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Use of Multidetector Computed Tomography in Evaluation of Anatomical Variations of Nose and Paranasal Sinuses in Indian Population

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Abstract

Background: Our study aims to assess the anatomical variations of paranasal sinuses in the Indian population and their association with sinusitis.

Methods: The present hospital based prospective observational study was performed at SMS medical College and Hospital, Jaipur. 80 patients referred for NCCT of PNS were included in the study between November 2020 and February 2021. The patients underwent NCCT scans of PNS on Phillips128 slice CT scanner.

Results: Most commonly, a deviated nasal septum was seen. Occurrence of a combination of variations was noted in a large number of cases.

Conclusion: Computed Tomography of the paranasal sinuses provides accurate evaluation of diseases of the paranasal sinuses. It also helps to establish the presence or absence of anatomical abnormalities that help in preoperative planning since these variations can predispose patients to intro-op complications. The radiologist, thus, must pay close attention to variants and provide road map to surgeons and help avoid possible complications.

Keywords: CT, PNS, FESS

Introduction

Paranasal sinuses (PNS) are the air filled extensions of the nasal cavity that reduce the weight of the anterior skull, humidify air and provide resonance to voice. There are four paired paranasal sinuses: maxillary, ethmoid, frontal and sphenoid sinuses. The precise knowledge of the anatomy of paranasal sinuses is essential for the surgeon.[1]This is especially true since the advent of functional endoscopic sinus surgery (FESS).

Radiography has been conventionally used to image the paranasal sinuses and does provide information in the diseases of maxillary and frontal sinuses. However, it has limited role in the evaluation of pathologies of the nasal cavity, ethmoid and sphenoid sinuses and the osteomeatal complexes.

Multi detector computed tomography is an excellent modality to image the bone, soft tissue and air in the paranasal sinuses. It helps in identifying the presence or

absence and nature of anatomical variations and abnormalitiesof the paranasal sinuses. The extent or severity of an abnormality can be seen.Multiplanar imaging assists in accurate delineation of the anatomic locales and disease in the paranasal sinuses. It provides a preoperative road map for functional endoscopic sinus surgery. A combination of CT and diagnostic endoscopy is the keystone in the management of paranasal sinus diseases.

MRI is often used in the evaluation of tumors of the PNS due to its ability to provide excellent soft tissue resolution. However, due to its inability to display the skeletal anatomy, it provides little information about the anatomical variations and bony afflictions. So, Computed tomography is currently used as a method of choice in the evaluation of the paranasal sinuses and adjacent structures.[2]

Sinusitis is a common health problem, and can be diagnosed clinically. CT is performed to ascertain the extent of disease, to provide information about anatomy of the sinonasal system and for preoperative information beforeFESS. Presently, computed tomography (CT) is the modality of choice for the imaging evaluation of the morphology. FESS is undertaken when patients do not respond to medical therapy. Our study aims to assess the anatomical variations of paranasal sinuses in the Indian population and their association with sinusitis.

Material and methods

The present hospital based prospective observational study was performed at SMS medical College and Hospital, Jaipur. 80 patients referred for NCCT of PNS were included in the study between November 2020 and February 2021. The patients underwent NCCT scans of PNS on Phillips128 slice CT scanner. Images were examined in multiplanar image reconstructions in both bone and soft tissue windows.

Inclusion criteria: Patients included in the study were those with complaints pertaining to PNS, and referred for CT PNS.

Exclusion criteria

1. Facial trauma.
2. History of sinonasal surgery
3. Paranasal sinus neoplasm

Technique

NCCT scan of patients were taken with the patient in supine position, parallel to the hard palate. The scan extended superiorly from the superior margin of frontal sinus, upto the upper alveolar arch inferiorly, and from the posterior margin of sphenoid sinus to tip of the nose anteriorly. Multiplanar reconstructions of the axial images in coronal and sagittal views were reviewed.

Results

Among 80 patients selected for the study of variations in the paranasal sinus 40 (50%) were males and 40 (50%) females. (Figure 1)

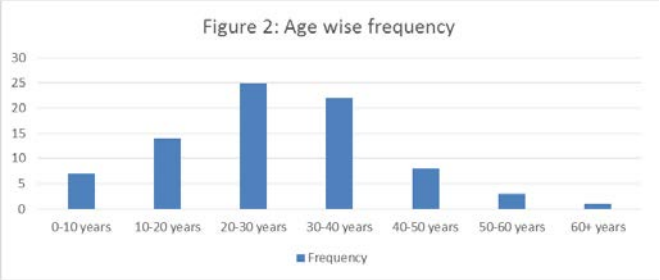
Figure 1: Gender wise distribution

Majority of the subjects, patients were in the age group of 20-40 yrs. (Table-1, Figure 2).

Age	Frequency	Percentage
0-10 years	7	8.75
10-20 years	14	17.5
20-30 years	25	31.25

30-40 years	22	27.5
40-50 years	8	10
50-60 years	3	3.75
Over 60 years	1	1.25

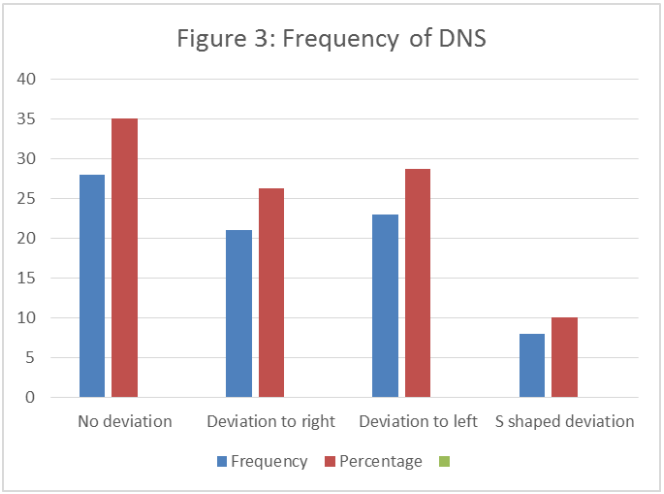
Table 1: Age wise frequency



In our study 65% of patients showed deviated nasal septum. There was slight predominance to the left side (28.75%) as compared to right side (26.25%) (Table 2, Figure 3).

	Frequency	Percentage
No deviation	28	35
Deviation to right	21	26.25
Deviation to left	23	28.75
S shaped deviation	8	10
Total	80	100

Table 2: Frequency of deviated nasal septum



The anatomical variant cells are considered in the paranasal sinuses (table-3).

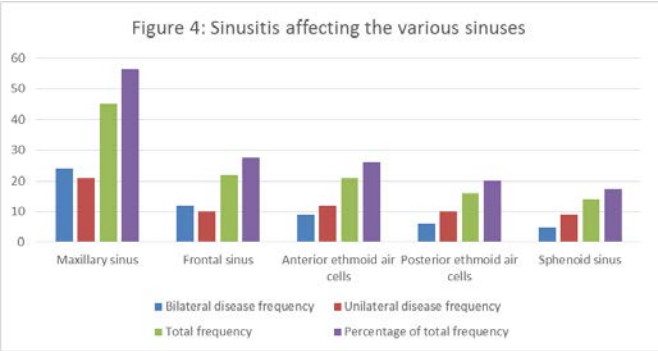
Anatomical variant cell	Frequency	Percentage
Haller cell	11	13.75
Agger nasi cells	16	20
Onodi cells	3	3.75
Supraorbital pneumatization of ethmoidal cells	6	7.5

Table 3: Occurrence of special cells

Mucosal abnormalities in the form of mucosal thickening, air-fluid levels, or opacification of sinus suggesting sinusitis were seen most commonly in the maxillary sinuses, usually bilaterally. (Table 4, Figure 4)

Sinusitis in	Bilateral disease frequency	Unilateral disease frequency	Total frequency	Percentage of total frequency
Maxillary sinus	24	21	45	56.25
Frontal sinus	12	10	22	27.5
Anterior ethmoid air cells	9	12	21	26.25
Posterior ethmoid air cells	6	10	16	20
Sphenoid sinus	5	9	14	17.5

Table 4: Occurrence of mucosal abnormalities in various sinuses



The various anatomical variations studies and their frequencies are enlisted in Table 5. Most commonly, a deviated nasal septum was seen. Occurrence of a combination of variations was noted in a large number of cases.

Anatomical variation	Number of cases	Percentage
Deviated nasal septum	52	65
Concha bullosa	26	32.5
Haller cell	11	13.75
Agger nasi cells	16	20
Onodi cells	3	3.75
Supraorbital pneumatization of ethmoidal cells	6	7.5
Frontal sinus septation	14	17.5
Frontal sinus agenesis	4	5
Frontal sinus hypoplasia	10	12.5
Maxillary sinus septation	9	11.25
Maxillary sinus hypoplasia	1	1.25
Sphenoid sinus septation	16	20
Sphenoid sinus hypoplasia	1	1.25
Paradoxical middle turbinate	6	7.5
Crista galli pneumatization	5	6.25

Table 5: Anatomical variations studied

The presence of anatomical PNS variations and mucosal abnormalities in sinuses is enlisted in Table 6.

	Sinusitis Present	Sinusitis absent	Total
Anatomical variations present	61	9	70
Anatomical variations absent	5	5	10
Total	66	14	80

Table 6: Occurrence of sinusitis and mucosal abnormalities

Figure 5: Bilateral Concha bullosa and supraorbital pneumatization of ethmoidal air cells on left side.

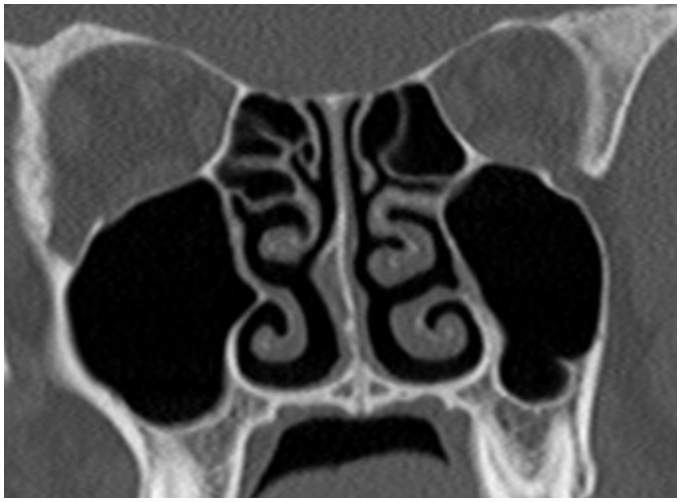


Figure 6: Left paradoxical middle turbinate

Discussion

The para nasal sinuses originate as pneumatic diverticulae from the primitive nasal cavity in the fetus. Hence, all paranasal sinuses drain into the nasal cavity. There is a a large spectrum of lesions that may affect this region, from trauma and infection, to neoplasms.

Anatomical variations are frequently encountered in this region and are important as they may have pathological consequence or may complicate surgery. Conventional radiology provides limited information about the sinuses. However, CT provides precise knowledge of nasal sinus anatomy and of the anatomical variants in nasal cavity and paranasal sinuses. This is of particular value in FESS, which has revolutionized the treatment of sinusitis. These variations narrow the drainage pathways of the sinuses.

Age and sex: Among 80 patients selected for the study of variations in the paranasal sinus 40 (50%) were males and 40 (50%) females. Majority of the subjects, patients were in the age group of 20-40 yrs. We found that most of the patients were in the age groups of <20, 21-30, and 31-40 years and very few of them in higher age groups.

Deviated nasal septum: In a study of 110 subjects by Perez-Pinas J Sabate et al, 80 subjects showed DNS. Most were non traumatic deviations of the septum (64 cases, 72%); the numbers of left and rightward deviations were similar, with a slight predominance of the former.[3] According to John Earwaker, deviated nasal septum (55%) is the most common variation, in his study there is slight predominance towards right side.[4] Talaiepour AR et al study showed Nasal septal deviation was found in 63% of which 28.0% deviated to the right and 31.5% to the left. Bilateral deviation was observed in 3.5% of all cases.[5] Gupta S et al study showed Nasal septal deviation was found in 78.80% followed by paradoxical middle turbinate (46.10%).[6] In our study 65% of patients showed deviated nasal septum and also showed slight predominance to the left side (28.75%) as compared to right side (26.25%).

Anatomical variant cells: Talaiepour AR et al, study showed Agger nasi cell in 56.7% of cases, with 17.5% on the right, 7.7% left and 31.5% of patients having Agger nasi cell as a bilateral finding.[5] In another study done by Yadav R R et al reported that, Agger nasi cell is the commonest anatomical variation (75.8%).[7] In our study the occurrence of Agger nasi cells was seen in 20%.

Study of Talaiepour AR et al, showed Haller cells in 3.5% of all subjects with 1.4% on the left and 2.1% bilateral; none were observed on the right side. The occurrence of Haller cell is variable according to various studies.[5] Dua K, Chopra H et al, study showed occurrence of Haller cell is 16%.[8] Jack M Gwaltney et al, study showed the occurrence of Haller cells is 45%.[9] According to Mohannad A Al Qudah, Haller cell was noted in 20%.[10] In our study occurrence of Haller cells is 16%. According to Talaiepour AR et al, Onodi cell appeared on 7% of the scans with 2.8% on the right, 0.7% left and 3.5% located bilaterally.[5] According To John Earwaker, occurrence of Onodi cell is 191 out of 800 patients studied i.e. 24%.[4]In study by Dua K, Chopra H et al, occurrence of Onodi cell is 6% out of 50 patients studied.[8] In our study the occurrence of Onodi cells is 3.75%. Accurate delineation of optic nerve is important in preoperative planning and the presence or absence of Onodi cells can be important in preoperative planning, and can be an important factor in limiting posterior extent of endoscopic clearance.[8]

Cribriform plate: In a study conducted by Soraia Ale Souza et al, it was found in their study that Keros type II was most frequently found in 73.3% of cases followed by type I in 26.3% and type III in 0.5% of cases.[11] In our study the occurrence of different types of cribriform plates were: Type I -35% (in 28 patients), Type II -56.25% (in 45 patients) and Type III -8.75% (in 7 patients). The type of cribriform plate is important in predicting the intra operative complications during functional endoscopic sinus surgery.

Frequency of variations of middle turbinate: Joe JK et al reported 15%[12]; Liu X et al reported 34.85%[13], Basic N et al reported 42%[14], Lothrop reported 9%[15], Davis reported 8%[16], Shaeffer reported 11%[17]pneumatization of middle turbinate.

According to Talaiepour AR, Concha bullosa was found in 35% of the samples. Of these, 11.9% were on the right, 11.2% left and 11.9% occurred as a bilateral anatomic variation.[5] According to John Earwaker 443 patients showed concha bullosa out of 800 patients studied.[4] In our study, 32.5% of the cases showed concha bullosa.

Paradoxical middle turbinate: We found paradoxical curvature of middle turbinate in 7.5% of patients.

Septated sinuses: According to John Earwaker, maxillary sinus showed septations in about 19 cases out of 800 patients studied.[4] According to Abdullah BJ et al, out of 70 patients studied 68.9% showed septations in the sphenoid sinus.[18] In our study frontal sinus showed septations in about 17.5%. Maxillary sinus showed septations in about 11.25%. Sphenoid sinus showed septations in about 20%.

Hypoplastic/ Agensis of sinuses: In a study conducted by Binali Çakur et al showed that 0.56% of cases showed hypoplastic sphenoid sinus. The diagnosis of sphenoid sinus hypoplasia is potentially important in patients in whom trans-sphenoidal hypophysectomy is indicated.[19] In our study a total of 1.25% of cases showed hypoplastic sphenoid sinus.

Bolger et al found the prevalence of unilateral hypoplastic maxillary sinus to be 10.4% on coronal CT scans. In our study Maxillary sinus hypoplasia was seen in 1.25%. Maxillary sinus hypoplasia predisposes to orbital penetration during endoscopic sinus surgery; therefore this bony abnormality must be recognized as well as associated anatomic variations, especially prior to sinus surgery.[20] In our study frontal sinus hypoplasia was noted in 12.5%.

Mucosal abnormalities and their association with anatomical variants: In our study 82.5% patients had PNS mucosal abnormalities and 17.5% patients had no

mucosal abnormalities. PNS mucosal abnormalities were seen in 61 (87.14%) out of 70 patients with anatomical variants and 5 (50%) out of 10 patients without anatomical variants. From this observation our study also reveals that the presence of anatomical variants may predispose but not always with the occurrence of sinus pathology.

Conclusion

Computed Tomography of the paranasal sinuses provides accurate evaluationof diseases of the paranasal sinuses. It also helps to establish the presence or absence of anatomical abnormalities that help in preoperative planningsince these variations can predispose patients to intro-op complications. The radiologist, thus, must pay close attention to variants and provide road map to surgeons and help avoid possible complications.

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