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A study on correlation between CT findings and the endoscopic findings in Functional Endoscopic Sinus Surgery of chronic rhinosinusitis

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Abstract
Background: Chronic rhinosinusitis is one of the most common chronic diseases affected worldwide. Computerized tomography imaging (CT) of the paranasal sinuses and FESS has become a widely accepted tool for assessing the PNS and providing detailed anatomy of the lateral nasal wall and the disease process. CT scan evaluation of the patients, who have to undergo eventually FESS, is useful in confirming the clinical diagnosis of chronic rhinosinusitis [1]. The ostiomeatal complex (OMC) is the main area for the pathogenesis of chronic rhinosinusitis. Based on this concept, functional endoscopic sinus surgery (FESS) aims to eliminate the disease from its primary site, i.e. the ostiomeatal complex and allow the resolution of secondary infection from the larger sinuses [2].
Materials and Methods: In this prospective study, clinically diagnosed cases of chronic rhinosinusitis, referred from Department of ENT, government general Hospital Kurnool, underwent CT scan and functional endoscopic sinus surgery during the period from November 2016 to October 2018.
Results: Of the 50 patients, maximum numbers of patients are in 20 – 40 years of age. There is slight male preponderance with male to female ratio is 1.08: 1. Nasal obstruction and headache are the commonest Symptoms which are present in 37(74%) and 40 (80%) cases respectively. Deviated nasal septum is seen in 33(66%) patients on endoscopy and 28(56%) patients on CT scan. Patency of the maxillary ostium is seen in 33(66%) cases in right and 34(68%) cases on the left on FESS whereas CT scan shows 31(62%) on right and 32(64%) cases on left. Inferior turbinate hypertrophy is seen in 33 (66%) patients on both right and left on FESS, whereas CT scan shows 35 (70%) on both the left and right side. Hypertrophy of middle turbinate is seen in 8(16%) cases on FESS & CT scan. Polyps are seen in 12(24%) cases detected on FESS, whereas CT scan did not show the findings. Maxillary mucosal thickening noted in 23(46%) cases on CT scans and 20(40%) in FESS.
Conclusion: There are good to excellent correlation between the two diagnostic procedures, except for the choanal atresia. In spite of a good agreement between CT and FESS findings in most patients, in some unusual cases, CT may miss some findings. The value of FESS is more because of its therapeutic value. From this study it is evident that CT can complement FESS to a great extent.

Keywords: Rhinosinusitis, CT scan, FESS, prospective, Maxillary mucosal thickening

Introduction
The diagnosis of chronic rhinosinusitis depends heavily on clinical judgment based on a number of subjective symptoms and signs. During the past two decades, the concept of sinusitis and its management have undergone drastic changes. CT has become the standard diagnostic technique in the evaluation of paranasal sinuses [16]. The pre-operative diagnosis for these patients is based upon the combination of endoscopy of the lateral nasal wall along with CT scan of the paranasal sinuses, but however, the prevalence of the incidental mucosal changes in an asymptomatic population is quite significant. There are various comparative studies on the imaging modalities, clinical symptomatology, histopathology, culture pattern, anatomical variations and mucosal disease by intranasal endoscopy and there are also imaging studies including CT scan, but a clear correlative study between pre-operative CT scan and anatomical defects and mucosal assessment which is found during functional endoscopic sinus surgery (FESS) is lacking. The present study was done to correlate and evaluate between the CT findings and the intraoperative findings of FESS.
One of the major aims of CT of the sinuses is to delineate the extent of the disease, define any anatomical variants and relationship of the sinuses with the surrounding important structures.

Functional endoscopic techniques for paranasal sinus surgery have allowed detailed and complete visualization of sinus disease while promising minimum distress to the patient. The endoscopic view of the operative field shows detail of the sinus anatomy and its disease. It is possible to see areas of the cribriform plate and orbital wall that are prone to produce cerebrospinal fluid rhinorrhoea and orbital complications during the surgery. At the same time, landmarks for avoiding these complications can be defined to guide the surgeon during the surgery as it is seen through the endoscope. In this study, we have compared the CT findings and functional endoscopic findings of the patients with chronic rhinosinusitis.

Aims and Objectives

To correlate between CT findings and the endoscopic findings in Functional Endoscopic Sinus Surgery of chronic rhinosinusitis

Materials and Methods

In this study, 50 patients, who presented to the hospital were worked up based on detailed history, physical examination and biochemical investigation and were then subject to CT scan and functional endoscopic sinus surgery during the period from November 2016 to October 2018.

The method of study: The diagnostic validity was used for correlation between CT findings & FESS. The parameters which are used for correlation were: paradoxical middle turbinate, concha bullosa, turbinate hypertrophy, choanal atresia, mass, cysts, osteomeatal complex patency, polypoidal changes, mucosal thickening and frontoethmoidal disease.

Prior to subjecting the patients for radiographic examinations, age, sex and detailed clinical history was obtained along with thorough physical examination. The CT examination was performed with a GE BRIGHT SPEED ELITE Spiral CT scanner.

Images were obtained with 3 mm collimation in the coronal plane with the patient in the prone position and the neck hyper extended. The image interval was 3 mm through the osteomeatal complex and 5 mm in the more posterior sections. Axial images were also taken in supine position.The tube potential 120 kVp and tube current 200–240 mA. Images were reconstructed using a high spatial frequency reconstruction algorithm. The sections were imaged at a wide window width (WW2000) centred at 2250 Hounsfield units.

Staging of Rhinosinusitis [3]

Some of the problems encountered in the assessment of result could be overcome by accurate staging of the extent of sinusitis. A simple approach has been devised which produces a numerical score for four aspect of the condition.

1. The CT findings are assessed using the Lund and Mackay staging system for each of the sinus (maxillary, anterior ethmoid, posterior ethmoid, frontal and sphenoid) of 0-2

a. 0= no abnormality
b. 1= partial opacification
c. 2=total opacification and
d. And 0 or 2 for ostiomeatal complex
e. Anatomical variants varied from 1 to 0

2. Symptoms are evaluated on a visual analogue score VAS of 0-10. VAS is performed pre-therapy and at regular intervals post treatment. The symptoms include

a. Nasal congestion
b. Headache
c. Facial pain
d. Perception of smell
e. Nasal discharge
f. Overall symptomatic assessment

The results were evaluated in details by an expert radiologists who also completed an objective questionnaire, which included paradoxical middle turbinate, concha bullosa, bony destruction, osteomeatal complex diseases, polypoidal changes, mucosal thickening and frontoethmoidal disease.

3. A surgical score is derived for each maneuver of an endoscopic operation (0= not performed, 1=undertaken), producing a maximum score of 14.

a. Uncinectomy
b. Reduction of middle turbinate
c. Middle meatal ethmoidectomy
d. Anterior ethmoidectomy
e. Posterior ethmoidectomy
f. Sphenoidotomy
g. Frontal recess surgery

4. Endoscopic appearance are quantified on a 0-2 point basis for the presence of polyps, discharge, edema, scarring or adhesions and crusting and this is also performed pre and post therapy [3].

1. **Inclusion Criteria:** Clinically diagnosed cases of chronic rhinosinusitis who will undergo FESS.
2. **Exclusion Criteria:** Complicated sinusitis, Osteomyelitis, Aggressive fungal infections, Infiltrating tumors

Methods of Collection of Data

1. The cases selected for the study were subjected to detailed history taking and examination.
2. A routine haemogram (HB%, BT, CT, TC, DC) and urine examination (albumin, sugar, microscopy), swab from middle meatus for culture sensitivity along with X-ray Para nasal sinuses were done for the patients.
3. All the patients were having symptoms for more than 12 weeks and are in active stage of the disease were treated with course of suitable antibiotic, systemic antihistamines and local decongestants. They were also treated for medical conditions like diabetes mellitus, hypertension, and nasal allergy.

Each patient underwent a computed tomography of Para nasal sinuses and FESS.

Surgical Technique

After suitable vasoconstriction measures, the middle turbinate is identified. This is the most important landmark for the procedure. On the lateral wall of the nose at the level of the anterior end of the middle turbinate lies the uncinated process. This is removed, exposing the ethmoid bulla and the opening called the hiatus semilunaris, into which the frontal and maxillary sinuses drain.

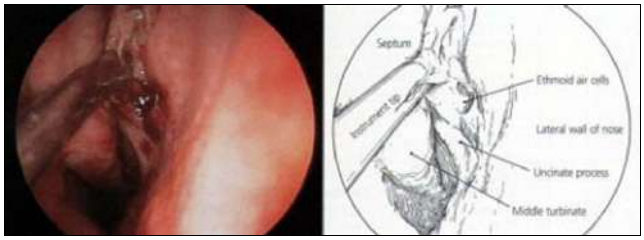

Fig 1: Surgical removal of the uncinate process

The anterior ethmoid air cells are then opened, allowing better ventilation but leaving the bone covered with mucosa. Following this, the maxillary ostium is inspected and, if obstructed, opened by means of a middle meatal antrostomy. This minimal surgery will often be sufficient to greatly improve the function of the osteomeatal complex and therefore provide better ventilation of the maxillary, ethmoid and frontal sinuses

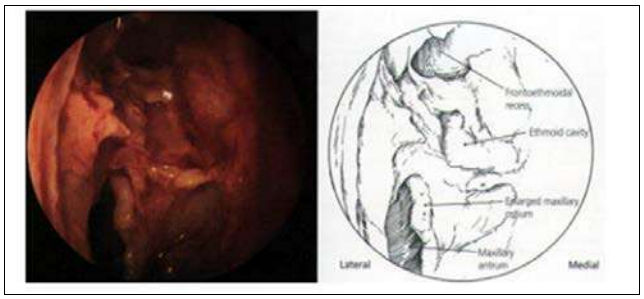

Fig 2: A middle meatal antrostomy in the right nostril.

Occasionally the CT scan shows disease in the posterior ethmoids and the sphenoid sinus. It is then necessary to continue further into these sinuses. However, in most cases of sinusitis, the inflammation is confined to the osteomeatal complex and the anterior ethmoids [4, 5].

Statistical analysis

The data from data collection forms were tabulated in a Microsoft Excel spread sheet. Data were then exported to SPSS, ver 10.0 for statistical analysis.

The level of agreement between CT and ESS findings was determined by calculating kappa statistics. Chi-square was used for statistical analyses.

Observations and Results

Table 1: Age distribution

Age (years)	Number of patients	percentage
0 - 20	16	26
20 - 40	24	48
40 - 60	9	18
60- 80	1	2
Total	50	100

The age of the patients in the present study is from 15 – 75 years. Maximum numbers of patients are in 20 – 40 years of age. 48% of patients are in 2nd & 3rd decade

Table 2: Sex distribution

Sex	Number of patients	percentage
Male	26	52
Female	24	48
Total	50	100

The present study shows slight male preponderance i.e. 52% in males and 48% in females patients

Table 3: Symptoms

Symptoms	Number of patients	Percentage
Headache	40	80
Nasal obstruction	38	74
Nasal discharge	20	40
Post nasal discharge	19	38
Sneezing	13	26
abaft	9	18
Others	4	8

Table 4: SIGNS

Signs	Number of patients	Percentage
Nasal mucosa: congested	17	34
Nasal mucosa: pale	13	26
Nasal mucosa: normal	11	22
Nasal mucosa:edematous	9	18
Inferior turbinate:hypertrophy	21	42
Middle turbinate:hypertrophy	17	34
Middle meatus: non purulent	15	30
Middle meatus: purulent	38	76
Nasal polyps	16	32
Sinus tenderness	43	86
Granular posterior pharyngeal wall	31	62

Table 5: Correlation between CT- Scan and FESS in patients with chronic rhinosinusitis

Findings	Fess positive		Fess negative		Kappa
	CT Scan positive	CT Scan negative	CT Scan positive	CT Scan negative	
Mucosal thickness	28	2	5	15	0.71
Left OMC patency	32	2	0	16	0.86
Right OMC patency	31	3	0	16	0.87
Hypertrophy of inferior turbinate	32	1	3	14	0.88
Hypertrophy of middle turbinate	7	1	1	41	0.85
Septal deviation	27	4	1	18	0.81
Polyp	8	4	0	38	0.77
Mass	4	0	1	45	0.88
Cyst	6	0	0	44	1
Choanal atresia	0	1	0	50	0
Concha bullosa	4	0	2	44	0.7

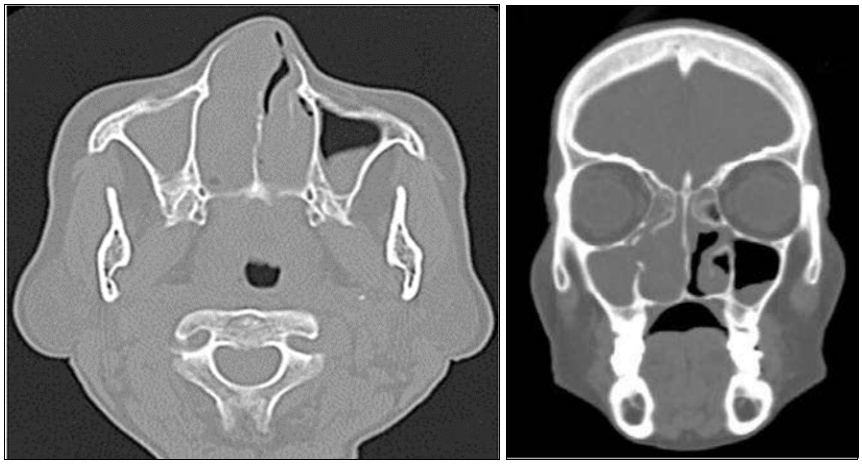

Fig 3: Coronal and CT scan image showing pansinusitis with right sided sinonasal polyposis

Fig 4: Coronal CT-PNS Showing antrochoanal polyp and right maxillary and ethmoid sinusitis

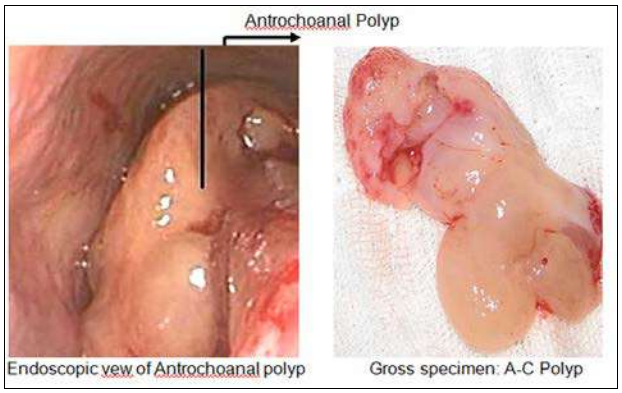

Fig 5: Antrochoanal Polyp

Discussion

Age distribution

In the present study age of patients varies between15 and 75 years, with the maximum number of patients in 20 to 40 years category.

In study conducted by Sheetal *et al.* (2011) with 45 patients the majority of patients is in the age group of 20 to 40 years. By above study we understand this age group is predominant because they are more exposed to the environment, recurrent upper respiratory tract infections, irregular check-up and treatment.

The study conducted by Zojaji *et al.* (2008) of 51 patients the mean age of the patients is 33 years, and in study conducted by Rafael José Geminiani *et al.*, in 35patients the mean age turned out to be 40.

Sex distribution

In the present study of 50 patients, 26 cases are male while 24 cases are females which accounts for 52% being male and 48% being female.

In the study conducted by swati tandon *et al.* (2012) with 49 patients, 22 (45%) were females and 27(55%) were males (swati tandon *et al.*, May - august 2017)

In the study conducted by Sheetal D *et al.* (2011) the majority of the patients are male62% and 38% are female. The study conducted by Rafael José Geminiani *et al.* the maximum number of patients are male 18(51.5%) as compared to female 17(48.5%)

Clinical features

1) Symptoms

In the present study nasal obstruction and headache are the commonest Symptoms which are present in 37(74%) and 40 (80%) cases respectively. The next frequently occurring complaint is nasal discharge present in 20(40%) cases. The other symptoms are postnasal discharge 19(38%), sneezing 13(26%), epistaxis 9(18%) and symptoms like fever, anosmia/cacosmia etc in 4(8%) cases. In the majority of the cases, the duration of symptoms is more than 4 weeks and is not responding to a medical line of management.

In the study conducted by Swati Tandon *et al.* most common complaint was chronic nasal discharge seen in 79.5% of the patients, followed by a nasal obstruction in 77.5%, post nasal drip in 67.3%, headache in 59.1%, anosmia in 16%, facial pain in 10.2%. (swati tandon *et al.*, May - august 2017)

In the study conducted by Sheetal D *et al.*(2011) the commonest complaints is headache in 90% followed by nasal discharge in 80%. The other complaints such as sneezing are seen in 9% of the patients. The average duration of symptoms varies from 1-5 years.

In the study conducted by Zojaji *et al.* (2008) nasal obstruction is the most common symptom with 51 patients and headache is noted in 37(72.5%) patients and nasal discharge in 46(90.1%) patients and other related complaints such as hyposmiais seen in 15 cases, cough in 11 and asthma in 6 cases. The signs and symptoms ranged from 12 weeks to many years.

The results of the present study are correlated with Sheetal D *et al.* and Zojaji *et al.*

2) Signs

In the present study by anterior rhinoscopic examination the commonest clinical sign present is sinus tenderness, seen is 43(86%) patients. Next most common sign is purulent discharge in middle meatus seen in 38(76%) patients and granular posterior pharyngeal wall seen in 31(62%) patients. Deviated nasal septum is seen in 23(46%) patients with majority being asymptomatic DNS. Inferior turbinate hypertrophy 21(41%) and middle turbinate hypertrophy 17(34%), Congested nasal mucosa in 17(34%) patients, while pale mucosa, is present in 13(26%) patients.

Comparative findings in CT and FESS of nasal cavity

1. **Deviated nasal septum:** It is seen in 33(66%) patients on endoscopy and 28(56%) patients on CT scan.

In the study conducted by Swati tandon *et al.* most common variant was deviated nasal septum seen in 81% of the patients. (swati tandon *et al.*, May - august 2017).

In the study conducted by FikretKasapoglu *et al.* the most common findings are deviated nasal septum noted in 18 (41.9%) cases on CT scan.

In the study conducted by Jareoncharsri P *et al.* septal deviation is obvious in 60(72.3%) of the patients out of 83 cases on nasal endoscopy.

No conclusive literature is presents to compare CT scan and endoscopy of deviated nasal septum on the same patients.

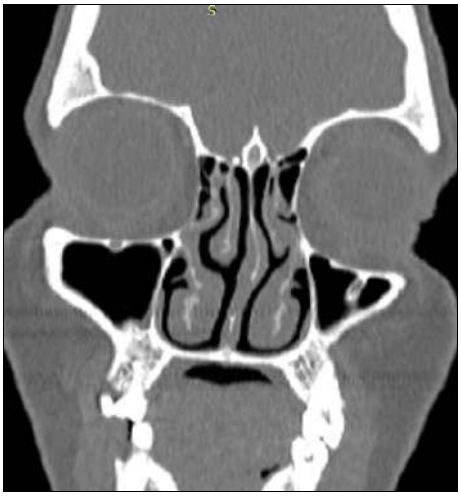

Fig 6: Coronal CT section showing deviated nasal septum towards left side

2. Maxillary ostium patency: patency of the maxillary ostium is seen in 33(66%) cases in right and 34(68%) cases on the left on FESS. On CT scan the present study shows 31(62%) on right and 32(64%) cases on left, has patency.

In the study conducted by Zojaji *et al.* maxillary sinus patency is seen in 32 (62.7%) on right and 33(64.7%) on left when seen by CT scan and 35(68.6%) on both right and left when seen by FESS on comparison the present study shows similar results.

Comparative findings in CT and FESS in relation to anatomical variant Uncinate process: Pneumatized uncinate process is seen in 2 cases (4%) on the right and one case on the left on CT scan, while on FESS only 1case (2%) is seen on the left.

In the study conducted by G.L Fadda *et al.* Pneumatized uncinate process is noted in 1(0.7%) case on the right and 4(2.8%) on left.

On comparison both the studies shows almost equal percentage of patients with Pneumatized uncinate.

Agger nasi: 8(16%) cases on the right and 14((28%) cases on left were demonstrated with FESS whereas on CT scan shows 15 (30%) on right and 18(36%) cases on the left.

In the study conducted by Sheetal D *et al.* on CT scan the Agger nasi cells are present in 37% and 33% of the cases on the right and left sides respectively.

On comparing both studies showed similar number of cases with Agger nasi cells.

Comparative study of CT and FESS on mucosal changes and other pathological conditions

Inferior turbinate hypertrophy: It is seen in 33 (66%) patients on both right and left on FESS, whereas on CT scan shows 35 (70%) on both the left and right side.

In the study conducted by S. Naghibi et.al Hypertrophy of the inferior turbinate is the most obvious finding in the CT scan (70.6%) as well as in endoscopic evaluation (68.6%).

- The striking finding seen both in CT and FESS is the inferior turbinate hypertrophy is always bilateral and in no case can a unilateral hypertrophy be seen and in most of the cases, it is associated with pale mucosa indicating the allergic condition. Pale inferior turbinate is evident in 31 cases on the right (62%) and 31 cases on the left (62%). Whereas this finding is not appreciated on CT scan, hence indicating that the condition of the mucosa whether pale, congested and edematous can only be clearly appreciated on endoscopy, whereas CT scan holds no diagnostic value about the condition of the mucosa.

In comparison with the present study both the study shows both FESS, as well as CT scan, can detect hypertrophied inferior turbinate in almost equal percentage of cases.

- **Hypertrophy of Middle turbinate:** It is seen in 8(16%) cases on FESS & CT scan. The hypertrophy of the middle turbinate is mostly seen in cases with allergy. In a similar study conducted by Zojaji *et al.* out of 51 patients, middle turbinate hypertrophy is seen in 8(15.6%) cases endoscopically and 7 (13.7%) cases in CT scan.

In comparison, both the studies have an almost similar number of cases seen with middle turbinate hypertrophy

- **Masses and Cysts:** CT Scan and FESS showed almost similar results
- **Polyp:** It is seen in12(24%) cases detected on FESS whereas CT scan did not show the findings, thereby showing that FESS is of more diagnostic value in evaluating polyps as mild polyposis could only be seen in FESS. On CT, only extensive polyposis can be identified.

In the study conducted by Arun Kumar Patel *et al.* nasal polyposis is seen in 22(23.91%) cases of which bilateral is seen in 10(10.86%) and unilateral in 12(13.04%), whereas a total of 17(34%) cases is seen in the present study.

Mucosal thickness

Frontal sinus haziness can be better seen in CT scan compared to FESS. Maxillary mucosal thickening noted in 23(46%) cases on CT scans and 20(40%) in FESS. Maxillary mucosal thickening is mostly seen associated with

other sinus involvement Anterior ethmoidal and sphenoid sinus haziness is seen in 12 cases (24%) in CT scans and 8(16%) in FESS. Endoscopically, drainage of secretions from the superior or supreme meatus or from the sphenoethmoidal recess may be the only indication of posterior sinus disease.

In the study by Swati tendon *et al.* in 49 patients, on CT maxillary sinus was most commonly involved in (88% on the left and, 91.8% on the right side)

In the study of Sheetal D *et al.* on CT scan maxillary sinus is found to be the most common sinus to get affected (57% on the right and, 46% on the left side), followed by the anterior ethmoid cells (40% on the right and, 37% on the left side), the posterior ethmoid cells (33% on the right and, 28% on the left side), the frontal sinus (28% on the right and, 26% on the left side) and, sphenoid (20% on the right and, 13% on the left side) respectively.

CT has become the standard diagnostic tool in the evaluation of paranasal sinuses. When coupled with nasal endoscopy, it provides most of the objective data needed for diagnosing CRS. Despite the widespread use of CT, its true accuracy in diagnosing CRS is less clear[2]. The aim of this study was to determine the correlation between preoperative CT and intraoperative ESS findings in patients with CRS. The results of our study indicated that although for most of the findings, there was a good to the excellent level of agreement between the results of the two methods, some discrepancies existed in five patients. These five patients had normal CT imaging based on the radiologist's report, while four of them demonstrated nasal polyps during FESS evaluation and one was diagnosed as choanal atresia. Similar findings were reported by other studies, in which patients who had negative CT scans, showed endoscopic exams with nasal polyposis and septum deviation. According to the present results, the finding of hypertrophic concha was more evidenced in CT scan compared to sinus endoscopy (88% vs 84%).

In 33 (66%) of 50 patients, we found mucosal thickness evidenced by CT; only 30 (60%) of 50 patients had the same problem in FESS. This discrepancy may be due to the fact that up to 40% of asymptomatic individuals have incidental opacification of the paranasal sinuses on CT. In children, the prevalence of mucosal change is even larger. CT scans form an important and reliable objective assessment tool for patients undergoing surgery for CRS.

No single intervention, questionnaire, or radiologic study is sufficient to make the diagnosis alone. When combined with a directed and thoughtful history, CT scan can yield valuable information regarding anatomic location and severity of the disease which will act as "road map" for the surgeon who plans FESS.

Onodi cells: It is only seen on CT scan in 2(4%) cases on the right side.

Importance of Onodi cells is its close relation to the optic nerve and it can be only appreciated completely in axial cuts of the CT scan hence making axial cuts to be a must in CT study of the paranasal sinus. Middle turbinate concha bullosa & paradoxical turbinate: Middle Turbinate concha bullosa is the most common variation present, seen both in FESS and CT scan. 4(8%) cases show concha bullosa on FESS whereas CT scan shows 6(12%) The advantage of CT scan is that it detects both lamellar as well as concha pneumatization with more accuracy. The presence of concha is more important because pneumatization of middle turbinate causes compression of the middle meatus and hence causes narrowing of the hiatus semilunaris. Paradoxical middle turbinate is seen on left side in 3 (6%) on endoscopy whereas in CT scan 1 (2%) case is seen on the right and 5 (10%) is seen on the left side.

In the study by Sheetal D *et al.* on CT scan Concha bullosa is seen in 35% and 42% of the patients on the right and left sides respectively. On endoscopy concha bullosa isseen in 33% and 40% of the patients on the right and left sides respectively. On CT scan Paradoxical middle turbinate is seen in 17% and 8% of the patients on the right and left sides respectively.

On comparison, the present study has less number of paradoxical middle turbinate as well as concha bullosa

Conclusion

- From the present study, it is concluded that sino-nasal pathology has a higher preponderance in male patients and is commonly seen in the age group of 20 to 40 years.
- CT scan has got a better advantage compared to FESS in detecting the anatomical variants as well as to know the condition of the sinus cavity and the extent of disease in sinuses.
- FESS can prove to be a better diagnostic modality compared to CT scan when conditions like middle meatal secretions, the condition of mucosa, polyps are looked for.
- The study stresses that in all patients with sino nasal disease CT scan has to be done, to know the exact pathology and to plan for FESS if required.
- CT scan provides findings almost similar the preoperative findings of FESS and helps in management and provides "road map" to the surgeons if FESS is indicated.

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Conflict of Interest

None

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