

Comparison between preoperative computed tomography scan of paranasal sinuses and operative findings in functional endoscopic sinus surgery (FESS) in chronic sinusitis

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Abstract

Background and objectives: The study was done to evaluate the role of computed tomography (CT) in clinically suspected cases of chronic sinusitis for detection, assessment of anatomical variants and pathological abnormalities of nasal cavity and paranasal sinuses. Also findings of CT were co-related with operative findings in functional endoscopic sinus surgery (FESS). The study was conducted on 60 cases attending CT section of Radiodiagnosis Department and ENT Department Rajindra Hospital, Patiala. **Materials and Methods:** The study was conducted on 60 cases over a period 3 years from 2010 to 2013 irrespective of gender and age group attending the ENT and radiology department. Selections of patients were based on clinical features like nasal or post nasal discharge, nasal obstruction, headache anosmia, cough and hoarseness of voice. Relevant history, clinical examination and CT examination of every patient were done. **Results:** In our study, the CT scan and operative findings correlated excellently in cases of paradoxical middle turbinate, bony destruction, concha bullosa, polypoidal changes in ethmoidal sinuses and osteomeatal complex normal widening. There was very good agreement between preoperative CT scan and operative findings for concha bullosa, paradoxical middle turbinate, bony destruction, osteomeatal complex normal widening, polypoidal change in sphenoid sinus. The most common pattern observed on CT scan was osteomeatal unit pattern in 35% followed by infundibular pattern (20%), sphenoethmoidal recess pattern (23.3%), unclassified pattern (15%) & sinonasal polyposis pattern (6.6%). **Conclusion:** CT is the imaging modality of choice to reveal mucosal changes deeper in osteomeatal complex which are not visible endoscopically and to identify extent of paranasal sinus disease. However, endoscopy has complementary role with CT in evaluation of patients of chronic sinusitis.

Keywords: Chronic sinusitis, Computed Tomography, FESS.

Introduction

The term sinusitis refers to a group of disorders characterized by inflammation of mucosa of paranasal sinuses. Rhinosinusitis is replacing the term sinusitis because sinusitis is often preceded by rhinitis and rarely occurs without concurrent nasal airway inflammation [1, 2]. The article "Adult Rhinosinusitis Defined" characterizes rhinosinusitis into 5 separate clinical categories: acute, subacute, chronic, recurrent acute and acute exacerbation of CRS. Acute rhinosinusitis is a

clinical condition lasting less than 4 weeks, and subacute rhinosinusitis is present for more than 4 weeks but less than 12 weeks [1]. Chronic sinusitis is a clinical diagnosis and is defined as a rhinosinusitis lasting >12 weeks that includes two or more major sinus symptoms or at least one major and two minor sinus symptoms with or without findings on physical examination[1].

Chronic sinusitis is diagnosed when the patient has repeated bouts of acute infection or persistent inflammation. Staphylococcus, streptococcus, corynebacteria, bacteroides, fusobacteria, and other

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anerobes are more commonly involved in chronic sinusitis than in acute sinusitis[3]. The sinuses most commonly involved with chronic sinusitis are the anterior ethmoid air cells.

Plain radiography has limited value for imaging paranasal sinuses, especially the ethmoid sinuses and the ostiomeatal complex and its use is not indicated[4,5].

Computed tomography is the imaging method of choice for the paranasal sinuses. CT is the imaging study of choice in both adult and pediatric patients[6]. CT is the technique of choice in the preoperative evaluation of the nose and paranasal sinuses and is the gold standard for delineation of inflammatory sinus disease resulting from obstruction[7].

The two primary diagnostic imaging techniques for evaluating the paranasal sinuses are CT and MRI. Radiography was once the most commonly ordered study; however, CT has surpassed radiography in the evaluation process because of its superior anatomic detail and when a lower mA protocol is used, a radiation dose similar to a standard four-view radiographic series[8,9].

The use of a bone algorithm provides excellent resolution of the complete osteomeatal complex and other anatomic factors that play a role in sinusitis. Coronal CT images most closely correlate with the surgical approach[9].

Therefore, it is the preferred study for the surgeon performing functional endoscopic sinus surgery (FESS) because coronal images simulate the appearance of the sinonasal cavity from the perspective of the endoscope[10].

The characteristic findings of sinus disease include air-fluid levels, mucosal thickening, and opacification of the normally aerated sinus lumen. The single distinguishing feature of acute sinusitis is the air-fluid level as an isolated finding, whereas the only characteristic finding in chronic sinusitis is sclerotic, thickened bone of the sinus wall[11].

It is critical to identify the technique of choice for preoperative screening and evaluation. CT is superior to MRI for the delineation of the fine bone structures of the infundibular complex, orbital lamina, orbital floor, and cribriform lamina [12]. Thus, CT is superior to MRI in planning FESS[13]. With MRI, these bone structures

have low signal intensity, making them difficult to completely assess.

CT was also used to evaluate following anatomical variations:

- Variations of the middle nasal concha
- Concha bullosa
- Middle paradoxical concha
- Uncinate process variations
- Ethmoid variations
- Haller air cells
- Giant ethmoid bulla
- Agger nasi cells
- Hyperpneumatization of the sphenoidal sinus
- Medial protrusion of the lamina papyracea
- Nasal septal deviation.

Material and methods

The present study was a hospital based prospective study conducted in Rajindra Hospital Patiala in patients who presented with clinical symptoms of chronic sinusitis. The study sample was limited to 60 patients and was done over a period of three years from 2010-2013. Institutional review board approval for conducting this study was obtained and informed consent of study patients was taken.

CT scan was performed with Siemens- Somatom Emotion 6 slice third generation spiral CT. Slices of 5 mm were taken in axial and coronal planes. The coronal plane depicts anatomy in a way somewhat similar to what ENT surgeon will see as the nasal vault is approached with an endoscope. It is also the imaging plane which best displays the osteomeatal unit. Coronal scan was done with patient lying prone with chin hyperextended and gantry tilted to the approximate plane at right angle to the orbitomeatal line.

Scanning was done from anterior wall of frontal sinus to posterior wall of sphenoid sinus. In all the patients functional endoscopic sinus surgery was done under local anaesthesia 2% lignocaine with 1:1,00,000 adrenaline was used for mucosal infiltration for anaesthesia and vasoconstriction.

Patients were placed in supine position with head turned towards examiner. Endoscope was fixed just above the nostril with thumb and forefinger of left hand while it was gently introduced with right hand, care was taken not to cause mucosal damage. Endoscope was

introduced initially along the floor of nose till nasopharynx was seen and then withdrawn slowly to look for disease pathology. It was then removed and reintroduced below the middle turbinate to examine middle meatus and sphenoidal recess. When endoscope was in middle meatus, the uncinate process, bulla ethmoidalis, hiatus semilunaris, infundibular opening and maxillary sinus opening were inspected. The endoscope was passed posteriorly after viewing the

middle meatus area to examine sphenoidal area. Depending upon disease appropriate endoscopic sinus surgery was done which could be uncinectomy, middle meatus antrostomy, anterior ethmoidectomy, posterior ethmoidectomy, sphenotomy, resection of middle turbinate.

Statistical Analysis: The data was statistically analysed and was compared by using kappa value.

Results

The present study was conducted in the departments of Radiodiagnosis and ENT, Rajindera Hospital, Patiala on 60 patients, clinically diagnosed to have chronic sinusitis. The findings of the CT scan were correlated with operative findings of Functional Endoscopic Sinus Surgery.

In the present study, there were 35 males and 25 females in the study group. The youngest patient was 12 years old and oldest 60 years. The disease frequency was found to be maximum in age group 21-30 years (31.66%).

The common presenting symptoms were nasal obstruction in 70% cases, headache in 66.6%, nasal discharge in 65%, epistaxis in 30% and post nasal drip in 20% of cases. On anterior rhinoscopy examination, deviated nasal septum (46.6%) was the most common sign followed by inferior turbinate hypertrophy (31.6%).

Maxillary sinus was most frequently involved in 80% cases followed by anterior ethmoid, posterior ethmoid, sphenoid & frontal sinuses respectively.

Table-1: Mucosal abnormality of sinuses in patients of chronic sinusitis on CT scan

Involved Sinuses	No. of patients with involved sinuses			Total	Total no. of Sinuses involved	Involved sinuses (%)
	Left	Right	B/L			
Maxillary	13	11	36	60	96	80
Anterior ethmoid	16	12	13	41	54	45
Posterior ethmoid	6	8	14	28	42	35
Sphenoid					17	28.3
Frontal	4	5	3	12	15	12.5

Overall 80% of maxillary (Figure 1,3), 45% of anterior ethmoid, 35% of posterior ethmoid, 28.3% of sphenoid and 12.5% of frontal sinuses were found to have mucosal abnormality on CT scan.

Table-2: Patients of inflammatory sinonasal disease on CT scan

Patterns	No. of Patients	Percentage
Infundibular pattern (INF)	12	20
Osteomeatal unit pattern (OMU)	21	35
Sphenoidal recess pattern (SER)	14	23.3
Sinonasal polyposis pattern (SNP)	4	6.6
Unclassified pattern (UNC)	9	15

The most common pattern to be observed was osteomeatal unit pattern in 35%, followed by sphenoidal recess pattern in 23.3% of cases. Infundibular, unclassified and sinonasal polyposis pattern were observed in 20%, 15%, 6.6% of cases respectively.

DNS, Concha bullosa (Figure 2), Haller cells and onodi cells were the common anatomic variants noted in 46.6%, 33.3%, 25% and 28.3% cases respectively. The other less common variants noted were Pneumatization of pterygoid

process, Agger nasi cells, Pneumatization of anterior clinoid process, Enlarged bulla ethmoidalis, Paradoxical middle turbinate and Pneumatization of crista galli.

Table-3: Anatomical variations on ct scan in patients of chronic sinusitis

Anatomical Variants	No. of cases	%age
Deviated nasal septum	28	46.6
Agger Nasi cells	10	16.6
Haller cells	15	25
Concha bullosa	20	33.3
Pneumatization of crista galli (PCG)	5	8.3
Pneumatization of anterior clinoid process (PAC)	4	6.6
Onodi cells	17	28.3
Paradoxical middle turbinate(PMT)	5	8.3
Pneumatization of pterygoid process (PTG)	8	13.3
Enlarged bulla ethmoidalis	6	10

Table-4: Kappa agreement between preoperative CT and FESS findings in chronic rhinosinusitis (n=60)

Findings	FESS positive		FESS negative		Kappa value
	CT scan positive	CT scan negative	CT scan positive	CT scan negative	
DNS (Deviated nasal septum)	28	2	1	29	0.9
Polyp	11	3	5	41	0.64
Mucosal thickness (>3mm) in sinuses	38	0	6	16	0.77
Right osteomeatal complex blockage	30	1	3	26	0.86
Left osteomeatal complex blockage	32	2	4	22	0.8
Hypertrophy of inferior turbinates Anatomical variants	18	1	2	39	0.886
a) Haller cell	12	0	3	45	0.857
b) Onodi cell	15	1	1	43	0.91
c) Agger nasi cell	8	0	2	50	0.87
d) Bulla ethmoidalis	4	0	2	54	0.78
e) Concha bullosa	15	0	5	40	0.8

(Kappa value if 0.61-0.80 then good agreement and if 0.81-1.00 almost perfect or very good agreement)

The incidence of abnormal findings on CT was compared with FESS in table 4. There is good to very good agreement between the two diagnostic procedures as mentioned. DNS, polyp, inferior turbinate hypertrophy, mucosal thickness, osteomeatal complex blockage and anatomical variants all show kappa value >0.6 and CT has better detection rate in certain aspects as compared to FESS as shown in table 4.

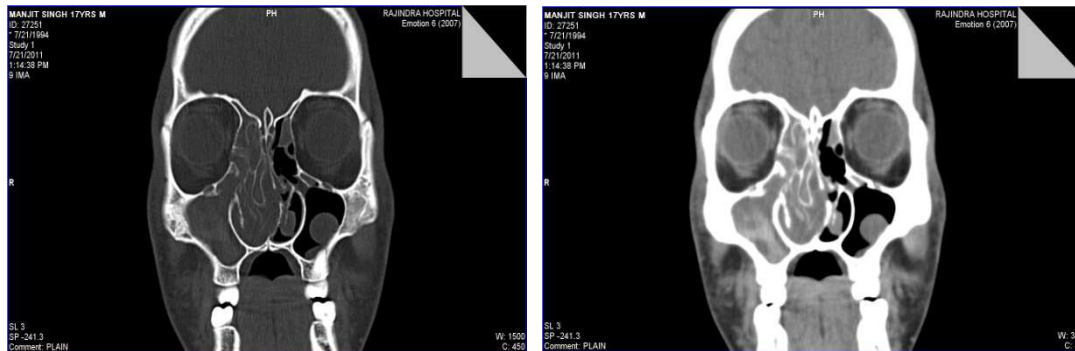


Figure-1: Coronal CT images show soft tissue density material with hyperdense foci in right ethmoidal air cells and maxillary sinus suggestive of fungal sinusitis and left maxillary polyp.



Figure-2: Coronal CT images show right-sided concha bullosa with S-shaped deviated nasal septum (DNS) and left maxillary sinusitis.

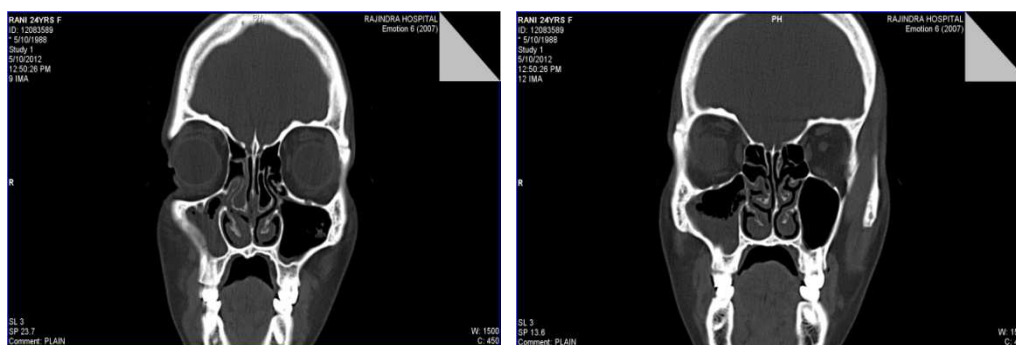


Figure-3: Coronal CT images show right maxillary sinusitis with bilateral inferior turbinate hypertrophy.

Discussion

The complex regional anatomy of the paranasal sinuses has only recently been elucidated through the use of modern imaging techniques. The advent of computerized tomography in the delineation of sinonasal pathology and anatomic variations has proven invaluable to the otolaryngologist in preoperative

planning for functional endoscopic sinus surgery [14]. CT scan assessment of chronic rhinosinusitis is a reliable test. The CT findings in patients with chronic rhinosinusitis remain consistent over time [15].

Mucosal abnormality of sinuses on CT Scan- Mucosal abnormality percentage of various paranasal sinuses noted on CT scan in present study was compared with other studies. In the present study, maxillary sinus was most frequently involved in 80% cases followed by anterior ethmoid, posterior ethmoid, sphenoid & frontal sinuses respectively. Similar observations were also made by Calhoun et al [16] and Stoney et al[17].

Patterns of Sinonasal Disease- In present study, five recognisable patterns of inflammatory sinonasal disease on CT was noted. 1st was infundibular pattern when obstruction occurred within the maxillary sinus, infundibulum resulting in blockage of ipsilateral OMC. 2nd was Osteomeatal unit pattern- when obstruction occurred within the middle meatus with resultant possible ipsilateral maxillary, anterior ethmoidal, middle ethmoid & frontal sinusitis. 3rd was sphenoidal recess pattern when Inflammatory post nasal pathology leads to obstruction of sinus ostia in sphenoidal recess with variable involvement of ipsilateral posterior ethmoid and sphenoid sinuses. 4th was sinonasal polyposis pattern when characteristic findings included polypoid masses filling nasal vault and sinuses, bilateral infundibular enlargement, convex (bulging) ethmoid sinus walls, attenuation of bony nasal septum and ethmoid trabeculae. 5th was sporadic or unclassifiable pattern - when the inflammatory disease did not fit into the obstructed mucous drainage routes of pattern or polyposis pattern. Preoperative & post operative sporadic inflammatory changes, retention cysts & mucocele were included within this pattern.

In the present study OMU pattern was the most common pattern to be observed and was present in 35% of cases, Infundibular in 20% of cases, Sporadic in 15% of cases, SER pattern was observed in 23.3% & SNP in 6.6% of patients on CT scan. Our results are comparable to Asruddin et al [18].

Anatomic variations in region to paranasal sinuses noted on CT scan in present study- Anatomic variations are important for that they may narrow normal drainage channels, thereby predispose to chronic recurrent sinusitis. They increase operative risk and surgeon should be forewarned about these. Different investigators report different prevalence rates. Though variations may be encountered in the normal population (without sinusitis) their prevalence rates are significantly higher in patients with chronic sinusitis. In our study we observed that DNS, Concha Bullosa,

Haller cells, Onodi cells & Pneumatization of pterygoid process were the common anatomic variants in 46.6%, 33.3%, 25%, 28.3%, 13.3% of patients. Where as Agger nasi cells, pneumatization of anterior clinoid process, enlarged bulla ethmoidalis, pneumatization of crista galli, paradoxical middle turbinate were noted in 16.6%, 6.6%, 10%, 8.3%, 8.3% of patients respectively.

Association of DNS with ipsilateral maxillary sinus disease- In our study out of 28 patients having DNS, maxillary sinus disease was present in 16 patients on one side but also present at the same time on contralateral side in 12 patients, so incidence of sinusitis in maxillary sinuses ipsilateral and contralateral to the side of nasal septal deviation was almost equal. The same was also observed with anterior ethmoid sinus disease. The results are comparable to Yousem et al[19]. So, it is concluded that septal deviation affected both ipsilateral and contralateral sinuses equally and there is no significant association of deviation of nasal septal disease with ipsilateral maxillary and/or anterior ethmoid sinus disease and this reflected multi factorial components involved in causation of sinusitis.

Agger NASI cells- Agger nasi cells were observed in 16.6% of cases in our study. Incidence was noted to be 15% by Stoney et al[17] and 48% by Asruddin et al[18]. So our incidence is almost comparable to other studies.

Haller Cells-Haller cells were observed in 25% of cases in our study. Prevalence of Haller cells have been reported to be 10% Zinreich [20] to 45% of cases Bolger et al,[21]. Asruddin et al[18] observed haller cells in 28% cases.

In our study along with 9 Haller cells on left ipsilateral maxillary sinus disease was seen in 5 sinuses and absent in other 4, while on right along with 8 Haller cells, ipsilateral maxillary sinus disease was seen in 4 and absent in 4 sinuses. So, no significant association was found between Haller cells and ipsilateral maxillary sinus disease. This was also observed by Bolger et al[21].

Concha Bullosa- In the present study concha bullosa was seen in 33.3% of patients. Incidence of concha bullosa was noted to be 34% by Zinreich et al[22], 33-36% by Shroff et al[23], 10% by Lusk et al[24] and 28% by Asruddin et al[18]. Though there may be difference of incidence in different studies, size of the anatomic variant and its relationship with surrounding structures is much more important than presence only of

the anatomic variant. However in our study, no significant association was observed between concha bullosa and ipsilateral OMU disease. Our results match with those of Zinreich et al[22] in that overall incidence or inflammatory disease in the osteomeatal complex in symptomatic patients was not different between those with and without concha bullosa.

Paradoxical Middle Turbinate- Incidence of paradoxical middle turbinate in our study was observed to be 8.3%. Incidence of paradoxical middle turbinate was <10% according to Yousem et al[19], 15% according to Zinreich[20] and 12% according to Asruddin et al[18].

Pneumatization of crista galli, anterior clinoid process & pneumatization of pterygoid process- In present study pneumatization of crista galli was seen in 8.3% cases and anterior clinoid process in 6.6% cases, pterygoid process pneumatization was seen in 13.3%. According to Bolger et al[21] any degree of pneumatization of the anterior clinoid process was considered significant and noted incidence of crista galli pneumatization in 83.7% cases of anterior clinoid process pneumatization in 13.3% and of pterygoid process in 43.6% of cases.

Infundibular opacification and ipsilateral maxillary sinus disease- In present study when infundibulum was opacified 94.4% of ipsilateral maxillary sinuses showed mucosal abnormality on CT scan. when infundibulum was normal, only 4.1% of the ipsilateral maxillary sinuses were abnormal.

So, there was significant association between infundibular opacification and ipsilateral maxillary sinus disease. Our results are comparable to Bolger et al[21], who found that when disease was present in infundibulum, 98% of cases had mucosal thickening of ipsilateral maxillary sinuses. When infundibulum was normal, ipsilateral maxillary sinuses were normal in 95.8% of cases.

CT and Endoscopy-Though CT is the most sensitive and specific currently available radiographic modality for diagnosis of chronic sinusitis. Moreover the findings during FESS reflect the exact pathology and remain superior to the evidence provided by CT. The endoscopy provides morphologic, histological and bacteriological information about state of nasal cavities and particularly middle meatus but endoscopy has got certain limitations like its inability to show frontal sinus

and frontal recess, posterior ethmoid and sphenoid sinuses. CT is therefore a complementary procedure that ensures complete evaluation of AIM changes caused by inflammatory paranasal sinus disease.

In our present study we found that CT is highly sensitive and specific but FESS remains superior to CT because it reflects exact pathology of the paranasal sinuses.

Our results are comparable to Lazar et al[25] who stated that the high resolution CT of the sinuses is the most sensitive and specific radiographic modality. Despite good results, the CT scan is not an ideal radiographic modality. The findings during FESS reflect the exact pathology and remain superior to the evidence provided by CT. We do agree with Terrier et al[26] that endoscopy provides morphologic, histologic and bacterologic information about state of nasal cavities and middle meatus.

CT may reveal an anatomic abnormality that predisposes sinusitis. However, the treatment (medical or surgical) should be based on combined information extracted from clinical evaluation, CT and endoscopy findings. When considering the overall success rates in the postoperative period, the results of FESS are very satisfactory. An improvement rate of 80% to 98% in this sense is found for FESS in the literature. The authors attribute this small percentage of failure to different factors in the pathophysiology of the disease, including environmental factors like pollution, dust and cigarette smoke [27]. In the study by Damm et al [28] the overall improvement after surgery was 85%, while Bhattacharyya et al [29] described improvement in 100% of patients, especially in the following symptoms: facial pain, congestion, nasal obstruction, rhinorrhea, and headache.

Conclusion

CT scan detected more sinonasal inflammatory disease than endoscopy but endoscopy helped in further characterization of contents of opacified sinus on CT scan. CT is the imaging modality of choice to reveal mucosal changes deeper in osteomeatal complex which are not visible endoscopically and to identify extent of paranasal sinus disease. Direct visualization using endoscopy allows surgeon to assess the exact nature of disease during surgery. Endoscopy is specially useful in delineating type of soft tissue; causing opacification on CT scan whether it is due to polyp, hypertrophied

mucosa or discharge. Endoscopy only displays the surface mucosa of ethmoid cells while CT shows it in depth displaying air chambers that are hidden from telescope. So, changes identified by CT should be correlated with symptoms and endoscopy findings.

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