 5: DNS With OMC Block With Maxillary and Ethmoid Sinusitis.

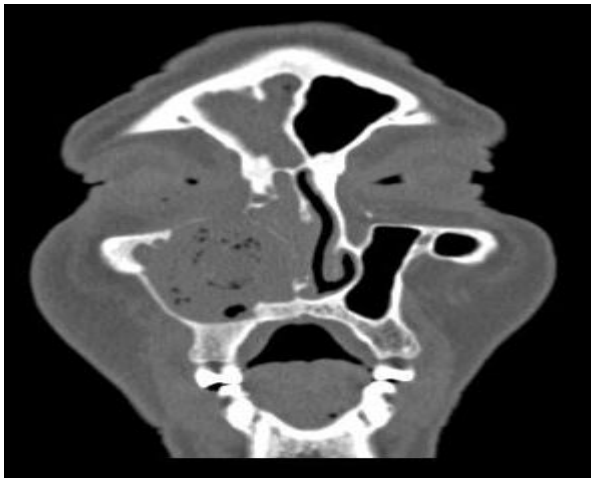

Figure 6: Erosion of floor of orbit.

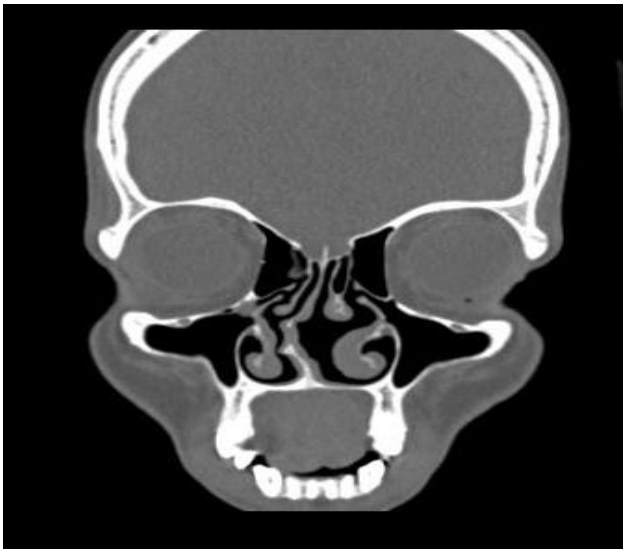

Figure 7: Gross DNS causing narrowing of infundibulum.

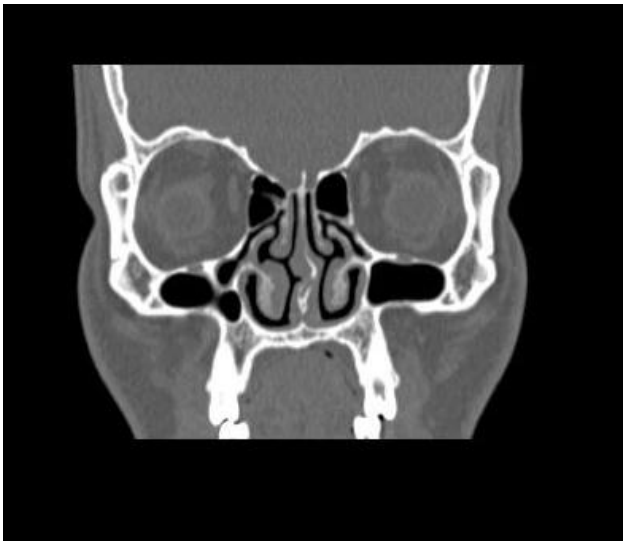

Figure 8: Type I olfactory fossa.

DISCUSSION

The knowledge of the sinonasal anatomical variations by the radiologist and otorhinolaryngologist is essential, considering their possible involvement in the genesis of sinusitis, changing the anatomy of the region and increasing the risk for eventual iatrogenic complications from endonasal procedure.[3] While there are many studies which indicate that anatomical variations of paranasal sinus structures may predispose patients to recurrent sinusitis, the relative importance of anatomical variations is still a matter of discussion with some authors considering local, systemic and environmental factors or intrinsic mucosal abnormalities as significant contributors to the pathogenesis of rhinosinusitis.[8-12]

In this study, patients with sinonasal symptoms undergoing CT scan were found to be more commonly in the 21-30 age group which is consistent with the observations by Verma et al, Kanwar et al.[13,14] There were more male patients (66.7%) than female patients (33.3%) with CT scan for sinonasal symptoms which is consistent with literature reported by Fadda GL et al, Kushwah APS et al.[8,15]

Sinusitis (single or multiple sinus involvement) was the most common pathology observed (43.1%) and maxillary sinus [38 (74.5%)] was the most common site of paranasal sinus disease (Table 2). This is in line with studies by Verma, Kanwar, Khushwa et al.[13-15]

Among the CT scans evaluated, anatomical variations were observed in 31 cases (60.8%). Variation in the nasal septum results in morphological variations such as deviated nasal septum, chondro-vomeral junction deformity, pneumatisation of nasal septum and nasal bone spur[1]. Deviated nasal septum (41.2%) was the most common anatomical variation observed (Figure 1) in this study with similar prevalence reported in studies by Verma et al, Asruddin et al.[13,16]

Concha bullosa was observed in 9.8% of the cases in this study. This incidence is lower than that reported by Zinreich et al (34%).[4] The wide reported incidence (14–53%) of concha bullosa in CT scan evaluation may be explained by varied definition of a concha bullosa among studies. Some reports defined a concha as any aeration of the middle turbinate, even if the aeration is restricted to the upper nonbulbous portion of the turbinate while others as aeration of the middle turbinate that caudally into the bulbous portion of the middle turbinate.[12] In this study all patients who had concha bullosa [5 (9.8%)] were observed to have sinusitis involving multiple, bilateral PNS while in literature, the relationship of concha bullosa to paranasal sinus disease continues to be debated.[12]

Abnormal curvature of the middle turbinate towards the midline (convexity is lateral instead of medial) is called the paradoxical middle turbinate. Compression of the

infundibulum and obstruction may occur based on the extent of curvature of the paradoxical middle turbinate.[1] In this study, 3 cases of paradoxically curved middle turbinate were observed.

Haller cell is an ethmoidal air cell located beneath the floor of the orbit.[17] Stackpole et al demonstrated a significant increase in maxillary sinus mucosal disease in patients with medium or large Haller cells.[18] In this study only one case of Haller cell was observed and this patient had bilateral maxillary sinusitis.

Frontal sinus lies in the diploic space between the outer and inner tables of the frontal bone. The right and left frontal sinuses are commonly unequal in size and are separated by a bony septum in the midline. Occasionally, one of them may be very small or absent. Frontal sinuses drain via frontal recess into the middle meatus or ethmoid infundibulum[1]. In this study, one case of bilateral absence of frontal sinus development was observed.

The depth of the olfactory fossa is determined by the height of the lateral lamella of the cribriform plate. In 1962, Keros defined three heights and classified the depth of the olfactory fossa into Keros type I (<3 mm), type II (4–7 mm) and type III (8–16 mm).

Depending on the Keros' type, a variable segment of the lateral wall of the olfactory fossa will be exposed during the dissection of the frontoethmoidal region. The Keros' type III is the most vulnerable one, considering the major risk for iatrogenic lesion of the lateral lamella of the cribriform plate.[19] In our study, olfactory fossa depth type I was most common followed by type II and type III (Table 3) unlike other studies where type II was most commonly observed.[17]

CONCLUSION

In this study, sinonasal diseases and many anatomical variants were observed with maxillary sinus the most commonly involved in sinus disease and DNS the most common anatomical variation. This study reinforces the importance of CT scan to identify the presence of anatomical variations in the paranasal sinus that may be correlated with onset, persistence or recurrence of sinonasal diseases. CT scan is especially important in patients undergoing endoscopic sinus surgery for sinonasal diseases where it acts as a road map in identifying the presence, extent of disease and any anatomical variations which improves planning and helps in significantly reducing morbidity and possible complications during surgery.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Handi PS, Patil MN. Evaluation of nose and paranasal sinus disease, anatomical variations by computerized tomography. Int J Otorhinolaryngol Head Neck Surg 2017;3:898-903.