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Correlation Between Preoperative Computed Tomography and Operative Findings in Functional Endoscopic Sinus Surgery in Chronic Rhinosinusitis Patients

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ABSTRACT

This study was done to evaluate the role of computed tomography (CT) in clinically suspected cases of chronic rhinosinusitis for detection of anatomical variants and pathological abnormalities of nose and paranasal sinuses. Findings in CT and functional endoscopic sinus surgery (FESS) were correlated. This study was conducted in Government medical college, Kannur during a period of one year from February 2018 to January 2019. It was a prospective hospital based descriptive study. About 60 patients with chronic rhinosinusitis were enrolled in this study based on inclusion and exclusion criteria. History and clinical examination were obtained from every patient. CT-PNS was taken 1-3 days prior to surgery. Detailed recording of CT scan findings and operative findings were carried out. In our study the CT findings showed very good agreement with operative findings for most of anatomical variations and for osteomeatal complex occlusion. With respect to the type of disease, chronic rhinosinusitis with polyposis (CRSwP) was the most common type and maxillary sinus was found most commonly affected. CRSwP showed good correlation between CT findings and FESS. There was poor correlation between CT-PNS and FESS findings with regard to secretions and mucosal thickening. CT-PNS is the investigation of choice and surgeons roadmap for FESS delineating the complex sinus anatomy, anatomical variations and pathology. CT-PNS by virtue of its 3D resolution detects the mucosal changes within osteomeatal complex. However direct visualisation during FESS allows the surgeon to further characterise the contents of the opacified sinus shown by CT scan.

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Key Words
Chronic rhinosinusitis, computed tomography, paranasal sinus, functional endoscopic sinus surgery

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INTRODUCTION

Rhinosinusitis encompass disorders involving concurrent inflammation of the mucosa of the nose and paranasal sinuses. Chronic rhinosinusitis is inflammation of mucosa of nose and paranasal sinuses with symptoms for >12 weeks, persistent inflammatory changes on imaging for >4 weeks after starting medical therapy (with no intervening acute episode)[1]. A study by the National Institute of allergy and infectious diseases (NIAID) recently concluded that 134 million Indians suffer from chronic rhinosinusitis[2]. To evaluate sinusitis one must understand the drainage pathways of sinuses. Anatomic variations in sinonasal region narrows the normal drainage channel predisposing to chronic recurrent sinusitis, increase the operative risks and surgeon should be forewarned about these. CT is the modality of choice for imaging and evaluation of morphology of this area. According to Lund-Mackay, the osteomeatal complex acts as a drainage pathway for maxillary, anterior ethmoid and frontal sinus. In several areas of osteomeatal complex two mucosal layers contact each other increasing the likelihood of local impairment of mucociliary clearance. Based on this concept FESS aims to eliminate disease in the osteomeatal complex and allow resolution of the secondary infection in the larger sinuses[3].

MATERIALS AND METHODS

This descriptive study included 60 patients with chronic rhinosinusitis who underwent FESS in the Department of Otorhinolaryngology, Government Medical College, Kannur over a period of 1 year from February 2018 to January 2019.

Inclusion criteria:

- Patients above 18 years of age
- Patients having 2 or more major symptoms and signs or one major and two minor symptoms as in European position paper on rhinosinusitis and nasal polyps 2012 (EPOS 2012):
    - **Major symptoms/signs:** Facial pain/pressure, Facial congestion/fullness, Nasal obstruction/ Blockage, Nasal discharge/Purulence, Hyposmia/Anosmia, Purulence on nasal examination
    - **Minor symptoms/signs:** Headache, fever, halitosis, fatigue, cough, Ear pain/pressure/ fullness
    - Patients not responding to 3 weeks of medical therapy

Exclusion criteria:

- Patients with any nasal mass, previous sinus surgery, allergic disorder
- Patients with chronic sinusitis who responded to medical treatment
- Patients with clinical evidence of sinusitis of dental origin, traumatic origin and fungal sinusitis
- Patients with chronic disease such as cystic fibrosis, primary ciliary dyskinesia, immune deficiencies and suspected malignancy
- Patients who did not give consent

After detailed history and clinical examination written informed consent was obtained from patients who participated in the study. Prior to commencement, the study was approved by the institutional ethical committee. CT-PNS (3mm coronal cuts) was taken 1-3days prior to surgery which was interpreted by discussing with consultant radiologist. The surgical technique adopted was the combination of Messerklinker and Wigand technique as described by Stammberger. The extend of the procedure was dictated by the extend of the disease as determined by CT scanning and intraoperatively. A typical complete FESS procedure included uncinectomy, middle meatal antrostomy, clearance of frontal recess and frontal sinus, opening bulla and exenteration of anterior ethmoids, posterior ethmoid exenteration and sphenoid exenteration. Detailed recording of operative findings was done in each patient.

The parameters that were studied included:

- **Anatomical variations:** Deviated nasal septum, concha bullosa, paradoxical middle turbinate, enlarged bulla ethmoidalis, variations in attachment of uncinate process, pneumatisation of uncinate process, medialised uncinate process, atelectatic uncinate process, agger nasi, haller cell, onodi cell, dehiscent lamina papyracea, prescence of frontal cells, pneumatisation of crista galli, anterior clinoid process and pterygoid process.The datas were recorded in binary form, 1-presence of findings and 0-absence of findings
- **Osteomeatal complex:** Normal/total/partial occlusion
- Mucosal thickening (Mild-3 mm or less, moderate 4-6 mm, severe >6 mm)
- Polypoidal changes
- Discharge
- Bony destruction
- Princetown staging (1993) was used for scoring polyp and discharge (0-abscence of polyp, 1-polyp confined to middle meatus, 2-polyp beyond middle meatus) (0-no discharge, 1-clear and thin discharge; 2-thick and purulent discharge)

- Lund and McKay system for degree of opacification (0-No abnormality, 1-partial opacification, 2-total opacification) and osteomeatal complex obstruction (0-no obstruction, 2-obstruction)

Sensitivity, specificity, positive and negative predictive values were calculated for the obtained data. Sensitivity of >90 showed excellent, >80 good, >70 acceptable, >60 poor correlation. Kappa value was used to find the concurrent agreement. Kappa value 0.81-1.0 is very good agreement, 0.61-0.80 is good agreement, 0.41-0.60 is moderate agreement, 0.21-0.40 is fair agreement, <0.2 is poor agreement.

RESULTS

In our study the age of the patients varied from 8-75 years with maximum number of patients, i.e., 18 of them belonging to the age group between 51-60 (30%). Our study population included 32 (53.3%) males and 28 (46.7%) females. Commonest presenting symptoms in our patients were nasal obstruction (75%), followed by headache (50%), anosmia (40%), nasal discharge (25%) (Table 1).

As per CT and FESS in our study most common type of uncinate attachment was to lamina papyracea (50 patients bilaterally). Uncinate was attached to roof of ethmoid (9 patients bilaterally) and to middle turbinate for 1 patient. Kappa value was 1 bilaterally. Thus there was very good agreement between CT-PNS and operative findings.

In 30 patients frontal cell was absent bilaterally as in CT-PNS and in FESS.17 patients had Kuhn 1 cells on (L) side and 18 patients had Kuhn 1 cells on (R) side in both CT-PNS and FESS. CT-PNS and FESS showed 10 patients with Kuhn 2 on (R) and (L) side, respectively. CT-PNS and FESS showed 3 patients with Kuhn 3 bilaterally. Kappa values were 1.0 bilaterally thus showing very good agreement between CT-PNS and operative findings bilaterally (Table 2-3 and Fig. 1-3).

In CT-PNS pneumatised crista galli was present in 7 (11.67%) patients, pneumatised pterygoid process in 9 (15%) patients bilaterally and pneumatised anterior clinoid process in 5 (8.3%) patients bilaterally.

Table 1: Sensitivity, specificity and kappa values of anatomical variations studied

		TP	TN	FP	FN	Sensitivity	Specificity	PPV	NPV	Accuracy	Kappa values
DNS	Left	17	42	0	1	94.44	100.00	100.00	97.67	98.33	0.960
DNS	Right	21	38	0	1	95.45	100.00	100.00	97.44	98.33	0.964
Concha bullosa	Left	17	39	4	0	100.00	90.70	80.95	100.00	93.33	0.847
Concha bullosa	Right	18	39	3	0	100.00	92.86	85.71	100.00	95.00	0.886
Paradoxical MT	Left	7	53	0	0	100.00	100.00	100.00	100.00	100.00	1
Paradoxical MT	Right	3	57	0	0	100.00	100.00	100.00	100.00	100.00	1
Enlarged bulla	Left	4	55	1	0	100.00	98.21	80.00	100.00	98.33	0.880
Enlarged bulla	Right	7	50	2	1	87.50	96.15	77.78	98.04	95.00	0.795
Pneumatised up	Left	0	59	1	0	NA	98.33	00.00	100.00	98.33	NA
Ppneumatised up	Right	0	60	0	0	NA	100.00	NA	100.00	100.00	NA
Medialised up	Left	19	34	2	5	79.17	94.44	90.48	87.18	88.33	0.752
Medialised up	Right	23	28	1	8	74.19	96.55	95.83	77.78	85.00	0.702
Atelectatic up	Left	0	60	0	0	NA	100.00	NA	100.00	100.00	NA
Atelectatic up	Right	0	60	0	0	NA	100.00	NA	100.00	100.00	NA
Agger nasi	Left	9	49	2	0	100.00	96.08	81.82	100.00	96.67	0.880
Agger nasi	Right	8	51	1	0	100.00	98.08	88.89	100.00	98.33	0.932
Haller	Left	16	41	3	0	100.00	93.18	84.21	100.00	95.00	0.879
Haller	Right	16	43	1	0	100.00	97.73	94.12	100.00	98.33	0.958
Onodi	Left	13	45	1	1	92.86	97.83	92.86	97.83	96.67	0.907
Onodi	Right	14	46	0	0	100.00	100.00	100.00	100.00	100.00	1
Dehiscent LP	Left	1	59	0	0	100.00	100.00	100.00	100.00	100.00	1
Dehiscent LP	Right	1	59	0	0	100.00	100.00	100.00	100.00	100.00	1
OMC obs CT	Left	42	15	3	0	100.00	83.33	93.33	100.00	95.00	0.875
OMC obs CT	Right	44	14	2	0	100.00	87.50	95.65	100.00	96.67	0.911

Table 2: Distribution by type of disease in CT-PNS

	Maxillary		Anterior ethmoid		Frontal		Posterior ethmoid		Sphenoid	
Type of disease	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Polyp	32	30	30	31	20	20	22	25	7	8
Secretion	12	10	5	4	2	2	4	2	4	2
Mucosal thickening	18	21	16	13	19	13	15	13	14	14

Table 3: Distribution of type of sinus disease in FESS

	Maxillary		Anterior ethmoid		Frontal		Posterior ethmoid		Sphenoid	
Type of disease	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
Polyp	35	35	32	32	17	19	22	26	7	9
Discharge	16	12	4	3	4	4	1	0	4	0
Mucosal thickening	6	3	1	1	0	0	1	1	0	0

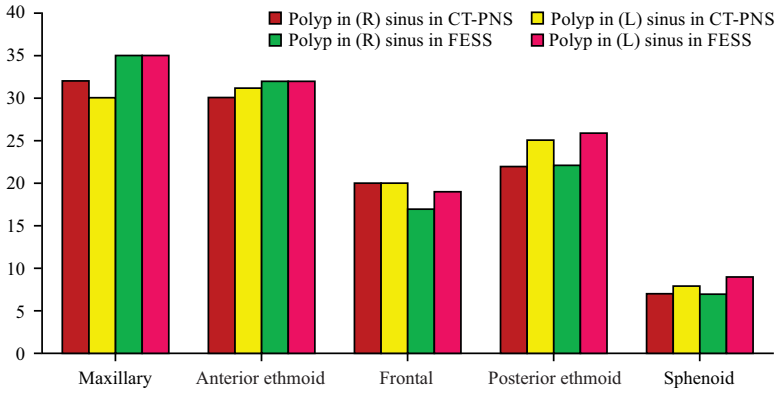

Fig. 1: Comparison between distribution of polyp in various sinuses as per CT-PNS and FESS

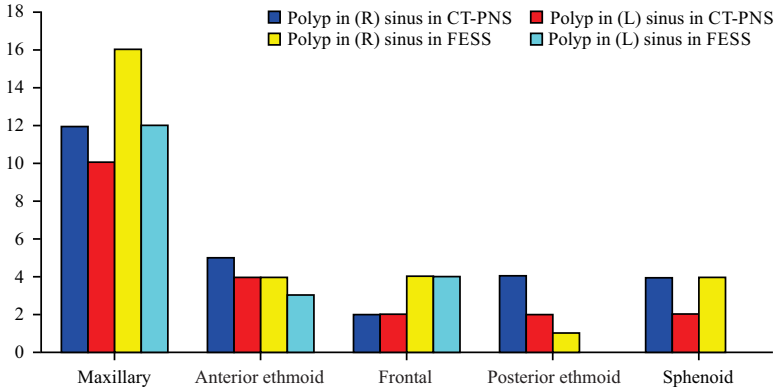

Fig. 2: Comparison between distribution of secretion in various sinuses as per CT-PNS and FESS

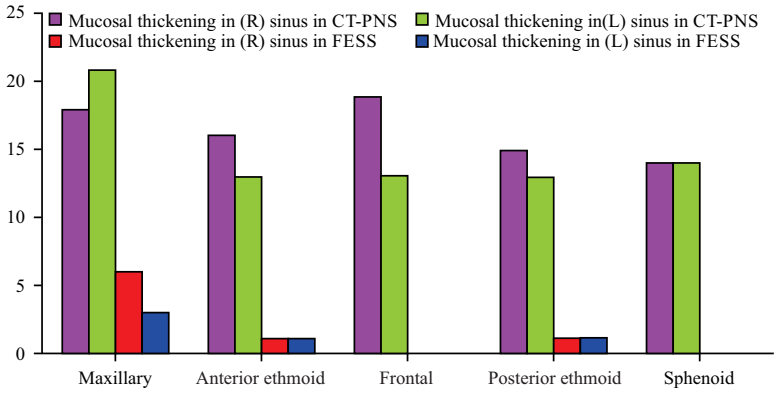

Fig. 3: Comparison between distribution of mucosal thickening in various sinuses as per CT-PNS and FESS

DISCUSSIONS

The present study was done to determine the agreement between preoperative CT-PNS and intra-operative FESS findings in patients with chronic rhinosinusitis in the Department of Otorhinolaryngology, Government Medical College, Kannur during February 2018 to January 2019.

In our study the most common anatomical variation was medialised uncinate process (35 and 40%) in (L) and (R) side, respectively in CT-PNS and 40 and 51.6% in (L) and (R) side respectively in FESS. In a study by Mendiratta *et al*.[4] medially curved uncinate process was found in 20% of patients and 22.8% of patients in a study by Fadda *et al*.[5] Sensitivity for medialised uncinate in our study was acceptable and Kappa values showed good correlation. The next most common anatomical variation in our study was deviated nasal septum (52.75% in CT-PNS and 55% in FESS) which is comparable with the study of Singh *et al*.[6] (66.6%). Excellent sensitivity and very

good correlation was there for deviated nasal septum in our study and was comparable with study by Kumari *et al*.[7] In this study concha bullosa was found in 35% patients bilaterally in CT-PNS while in FESS in 28.3 and 30% patients showed in (L) and (R) side, respectively which had excellent sensitivity, kappa value showed very good agreement. According to Kumari *et al*.[7] concha bullosa was found in 33.3% patients in CT-PNS and in 25% patients in FESS. Regarding paradoxical middle turbinate, it was present in 11.67 and 5% on (L) and(R) side, respectively as per CT-PNS and FESS. Sensitivity was excellent and kappa value also showed very good agreement. Rashmi *et al*.[8] showed that this incidence is 26.66% in both CT-PNS and FESS with excellent sensitivity and very good agreement. In our study enlarged bulla was found in 8.3% patients on (L) side and 15% patients on (R) side as per CT-PNS and in 6.67 and 13.3% in (L) and (R) side, respectively in FESS. Thus on (L) side there is excellent sensitivity and in (R) side there is good sensitivity. Kappa value on (L) side showed very good agreement and on (R) side good agreement. Study by Kumari *et al*.[7] had 10% of patients with enlarged bulla in CT-PNS and 6.7% in FESS with good agreement.

Regarding the variations in attachment of uncinate process in our study 83% was attached to lamina papyracea on both sides 15% to skull base on both sides and 1.6% to middle turbinate on both sides as evidenced by both CT-PNS and FESS. This is in accordance with the study of Sheetal *et al*.[9] Kappa value showed very good correlation. In our study pneumatized uncinate was found only in 1.6% patients on (L) side as per CT but was not noticeable in FESS. In the study by Dasar and Gokce[10] pneumatised uncinate was found in 13.8%. In our study agger nasi cell was found in 18.33% (L) side and 15% patients on (R) side in CT-PNS while in FESS 15 and 13% had agger nasi cell in (L) and (R) side, respectively showing excellent sensitivity and very good agreement. In a study by Sheetal *et al*.[9] agger nasi cells were present in 37 and 33% of patients on right and left sides, respectively on CT-PNS and in 33 and 28% patients on the right and left sides, respectively in FESS showing excellent correlation. Haller cell was present in 31.66% patients and in 28.3% patients on (L) and (R) side, respectively in CT-PNS and 26.67% bilaterally in FESS. Sensitivity was excellent and kappa value showed very good agreement in our study. Similar study conducted by Kumari *et al*.[7] demonstrated Haller cell in 25% patients in CT-PNS and in 20% patients during FESS. In our study 23.33% patients had Onodi cells in both (R) and (L) nasal cavities in CT-PNS as well as FESS. Thus, sensitivity was excellent and Kappa value showed very good agreement. Similar study conducted by Kumari *et al*.[7] showed Onodi cells in 28.3% in CT-PNS and 26.7% in FESS. In the present study frontal cells were absent in 50% patients in both (R) and (L) nasal cavities in CT-PNS as well as in FESS. Kuhn type 1 cells were present in 28.33% on (L) side and 30% on (R) side in both CT-PNS and FESS, Kuhn type 2 cells were present in 16.67% on (L) side and 15% on (R) side in both CT-PNS and FESS, Kuhn type 3 cells were in 5% both on (L) and (R) side in both CT-PNS and FESS with Kappa values showing very good agreement. Meyer *et al*.[11] reported a frequency of 20.4% for frontal cells and the most common type observed was type 1 cells. Frequencies of types 1, 2, 3 and 4 were reported to be 20.0, 48.8, 14.1 and 1.3%, respectively by Lee *et al*.[12] Dehiscent lamina papyracea were present in 1.67% in both (L) and (R) side as per CT-PNS and FESS in the present study .There was excellent sensitivity and very good agreement as per kappa values. In a study done by Dasar and Gokce[10] dehiscent lamina papyracea were found in 0.3% in CT-PNS. In this study pneumatized crista galli was found in 11.67% patients in CT-PNS similar to study conducted by Kumari *et al*.[7] In our study pneumatized pterygoid process was found in 15% patients on both (L) and (R) side in CT-PNS comparable to study conducted by Kumari *et al*.[7] Pneumatized anterior clinoid process was found in 8.3% patients on both (L) and (R) side in CT-PNS in our study which was comparable to study conducted by Kumari *et al*.[7], 6.6%. In our study osteomeatal complex was found to be obstructed in 75% in (L) side and 76% in (R) side as in CT-PNS and70% in (L) side and 73.33% in (R) side as in FESS. Sensitivity was excellent and kappa values showed very good correlation. Rashmi *et al*.[8] in their study showed that total occlusion was present in 46.66% of patients intraoperatively as compared to 33.33% in CT scan. Their study showed partial occlusion of osteomeatal complex in 30% patients intraoperatively and 23.33% in CT scan showing poor sensitivity. Kappa values showed good and moderate agreement for partial and total occlusion, respectively.

Herein maxillary sinus was the commonly diseased sinus. In CT-PNS maxillary sinus showed polyp in 51.67% of patients, o pacification suggestive of secretion in 18.33% and mucosal thickening in 32.5% in our study. In FESS 58.33% had polyp, 23.33% had discharge and 7.5% showed mucosal thickening. For polyp in maxillary sinus CT scan and FESS showed moderate agreement bilaterally whereas for discharge and mucosal thickening CT scan and FESS showed poor agreement bilaterally. Our study showed comparable results with Jianetto and Pratt[13] where there was excellent coorelation between polypoidal changes in maxillary sinus and acceptable coorelation for mucosal thickening in unilateral maxillary sinus disease. In CT-PNS anterior ethmoid sinus showed polyp in 50.88% of patients opacification suggestive of secretion in 7.5% and mucosal thickening in 24.17%. In FESS 53.33%

had polyp, 5.8% had discharge and 1.6% showed mucosal thickening. For polyp in anterior ethmoid sinus CT scan and FESS showed good agreement bilaterally whereas for discharge and mucosal thickening CT scan and FESS showed poor agreement bilaterally. In our study, posterior ethmoid sinus in CT-PNS showed polyp in 39.17%, opacification suggestive of secretion in 5%, mucosal thickening in 23.33% patients. In FESS polyp was found in 40%, 0.8% had discharge and 1.67% showed mucosal thickening in posterior ethmoid sinus. For polyp in posterior ethmoid sinus CT scan and FESS showed very good agreement bilaterally whereas for discharge and mucosal thickening CT scan and FESS showed poor agreement bilaterally. According to Jianetto *et al*.[13] there was excellent coorelation between polypoidal changes in ethmoid sinuses and good coorelation for mucosal thickening in unilateral ethmoid sinus disease and poor correlation for bilateral ethmoid disease. In this study, frontal sinus in CT-PNS showed polyp in 33.3%, opacification suggestive of secretion in 3.33%, mucosal thickening in 26.67% patients. In FESS polyp was found in 30%, 6.7% had discharge and none showed mucosal thickening in frontal sinus. For polyp in frontal sinus CT scan and FESS showed good agreement on (L) side and moderate agreement on (R) side whereas for discharge and mucosal thickening CT scan and FESS showed poor agreement bilaterally. In CT-PNS 12.5% of sphenoid sinus (the least affected in our study) had polyp, 5% had opacification suggestive of secretion 23.33% had mucosal thickening while in FESS 13.33% had polyp in sphenoid sinus, 3.3% had discharge and none had mucosal thickening. CT scan and FESS showed moderate agreement bilaterally for polyp in sphenoid sinus, poor agreement on (L) side and fair agreement on (R) side for discharge in sphenoid sinus while poor agreement for mucosal thickening in both sphenoid sinus.

CONCLUSION

CT-PNS findings shows very good agreement with findings during FESS for anatomical variation like, deviated nasal septum, concha bullosa, paradoxical middle turbinate, enlarged bulla, variations in uncinate attachment, agger nasi cell, Haller cell, Onodi cell, frontal cell and dehiscent lamina papyraceae and good agreement for medialised uncinate process. For the type of disease affecting various sinuses CT-PNS shows good correlation with operative findings for polyps but for discharge and mucosal thickening, our study showed poor correlation with peroperative findings. By careful study of preoperative CT-PNS, surgeon can also avoid dangerous complications which can occur in the presence of anatomical variations. However for mucosal pathologies like polyp, discharge and mucosal thickening peroperative findings are more conclusive.

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