



A Prospective Study to Correlate the Preoperative CT Scan Findings with Operative Findings in Patients Undergoing Functional Endoscopic Sinus Surgery

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Abstract

Background: Functional Endoscopic Sinus Surgery (FESS) is a surgical procedure used in the treatment of Chronic Rhinosinusitis (CRS). NCCT PNS is mandatory for all patients undergoing FESS and Rhinologist should know all the variations that can be found and diagnosed by CT scan. **Purpose:** The main aim of the study is to correlate the Computerized Tomography (CT) scan findings of Chronic Rhinosinusitis (CRS) with intra operative findings of Functional Endoscopic Sinus Surgery (FESS). Other objectives are to assess the clinical profile of patients with CRS and to determine the presence of anatomical variations. **Material and Methods:** All the patients were subjected to Diagnostic Nasal Endoscopy (DNE), CT Paranasal sinuses and findings recorded. The scoring systems used were Lund Mackay scoring system for CT scan. All the cases underwent FESS and the operative findings were correlated with preoperative CT findings. Statistical analysis was performed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and Kappa's measure of agreement. **Results:** The Lund Mackay scores on CT scan were 5.42 on right side and 5.64 on left side. Kappa scores varied from 0-1.0. The findings related to septum, posterior ethmoids and sphenoid sinus have perfect agreement (kappa-1.0) with operative findings whereas frontal sinus and inferior turbinate have almost perfect agreement (kappa 0.81-0.99). Middle turbinate has substantial agreement with 0.79 kappa score. In maxillary sinus, anterior ethmoids and OMU, agreement was by chance. **Conclusion:** CT scan has excellent sensitivity and PPV for CRS but specificity and NPV is low in diagnosing disease in Osteomeatal unit (OMU), middle turbinate (MT) and anterior ethmoids. So, it should always be complimented by thorough history and DNE.

Key Words

Chronic Rhinosinusitis, Diagnostic nasal endoscopy, Computed Tomography, Functional Endoscopic sinus surgery

Introduction

FESS is a surgical procedure used in the treatment of CRS and the aim of this procedure is to clear the disease from the OMC which is the primary area of chronic sinus disease. It will provide adequate ventilation and drainage of sinuses which will lead to resolution of secondary mucosal changes in sinuses. This will lead to restoration of normal physiological functions with minimum destruction of nasal and para nasal anatomy.

The term Rhinosinusitis refers to a group of disorders characterized by inflammation of the ciliated respiratory mucosa of nose and paranasal sinuses, and seldom affected in isolation. The Rhinosinusitis Task Force of the American Academy of Otolaryngology has classified Rhinosinusitis based on time frames and on clinical

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presentation into Acute Rhinosinusitis, Viral Rhinosinusitis, Recurrent Acute Rhinosinusitis, CRS and Acute Bacterial Rhinosinusitis (1).

Chronic Rhinosinusitis is diagnosed when the duration of symptoms is greater than 12 weeks. It presents with major symptoms such as facial pain/pressure/congestion/fullness, nasal obstruction/blockage, mucopurulent nasal discharge, hyposmia/anosmia. The minor symptoms include purulent mucus or edema in the middle meatus or anterior ethmoid region, polyps in nasal cavity or the middle meatus, and/or radiographic imaging showing inflammation of the paranasal sinuses. Two major symptoms with one minor symptom when present is clinically diagnostic of CRS. Nose and paranasal sinuses inflammation occur as a result of various factors such as concha bullosa, septal spur, paradoxical turbinate, allergy, cystic fibrosis, immune disorders, trauma, chemical gases, infections, post-surgery, medications etc.

Treatment of CRS is initially medical and those refractory to medical treatment are treated surgically. Along with progress in surgical techniques for CRS, sinonasal imaging has also progressed methodologically from X-rays to CT scan. NCCT PNS has now become mandatory for all patients undergoing FESS. Rhinologist should know all the variations that can be found and diagnosed by CT scan. The aim of this study is to correlate the pre-operative CT scan findings of CRS with intra operative findings of FESS, to evaluate the clinical profile of patients with CRS and to determine the presence of anatomical variations in nose and the para nasal sinuses.

Material and Methods

This prospective study was undertaken at Command Hospital, Bangalore and included 50 patients who were undergoing FESS for CRS with or without sinonasal polyposis who were earlier treated medically for more than 06 months with no improvement. The study was approved by the Institutional Ethics Committee. The patients with malignancies of PNS and revision cases were excluded from the study. The diagnosis of CRS was reached based on the Task force on Rhinosinusitis criteria 1997 and its 2007 update.

All patients were subjected to DNE, CT scan and findings were documented. The results were evaluated by Radiologist also who completed an objective questionnaire, which included septal deviation, hypertrophy of inferior turbinate, concha bullosa, uncinate process, sinus involvement, mucosal thickness, partial or complete obstruction of osteo-meatal complex (OMC)

(Figure 1), presence of polyps, cysts or masses and looked for anatomical abnormalities like paradoxical middle turbinate (Figure 2) and concha bullosa (Figure 3).

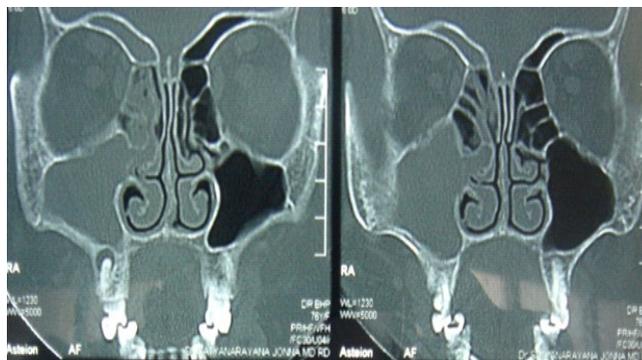


Figure 1: Blocked OMU Right



Figure 2: Paradoxical Middle Turbinate; Figure 3: Concha Bullosa

The CT scan findings were scored as per the Lund – Mackay scoring system separately for left and right side. Maxillary, anterior ethmoids, posterior ethmoids, frontal and sphenoid sinuses were scored from 0-2, where 0 score was for no opacification, 1 being partial opacification and 2 was complete opacification. OMC was scored as 0 (not blocked) or 2 (blocked).

All the patients underwent FESS and the operative findings were recorded and correlated with CT findings. Statistical analysis was performed by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and Kappa's measure of agreement.

Results

The mean age of patients was 38.44 years, the largest group of patients belonged to the age group 31-40. The



male to female ratio was 1.17 :1. The symptom profile of CRS patients in our study is tabulated in *Table 1*. In our study population, 30 cases (60%) were of Sinonasal Polyposis and 12 cases (24%) were of Chronic Rhinosinusitis. Only 8 cases (16%) were of Antrochoanal polyps. Average CT score according to Lund Mackay scoring system on right side was 5.42 and on left side was 5.64. The duration symptoms before undergoing surgery ranged from 8 months to 5 years, mean duration of symptoms being 17.08 months. In 20 patients (40%), DNS was observed and Septoplasty was done along with FESS when indicated. In 22 cases (44%) some kind of allergy either allergic rhinitis or bronchial asthma was found. All these patients were simultaneously taking treatment for these ailments.

Table 1: Symptoms Profile of Patients

S. No	Symptoms	Number of Patients	% of Patients
1	Facial pain/ pressure	33	66%
2	Nasal obstruction	39	78%
3	Nasal discharge/ discoloured post nasal drip	13	26%
4	Facial congestion	9	18%
5	Hyposmia/ Anosmia	28	56%
6	Purulent nasal discharge	4	8%
7	Fever (acute only)	3	6%
8	Headache	34	68%
9	Halitosis	5	10%
10	Dental pain	3	6%
11	Cough	13	26%
12	Ear pain/ pressure/ fullness	3	6%

Correlation of CT Scan Findings with Operative Findings:

(i) Frontal Sinus - On CT scan Frontal sinus hypoplasia was observed in 2 cases (4%), bilateral hypoplasia was observed in 01 patient and unilateral hypoplasia in 01 patient. In 26 cases (52%) frontal sinus homogenous opacity seen on CT scan (bilateral in 22 and unilateral in 04 cases). In 22 cases (44%) Frontal sinus was not involved at all. These findings correlated with operative findings in 46 (92%) patients. In 04 patients (8%) the CT scan showed no disease, but intra operatively mucosal thickening and polypoidal mucosa was observed in frontal sinus.

(ii) Inferior Turbinate - On CT scan, bilateral hypertrophy was observed in 2 cases (4%), unilateral hypertrophy in 16 cases (32%) and no hypertrophy was observed in 32 cases (64%). Intra operatively, bilateral hypertrophy was seen in 2 cases (4%) and unilateral hypertrophy in 6 cases (12%). In 11cases CT findings did not correlate with operative findings as intra operatively only polypoidal mucosa was seen instead of hypertrophy.

(iii) Septum - Septum was deviated mild to severe in 25 cases (50%) and pneumatized in 03 cases (6%). Correlation of CT findings with operative findings was 100%.

(iv) Middle Turbinate - On CT scan middle turbinate was normal in 23 cases (46%), lateralization of middle turbinate in 1 case (2%), concha bullosa in 5 cases (10%), paradoxical middle turbinate in 3 cases (6%) and hypertrophy was observed in 4 cases (8%). In 14 cases (28%) middle turbinate was not distinctly seen on CT scan. Intraoperatively in 4 cases (8%), polypoidal mucosa over the middle turbinate was found, even though CT scan showed normal middle turbinate in these cases. In 1 case (2%) no hypertrophy was observed. So, correlation was seen in 45 cases (90%).

(v) Bulla Ethmoidalis (BE) - In CT scan 33cases (66%) showed bilateral opacity and in 10 patients (20%) unilateral opacity of the BE. Intra operatively in 35cases (70%) polyps were seen and in 9 cases (18%) mucosal thickness observed. Only in 2 cases (4%) CT findings did not correlated with operative findings.

(vi) OMU - CT Scan showed blocked OMU in 35 cases (70%) bilaterally and 15 cases (30%) showed unilateral blockage. Intra operatively in 2 cases there was no correlation with CT findings and showed no blockage of OMU.

(vii) Anterior Ethmoids - All 50 cases showed opacity in anterior ethmoids. CT scan findings correlated with intraoperative findings in 46 cases (92% correlation).

(viii) Maxillary Sinus - In CT scan, maxillary sinus was involved in all 50 cases (100%). Bilateral opacity is seen in 35 cases (70%) and 15 cases (30%) showed only unilateral opacity. Out of the 35 cases of bilateral opacity, 7 cases (14%) showed complete opacity of both sinuses and 7 cases (14%) showed only partial opacity on both sides. In 21cases (42%) total and partial opacity were observed. Operative findings correlated with CT findings in 47 cases (94%). Only 33 cases showed bilateral disease, 25 cases (50%) showed polyps in both maxillary

sinuses, 3 cases showed bilateral purulence, in 3 cases bilateral mucosal thickening was found and 2 cases showed polyps on one side and mucosal thickening on other side.

(ix) Posterior Ethmoids - Posterior ethmoids were involved in only 23 cases (46%) (15 cases bilateral + 08 cases unilateral). 23 cases (46%) underwent posterior ethmoidectomy. Nineteen cases (38%) (bilateral=18, unilateral=1) had polyps and only 3 cases (6%) showed mucosal thickening.

(x) Sphenoid Sinus - In CT scan asymmetry of the sphenoid sinus was observed in 44 cases (88%). In 11 cases (22%) opacity of the sphenoid sinus was seen for which sphenoid sinus was opened. It was found that 10 cases (90.9%) showed mucosal thickening and 1 case showed polyp.

(xi) Lamina Papyracea (LP) – In CT scan, Grade 1 LP was found in CRS with mild or no polyposis (35 cases) and Grade 2 medially displaced LP was found in CRS with extensive polypoidal disease (15 cases). This correlated with intra-operative findings in 100%.

The sensitivity, specificity, PPV, NPV of preoperatively done CT scan in FESS were calculated and correlated for all sinuses, septum, turbinates and OMU (*Table 2*). The findings suggested that CT scan has excellent sensitivity and PPV for CRS but specificity and NPV is low in diagnosing disease in OMU, MT and anterior ethmoids. This suggests that CT scan is highly sensitive test for diagnosing CRS but its specificity is low, so occasionally it may not correctly describe the extent of disease. Hence it should always be complimented by DNE prior to surgery.

Kappa agreements between CT and operative findings in patients with CRS is as per *Table 3*. Kappa scores varied from 0-1.0. The findings related to septum, posterior ethmoids and sphenoid sinus have perfect agreement with operative findings whereas frontal sinus and inferior turbinate have almost perfect agreement. Middle turbinate had substantial agreement. In maxillary sinus, anterior ethmoids and OMU, as (d=0), so the kappa score came as 0.0 which indicates agreement is by chance.

Table 2: Correlation of CT Findings with Operative Findings

Operative Findings in	Sensitivity % of CT Scan	Specificity % of CT Scan	PPV % of CT Scan	NPV % of CT Scan
Frontal sinus	88.88	95.65	96	88
Septum	100	100	100	100
Inferior turbinate	88.88	75.60	44.44	96.88
OMU	100	0.0	96	0.0
Middle turbinate	82.60	96.29	95	86.67
Maxillary sinus	94	0.0	100	33.33
Anterior ethmoids	95.83	50.00	100	50
Posterior ethmoids	100	100	95.83	100
Sphenoid sinus	100	100	100	100

Table 3: Agreements Between CT Scan and Operative Findings in Patients with Chronic Rhinosinusitis

Findings in	Operative Findings Positive		Operative Findings Negative		Kappa* (po-pe)/(1-pe)
	CT Scan Positive (a)	CT Scan Negative (b)	CT Scan Positive (c)	CT Scan Negative (d)	
Frontal sinus	24	3	1	22	0.84
Septum	25	0	0	25	1.0
Inferior turbinate	8	1	10	31	0.86
OMU	48	0	2	0	0.0
Middle turbinate	19	4	1	26	0.79
Maxillary sinus	47	3	0	0	0.0
Anterior ethmoids	46	2	2	0	0.0
Posterior ethmoids	23	0	0	27	1.0
Sphenoid sinus	11	0	0	39	1.0

*Kappa is a measure of the difference between observed agreement and expected agreement, standardized to lie on a -1 to 1 scale, where 1 is perfect agreement, 0 is exactly what would be expected by chance, and negative values indicate agreement less than chance, ie, potential systematic disagreement between the observers. po=observed agreement, p^e=expected agreement



Discussion

CRS is one of common causes of hospital visits and are treated by multiple medical professionals resulting in high-practice variability (2). CT has evolved as important diagnostic tool in the evaluation of paranasal sinuses. Despite the widespread use, its true accuracy in diagnosing CRS is less clear (3). CRS involves all age groups. The mean age of patients in our study was 38.44 years with a male to female ratio of 1.17:1. In a study done by Wabnitz *et al.* (4) the mean age of patients were 44.5 years with male to female ratio being 1.3:1. In another study done by Ling and Kountakis (5), the mean age of patients was 49.4 years with male to female ratio of 1.1:1.

In our study, maxillary and anterior ethmoids were involved in all cases (100%), followed by frontal (52%) and posterior ethmoids (46%), sphenoid (22%). Zojaji *et al.* (3) results showed that most commonly affected was the maxillary sinuses (82%), followed by the ethmoidal sinuses (54%) and the least affected sinuses were the frontal (20%) and sphenoid sinuses (25%). Maxillary sinus was the most common sinus involved in a study by Ologe *et al.* (6). The common symptoms in our study were nasal obstruction (78%), followed by headache (68%), facial pain (64%), rhinorrhea (26%), hyposmia/anosmia (56%) and cough (26%). In a study done by da Lilly-Tariah (7), the symptoms were rhinorrhea (100%), stuffy nose (97.4%), sneezing (67.6%), anosmia (54.8%) and headache (54.8%) (7). The difference in the frequency of occurrence of different symptoms in various studies may be explained by the varied duration of the disease ranging from few months to few years.

Hwang *et al.* (8) correlated radiological and symptom-based diagnostic criteria for CRS and concluded that current TFR criteria has poor specificity and predictive value which may not be sufficient for diagnosis of CRS. Ramakrishnan *et al.* (9) in their study studied Computed tomography scans and suggested two methods of reading CT scans. The first is the quick assessment approach and second is detailed stepwise pre and perioperative approach in which CT scans serve as roadmap for surgeons during FESS. Jiannetto *et al.* (10) found that operative findings are better consistent with surgeon's read CT scans than radiologist's CT scan report and form a reliable objective assessment tool for patients undergoing FESS. In our study also both radiologist report and surgeon's interpretation were recorded and compared with operative findings. When combined with endoscopy, it gives better information regarding the severity of the

disease and bony landmarks (11,12). The anatomical variations in our study were septal deviation (56%), concha bullosa (10%), paradoxical MT (6%), medially displaced LP (30%). Similar anatomical variations were described by Varshney *et al.* and Li *et al.* (13,14). In this study also DNE was done pre-operatively in all cases. LP was medially displaced in gross polypoidal disease which was also concluded by El-Anwar *et al.* (15) in their study, who further stated this medially displaced LP is a major cause of complications in Grade 3,4 polyposis.

In a study done by Zojaji *et al.* (3), Kappa scores for inferior turbinate were 0.88, for middle turbinate were 0.85, for septum 0.81 and for OMU score were 0.84. In our study, Kappa scores varied from 0-1.0. The results of the two studies were comparable. Stanojkoviæ (16) in his study also found the percentage of false positive or false negatives of CT scan in less than 10%. The results of our study indicate that although for most of the findings, there was excellent agreement between the results of the two methods, some discrepancies existed. The findings suggested that CT scan has excellent sensitivity and PPV for CRS but specificity and NPV is low in diagnosing disease in OMU, MT and anterior ethmoids. This was also concluded in a study by Shpilberg *et al.* and Kaygusuz *et al.* (17,18) that CT scan for CRS is not useful unless surgery is planned. Bhattacharyya *et al.* (19) also concluded that CT scan has good sensitivity and average specificity for the diagnosis of CRS. This further reiterates that CT scan is highly sensitive test for diagnosing CRS but its specificity is low, so occasionally it may not correctly describe the extent of disease. Hence it should always be complimented by DNE and history when surgery is planned (20).

Conclusion

Computed tomography of PNS is an important preoperative evaluation tool in detecting pathology and it correlates well with intra operative findings in all cases and in almost all parameters. However, CT scan has low specificity, so it should always be complimented by thorough history and DNE.

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Conflicts of Interest

There are no conflicts of interest.



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