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A Study of Anatomical Variations of lateral wall of nose and paranasal sinuses by CT scan

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ABSTRACT

Nose and paranasal sinuses are the few structures in the human body liable to remarkable intersubject and intrasubject variations. Because of structural superimposition, conventional radiography does not allow detailed information on the paranasal sinuses. So computerized tomographic imaging has been established as a gold standard in the study of paranasal sinus diseases. The diagnosis of chronic inflammatory disease of the paranasal sinuses remains an enigma to most physicians. Combination of CT and diagnostic endoscopy has become the cornerstone in the evaluation of paranasal sinus disease. The aim of this study conducted on 100 patients over a two-year period on patients with chronic sinusitis is to determine the frequency and pattern of anatomical variations in patients and to
consider these anatomical variations in preventing potential hazards while performing endoscopic surgery.

KEYWORDS Paranasal sinuses, Computed Tomography, Agger Nasi cells, Haller cells, Onodi cells

INTRODUCTION

By definition, chronic sinusitis is present when irreversible tissue changes have occurred in the lining membrane of one or more of the paranasal sinuses. This is a definition of the pathologic state, however the diagnosis must be based on clinical and radiological correlates.

The symptoms of chronic sinus disease are multiple and often vague and nonspecific, while physical examination is limited as the paranasal sinuses cannot be examined directly. Anterior rhinoscopy reveals little information with regard to the middle meatal cleft and no information regarding the infundibular opening and maxillary sinus orifice. Nasal endoscopy provides the ability to accurately access these areas for evidence of localized disease or for anatomical defects that compromise ventilation and mucociliary clearance.

Rhinoscopic examination and X-ray of the paranasal sinuses are often not sufficient to demonstrate the pathology, especially in the ethmoids, while Computed Tomography (CT) in the coronal and axial sections provides a method for effectively demonstrating the mucosal changes and the various disease patterns in the paranasal sinuses. Even the subtle anatomical variations like Haller cells, pneumatized or paradoxically curved middle turbinate and variations in the conformation of the ethmoidal bulla, uncinate process, agger nasi cells and frontal recess can now be imaged with a level of clarity not afforded previously by standard sinus radiograph. Hence, CT has revolutionized the understanding and management of sinonasal inflammatory diseases in recent times.

Combination of CT and diagnostic endoscopy has become the cornerstone in the evaluation of paranasal sinus disease. In doing so, the diseases and the lesions that otherwise might have gone unnoticed can be identified and consequently be treated. This is the basis of the new concept of FESS. The precise knowledge of the existing anatomical variations, pathological changes and the relative position of the neighbouring vital structures like the orbit, optic nerve, cranial cavity, internal carotid artery, etc., which can be assessed by CT has an immense value and is an essential diagnostic aid for a functional, safe and effective endonasal sinus surgery.

AIMS AND OBJECTIVES

1. To determine the frequency and pattern of anatomical variations in patients with chronic sinusitis
2. To consider anatomical variations of paranasal sinuses in preventing potential hazards while performing endoscopic surgery

MATERIALS AND METHODS

The study was conducted in the Department of ENT of Sree Siddhartha Medical College and Research Centre and District Hospital, Tumkur between April 2001 to August 2002. Hundred patients attending the ENT OPD who had a proved upper respiratory tract infection with sinusitis for a period of more than three months duration not responding to the full course of antibiotics, analgesics and decongestants and in whom CT scan could be done.

Inclusion criteria

All patients proved to have chronic sinusitis and not responding to the full course of antibiotics, analgesics and decongestants, i.e, patients with Lloyds type II (rhinosinusitis) and type III (gross nasal polyposis) in whom CT scan could be done were included in the study.

Exclusion criteria

1. Patients with chronic sinusitis who responded to medical treatment
2. Patients in whom CT scan was not possible
3. Patients with previous history of sinonasal surgeries
4. Age <20 years and >55 years

Method of collection of data

1. The cases selected for the study were subjected to detailed history taking and clinical examination
2. Routine hemogram (Hb, BT, CT, TC, DC), blood sugar and urine examination
3. All the patients in active stage of disease were treated with a course of antibiotics, antihistamines, analgesics, local and systemic decongestants
4. Each of the patient underwent Computed Tomography scan of nose and paranasal sinuses

All the patients included in this study were examined with WIPRO Sytec 1800i Computed Tomography scanner. This is a third generation scanner. Factors of kV, mA were constant for all cases.

Parameters used for Paranasal Sinus CT were:

Patient position: Prone in coronal and supine in axial

Angulation: Perpendicular to infraorbitomeatal line in coronal and parallel to infraorbitomeatal line in axial sections

Thickness: 5mm with 5mm table incrementation in coronal and 10mm with 10mm incrementation in axial sections. 2 mm sections were taken particularly at osteomeatal complex and frontal recess areas.

Exposures: 120 kV, 3 second scan time, 300mA. Window width of approximately 2500 to 3000 and window level of 250 to 300

Extent of study: From the posterior margin of sphenoid sinus to the anterior most aspect of nasal cavity in coronal and from hard palate to frontal sinus in axial sections.

RESULTS AND OBSERVATION:
A total of 100 patients between 21 to 55 years were enrolled in the study who met with the criteria for chronic sinusitis.

Sex Distribution:
In the present study, there were 62 males (62%) and 32 males (32%) [Table 1]

Sex	No. of patients	Percentage
Male	62	62
Female	38	38

Table 1: Sex distribution

Age Distribution:
In our study, the maximum number of patients were between the ages of 36 to 40 years (31%), followed by 22% in the age group of 21 to 25 years. 15% patients were in the age group of 26 to 30 years, 12% in the age group of 31 to 35 years, 10% in the age group of 40 to 45 years and 2% in the age group of 51 to 55 years. The youngest patient was 21 years and the oldest was 53 years of age. [Table 2]

Age (years)	No. of patients	Percentage
21-25	22	22
26-30	15	15
31-35	12	12
36-40	31	31
41-45	8	8
46-50	10	10
51-55	2	2

Table 2: Age Distribution

Symptomatology:
The most common predominant symptoms were nasal obstruction, headache/ facial pain, nasal discharge, post-nasal discharge. Table 3 shows various severity of clinical symptoms of patients. Nasal obstruction was present in 86 (86%) patients, headache in 76 (76%) patients and nasal discharge in 69 (69%) patients. The other presenting complaints were postnasal discharge 51%, sneezing in 30% and others (crusting, epistaxis, anosmia) in 4%. [Table 3]

Symptoms	No. of patients	Percentage
Nasal discharge	69	69
Nasal obstruction	86	86
Headache/ Facial pain	76	76
Postnasal discharge	51	51
Sneezing	30	30
Others	4	4

Table 3: Symptoms

Signs:

In our study, nasal mucosal congestion, pale nasal mucosa and edematous mucosa were present in 10 patients (10%), 23 patients (23%) and 29 patients (29%) respectively. Inferior turbinate hypertrophy and polypoidal middle turbinate were present in 16 patients (16%) and 25 patients (25%) respectively. In 37 patients (37%), the middle meatus showed mucoid discharge and in 9 patients (9%), mucopurulent discharge was present. Nasal polyps were present in 32 patients (32%) and sinus tenderness in 11 patients (11%) [Table 4]

Signs	No. of patients	Percentage
1.Nasal mucosa	10	10
a. Congested	23	23
b. Pale	29	29
c. Edematous	20	20
2.Inferior turbinate hypertrophy	16	16
3.Middle turbinate	25	25
a. hypertrophy	32	32
b. polypoidal	37	37
4. Nasal polyps	9	9
5. Middle meatus	11	11
a. Mucoid discharge		
b. Mucopurulent		
6. Sinus tenderness		

Table 4: Signs

Diagnosis: [Table 5]
In our study, 68 patients (68%) had chronic sinusitis, while 32 patients (32%) had gross sinonasal polyposis.

Diagnosis	No. of patients	Percentage
Chronic sinusitis	68	68
Nasal polyposis	32	32

Table 5: Diagnosis

Computed Tomography patterns: [Table 6]
In our study, sinonasal polyposis was the commonest pattern with a prevalence of 32%, osteomeatal in 24%, infundibular in 22%, sphenoethmoid in 9% and normal in 13%.

Type	No. of patients	Percentage
Normal	26	13
Infundibular	44	22
Osteomeatal	48	24
Sphenoethmoid	18	9
Sinonasal polyposis	64	32

Prevalance of Anatomical Abnormalities in our study: [Table 7]

	No. of cases		Total no. of cases	Percentage
	Unilateral	Bilateral		
Medialised uncinate process	7	4	11	11
Lateralised uncinate process	25	15	40	40
Pneumatised uncinate process	4	-	4	4
Agger nasi cells	30	48	78	78
Haller cells	23	11	34	34
Paradoxical middle turbinate	19	6	25	25
Concha bullosa	31	10	41	41
Hypoplastic maxillary sinus	1	2	3	3
Onodi cells	5	-	5	5
Crista galli pneumatization	-	-	11	11

Sphenoid sinus				
1. Extensive pnematization	-	-	6	6
2. Multiple septae	-	-	41	41

Correlation of Uncinate process with Anterior group of sinuses: [Table 8]

In our study, an abnormal uncinate correlated significantly with the disease in the maxillary sinus but not with the anterior ethmoids or frontal recess. Maxillary sinus disease was present more commonly with the presence of abnormal uncinate process (82.43%) than with the presence of normal uncinate (59.52%). This was not the case with the disease in both anterior ethmoids or frontal recess.

Uncinate	Anterior Ethmoids		Maxillary sinus		Frontal recess	
	Diseased	Normal	Diseased	Normal	Diseased	Normal
Abnormal (74)	38 51.35%	36 48.64%	61 82.34%	13 17.56%	34 45.94%	40 54.05%
Normal(126)	72 58.73%	54 42.85%	75 58.52%	51 40.47%	77 61.11%	49 38.88%

Correlation of Agger Nasi cells with frontal recess: [Table 9]

The presence of Agger nasi cells was significantly associated with the disease in frontal recess. The frontal recess was diseased in 75.39% with the presence of Agger nasi cells while their absence was associated with only 14.86% of disease.

Agger Nasi	Frontal Recess	
	Diseased	Normal
Present (126)	95 75.39%	31 24.60%
Absent (74)	11 14.86%	63 85.13%

Correlation of Concha bullosa with the anterior group of sinuses: [Table 10]

In our study, concha bullosa was significantly associated with the disease in maxillary sinus but not in anterior ethmoids or frontal recess. The maxillary sinus was diseased in the presence of concha bullosa in 78.43% while they were normal inspite of presence of concha bullosa in only 21.56%. In case of anterior ethmoids and frontal recess the disease was present in 52.94% and 54.90% while they were normal in 47.05% and 43.73% respectively.

Concha bullosa	Anterior Ethmoids		Maxillary sinus		Frontal recess	
	Diseased	Normal	Diseased	Normal	Diseased	Normal
Present (51)	27 52.94%	24 47.05%	40 78.43%	11 21.56%	28 54.90%	22 43.13%
Absent (!49)	83 55.70%	66 44.29%	116 77.89%	33 22.14%	77 51.67%	72 48.32%

Correlation of paradoxical middle turbinate with the anterior group of sinuses: [Table 11]

Paradoxical middle turbinate was significantly associated with the disease in anterior group of sinuses such as anterior ethmoids, maxillary sinus and frontal recess. In the presence of the paradoxical middle turbinate, the disease was present in anterior ethmoids, maxillary sinuses and frontal recess in 64.51%, 83.87% and 61.29% respectively, while the disease was present inspite of normal curvature of middle turbinate in 49.70%, 76.33%, 47.92% of anterior ethmoids, maxillary sinus and frontal recess.

Paradoxical middle turbinate	Anterior Ethmoids		Maxillary sinus		Frontal recess	
	Diseased	Normal	Diseased	Normal	Diseased	Normal
Present (31)	20 64.51%	11 35.48%	26 83.87%	5 16.12%	19 61.29%	12 38.70%
Absent (!69)	84 49.70%	85 50.30%	129 76.33%	40 23.66%	81 47.92%	88 52.07%

DISCUSSION:

In the present series, age of the patients varied from 21 to 53 years with a mean of 36.2 years. Out of these, 62% patients were male and 38% patients were females. In the study conducted by Lloyd et al 1(1991) the age ranged from 10 to 78 years in which 55 % were males and 45% were females. While in the study conducted by Kirtane et al2 (1991) the ages ranged from 16 to 52 years with 19 (59.37%) being males and 13 (40.62%) being females. Majority(47%) of cases were in the third decade. In our study majority(31%) of cases were between the age group of 36 to 40 years.

In our study, nasal obstruction was the commonest symptom present in 86% of patients, followed by headache in 76%, nasal discharge in 69%. The other presenting complaints were postnasal discharge (51%), sneezing (30%), crusting, epistaxis and anosmia (4%). The duration of symptoms in majority of patients varied from 6 months to 3 years. However, there were a few patients in whom the duration of symptoms was more than 3 years. In a study conducted by SPS Yadav et al3 (2000), the commonest complaint was nasal discharge (70%) followed by heaviness of head or dull headache (40%). In another study conducted by Venkatachalam VP et al4(2000), the commonest symptoms were nasal discharge (70%) and nasal obstruction (87%). The other symptoms were post nasal drip(41%), sneezing(23%) and abnormalities in smell sensation (36%).

In our study, the commonest clinical signs present were pale nasal mucosa(29%), edematous mucosa(10%) and congested mucosa(10%). The other findings were inferior turbinate hypertrophy(20%), middle turbinate hypertrophy(16%) and polypoidal middle turbinate(25%). Middle meatus showed mucoid discharge in 37% patients and mucopurulent discharge in 9% patients. Nasal polyps were seen in 32% patients and sinus tenderness could be elicited in 11% patients. Our study is comparable with other studies conducted by Kirtane MV2 (1991) where clinical findings like hypertrophic inferior turbinate(9.5%), middle turbinate hypertrophy (12.3%), sinus tenderness (40.6%) and polyps(12.5%) were noted while in a study conducted by Venkatachalam VP et al4(2000), clinical findings were hypertrophied inferior turbinate (18%), congested mucosa (16%), sinus tenderness (7%) and ethmoidal polyps (13%).

In the present study, 68% had chronic sinusitis while 32% had sinonasal polyposis. Schaefer et al 5(1989) observed in his study that 49% had chronic sinusitis and 37% had recurrent sinusitis with polyps whereas Jones NS et al6 (1997) observed that 75% had chronic rhinosinusitis and 25% had sinonasal polyposis. All patients in our study were subjected to CT scans. Out of the 100 cases (200 sides), the most common pattern was sinonasal polyposis i.e., when a combination of polypoidal soft tissue densities were present throughout the nasal vault and paranasal sinuses in association with variable diffuse opacification of sinuses, seen in 32%. The next common pattern is the Osteomeatal Unit (OMU) pattern i.e., involvement of frontal, ethmoidal and maxillary sinuses or combination of any two sinuses with osteomeatal complex involvement, seen in 24%. The infundibular pattern i.e., involvement of maxillary sinus only due to ipsilateral obstruction of inferior aspect of infundibulum was seen in 22%. Sphenoethmoidal recess (SER) pattern i.e., when obstruction was present with involvement of posterior ethmoid and sphenoid sinus, seen in 9% and lastly the sporadic of unclassifiable pattern which includes inflammatory sinus disease which cannot be categorized into the above four patterns. This includes findings such as retention cysts, mucocoeles and mild mucoperiosteal thickening that was not present in our study. The CT findings were different than the previous studies done. [Table 12]

Type	Present study	Babbel et al7	SPS Yadav et al3
Infundibular	22%	26%	23%
Osteomeatal	24%	25%	36%
Sphenoethmoid	9%	6%	72%
Sinonasal polyposis	32%	18%	16%
Unclassified	-	19%	4%

Table 12: CT Patterns: Comparison of various studies

Anatomical variations of lateral wall of nose and paranasal sinuses predisposes patients to recurrent sinusitis and headache. Stammberger and Wolf 8(1988) cited variations in the Agger nasi cells, middle turbinate, uncinate process, presence of Haller cells or a deviated nasal septum as possible factors responsible for sinus disease and headache. In our study, one or more anatomic variations were observed in 99% of cases, whereas incidence in literature is 5.8% by Bolger et al9 (1991), 62% by Zinreich10 (1993), 79% by SPS Yadav3(2000) and 67% by Perez Pinas et al11 (2000). The presence of agger nasi cells was the commonest variation seen in our study, seen in 78% cases and in their presence, frontal recess was diseased in 75.39% cases. The next common variation was abnormal uncinate process (51%), which included medialised, lateralized and pneumatised uncinate process. In our study, presence of abnormal uncinate process correlated well with disease in maxillary sinus (82.43%). Concha bullosa was present in 41% of cases and its presence correlated well with disease in the maxillary sinus (78.43). Paradoxical middle turbinate was present in 25% of cases in our study. It correlated well with disease in the maxillary sinus (83.87%), anterior ethmoid (64.51%) and frontal recess (61.29%). Haller cells were present in 34% of cases in our study. Hypoplastic maxillary sinus was present in 3%, Onodi cells in 5% and Crista galli pneumatization in 11% of cases. Extensive pneumatization of sphenoid sinus was present in 6% of cases and multiple septae in sphenoid sinus were present in 41% of cases in our study. [Table 13]

Anatomical variations	Present study	NS Jones et al6	GAS Lloyd13	Zinreich 10	Shroff et al14	SPS Yadav et al3	Bolger et al9	John Earwarker 12	Perez Pinas et al11
Agger nasi cells	78%	95%	14%	-	-	48%	98.50 %	96%	-
Abnormal uncinate	51%	6%	21%	-	-	-	2.50 %	-	4%
Paradoxical middle turbinate	25%	7%	15%	15%	16%	12%	26%	38%	-
Concha bullosa	41%	18%	24%	36%	33%	28%	53%	55%	25%
Haller cells	34%	6%	15%	10%	6%	28%	45%	20%	-
Hypoplastic sinus	3%	-	-	-	-	-	10.40 %	-	6%
Onodi cells	5%	7%	-	-	-	-	-	24%	-
Crista galli pneumatization	11%	-	-	-	-	-	83%	-	-

Table 13: Anatomical variations: Comparison of various studies

CONCLUSION:

In this study of 100 patients with chronic sinusitis, we have analyzed the pathology in paranasal sinuses in relation to the various anatomical variations. In our study we found:

1. Majority of the patients were in the age group of 36-40 years with male predominance
2. The commonest symptoms were nasal obstruction and headache along with nasal discharge.
3. The commonest signs were middle meatal discharge, edematous mucosa and polyps.
4. The commonest CT pattern in our study was of sinonasal polyposis type followed by osteomeatal and infundibular type.
5. Computed tomography imaging of paranasal sinuses along with diagnostic endoscopy are important pre-operative evaluation tools in detecting pathology as well as anatomical variations.
6. Extent of disease in each sinus is very well recognized in computed tomography.
7. The purpose of our study was to examine the overall prevalence of anatomical variations of lateral wall of nose and paranasal sinuses which was found to be 99%, the commonest being agger nasi cells (78%). Others were abnormal uncinate process (51%), concha bullosa (41%), Haller cells (34%), paradoxical middle turbinate (25%), crista galli pneumatization (11%) and sphenoid sinus variations such as multiple septae (41%), extensive pneumatization (6%) and Onodi cells(5%).
8. Factors affecting the drainage of various sinuses were correlated with the disease in particular sinuses. We found that the presence of agger nasi cells, concha bullosa, paradoxical middle turbinate and abnormalities in uncinate process correlated with disease in anterior group of sinuses.
9. The presence of these variants may therefore impair normal drainage pathways, serve as a focus for occult disease, hinder endoscopic access to distal areas and increase the risk of endoscopic mishaps.

In our study, maxillary sinus was the most frequently diseased sinus (73%) followed by anterior ethmoid (45%), frontal sinus (40%), posterior ethmoid sinus (35%) and sphenoid sinus (22%). Hence Computed Tomography is the gold standard and has to be considered mandatory in the diagnostic evaluation of patients with chronic sinusitis. It helps in assessing the extent of sinus disease and to know the variations and vital relations of the paranasal sinuses.

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