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Original Article

Pre-operative Computed Tomography Findings and Pre-operative Findings in Sinonasal Diseases - A Comparative Study

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Abstract

Background: Computed tomography (CT) scan is a useful diagnostic tool in the evaluation of diseases of the paranasal sinuses (PNS) and an integral part of surgical planning. Mastering of anatomy of PNS and its variations helps in understanding the pathological changes and radiological signs of sinonasal diseases to guide an ear, nose, and throat in planning the surgery.

Aim of the Study: To compare the CT scans findings and intraoperative findings following functional endoscopic sinus surgeries (FESS) for sinonasal diseases.

Material and Methods: A total of 58 patients with sinonasal diseases were included in the study. Pre-operative CT scans were taken in all the patients, and their intra-operative FESS findings were noted. Both the findings were compared and correlated for any discrepancy in reading the radiological signs. The specificity and sensitivity of the CT scan findings were analyzed.

Observations and Results: A total of 58 patients were aged between 14 years and 63 years with a mean age of 39.50 ± 3.70. 32 patients belonged to the age groups of 24–43 (55.17%). The most common symptom in the study observed was nasal obstruction in 43 (74.13%) followed by nasal discharge in 38 (65.51%). The positive predictive value was the highest for mucosal thickening was 100% followed by a pathological variation in ethmoid sinus (92%).

Conclusions: Specificity of the CT scan findings pertaining to mucosal thickening, fungus, polyp and pathologic variations in ethmoid sinus was good (>80%). CT with its excellent capability for displaying bone and soft tissues is the current diagnostic modality of choice for evaluating the osteomeatal complex. Sensitivity was good for pathological variations in maxillary antrum and ethmoid sinuses (>90%).

Key words: Computed tomography scan, Sinonasal diseases, Functional endoscopic sinus surgery, Mucociliary, Osteomeatal complex

INTRODUCTION

Computed tomography (CT) scans have dramatically improved the imaging of paranasal sinuses (PNS) anatomy as compared to plain X-rays. Subtle variations and critical areas anatomy are well appreciated.[1] CT provides essential pre-operative information for the assessment of patients undergoing functional endoscopic sinus surgery (FESS). CT scan helps in delineating the extent of the disease, anatomical variations, relationship of the sinuses with the surrounding important structures such as orbit, anterior, and middle cranial fossae; CT scan also helps in identifying the extension to surrounding structures which produce complications.[2] Endoscopy and CT have revolutionized the understanding and management of chronic sinusitis in recent times.[3] In 1967 Messerklinger[4] studied mucociliary clearance of the sinuses utilizing endoscopy in patients and time-lapsed photography in fresh autopsy specimens. In 1978 Messerklinger[5] presented systematic and detailed work documenting his endoscopic findings. In 1985 Kennedy *et al.*[6] stated that FESS is a term collectively used for surgeries devised by Messerklinger to correct the underlying sinus infections. In 1987 Zinreich *et al.*[7] stated that CT and endoscopy are complementary in the diagnosis and treatment

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of nasal and paranasal sinus diseases. In 1988 Stammberger[8] believed that most sinus infections are rhinogenic in origin. The infection usually starts in middle meatus with mucosal contact, cessation of ciliary action, stasis and infection. In 1992 Kaluskar and Patil[9] correlated the CT and operative findings and reported that the maxillary sinuses correlated well, and for the ethmoids, the mucosal disease was found to be far more spread than detected on CT scan. In this context, a clinical study was conducted to correlate the CT scans findings and intra-operative findings in patients undergoing FESS for Sinonasal diseases.

Study Period

The study period was from August 2015 to July 2017

Institute of Study

This study was conducted at Teaching Hospital of Kannur Medical College, Anjarakandy, Kannur, Kerala.

MATERIALS AND METHODS

A total of 58 patients attending the ear, nose, and throat (ENT) out-patient department of a tertiary teaching hospital were included in the present prospective study. The patients with complaints of sinonasal diseases were included. An Ethical Committee clearance certificate was obtained before the commencement of the study. An Ethical Committee cleared consent form was used in the study.

Inclusion Criteria

1. Patients aged above 14 years and below 63 years were included.
2. Patients with sinonasal diseases of the PNS were included.

Exclusion Criteria

1. Patients with acute exacerbation of chronic sinusitis were excluded.
2. Patients with sinus malignancies were excluded.
3. Patients who are not willing to undergo surgery were excluded.
4. Pediatric age group (age <14 years) was excluded.
5. Patients who are pregnant and lactating were excluded.
6. Patients with chronic debilitating diseases were also excluded.

All the patients were subjected to thorough history taking, ENT examination and CT scans were taken after preparing the patient with antihistamines and nasal sprays of steroids for 1 month to eliminate acute pathology.

Methods of Collection of Data

1. All the patients involved were explained in detail about the involvement in this study, and voluntary consent was obtained.
2. After obtaining a detailed history and through clinical examination of nose and PNS, ears and throat and all other systems were done.
3. They were subjected to hematological examination such as hemoglobin, bleeding time and clotting time total count, differential count, and urine examination (albumin, sugar, and microscopy); swab from middle meatus for culture sensitivity along with X-ray PNS was done for the patients.
4. Patients in the active stage of the disease were treated with a course of appropriate antibiotic, systemic antihistamines, and local decongestants.
5. Each patient underwent a systematic diagnostic nasal endoscopy and CT of the nose and PNS.

All the patients were asked to complete a pre-operative questionnaire inquiring subjective chronic rhinosinusitis (CRS) symptoms including

nasal obstruction, rhinorrhea, post-nasal discharge, headache, facial pain/pressure and/or olfactory disturbances, and CRS-related symptoms such as cough and asthma. The diagnosis of CRS was made using the American Academy of Otolaryngology,[10] head and neck surgery definition, which describes typical symptoms persisting for 12 weeks or more. All the data were analyzed using standard statistical methods.

OBSERVATIONS AND RESULTS

Among the 58 patients selected in the present study the age groups involved were 14 years to 63 years with a mean age of 39.50 ± 3.70. 32 patients belonged to the age groups of 24–43 (55.17%). The extremes of ages were affected by 9 (15.51%) and 6 (10.34%), respectively [Table 1].

Among the 58 patients, 44 (75.86%) were males and the remaining 14 (24.13%) were female patients with a male to female ratio of 3.4:1 [Table 2].

The most common symptom in the study observed was nasal obstruction in 43 (74.13%) followed by nasal discharge in 38 (65.51%), headache in 23 (39.65%), and post-nasal drip in and sneezings in 8 (13.79%), [Table 3].

In the present study, CT scans finding in relation to pathology in the maxillary sinus, osteomeatal complex, mucosal thickening, presence of fungal infections, pus, polyp and pathological variations in ethmoids sinuses were observed and found that the sensitivities were 81.25%, 100%, 93%, 66.6%, 60% 100%, and 92.7%, respectively. Whereas, the specificity values were 42.5%, 50%, 100%, 85%, 865, 90%, and 83%, respectively. The osteomeatal complex patency and presence of polyp were 100% specific and sensitive in the study [Table 4].

Table 1: The age incidence in the study group (*n*=58)

Age	Number of patient (%)
14–23	9 (15.51)
24–33	17 (29.31)
34–43	15 (25.86)
44–53	11 (18.96)
54–63	6 (10.34)

Table 2: The gender incidence in the study group (*n*=58)

Sex	Number of patient (%)
Male	10 (50)
Female	10 (50)

Table 3: The incidence of symptoms in the study group (*n*=58)

Symptoms	Number of patient (%)
Nasal obstruction	43 (74.13)
Nasal discharge	38 (65.51)
Headache/facial pain	23 (39.65)
Sneezing	8 (13.79)
Post-nasal discharge	31 (53.44)

Table 4: The sensitivity and specificity values of radiological signs in the study (*n*=58)

Parameter	Sensitivity (%)	Specificity (%)
Pathologic variation in maxillary sinus	81.25	42.5
Osteomeatal complex patency	100	50
Mucosal thickening	93	100
Fungus	66.6	85
Pus	60	86
Polyp	100	90
Pathologic variation in ethmoid sinus	92.7	83

In the present study, CT scans finding in relation to pathology in the maxillary sinus, osteomeatal complex, mucosal thickening, presence of fungal infections, pus, polyp, and pathological variations in ethmoids sinuses were observed for their accuracy intraoperatively and found that true positive values were found and shown in Table 5.

In the study, the positive predictive value was the highest for mucosal thickening (100%) followed by a pathological variation in ethmoid sinus (92%).Then, it was polyp (90.9%) followed by a pathological variation in maxillary sinus. Least positive predictive value was for pus. Negative predictive value was the highest for pathological variation in maxillary sinus and osteomeatal complex patency. Least negative predictive value was for mucosal thickening [Table 6].

Statistical test applied was Fisher Exact test with an objective to find the *P* value (the probability of error value) is significant (i.e., <0.05)

1. For pathologic variations of maxillary sinus

Positive	Operative findings	
	Positive	Negative
CT		
Positive	13	4
Negative	0	3

Two-sided $P = 0.0307$ considered significant. Row-column association is statistically significant.

2. For osteomeatal complex block

Positive	Operative findings	
	Positive	Negative
CT		
Positive	14	3
Negative	0	3

Two-sided $P = 0.0175$, considered significant. Row-column association is statistically significant.

3. For mucosal thickening

Positive	Operative findings	
	Positive	Negative
CT		
Positive	14	0
Negative	1	5

Two-sided $P = 0.0004$, considered extremely significant. Row-column association is statistically significant.

4. For pus

Positive	Operative findings	
	Positive	Negative
CT		
Positive	3	2
Negative	2	13

Two-sided $P = 0.0726$, considered not quite significant. Row-column association is not statistically significant.

5. For fungus

Positive	Operative findings	
	Positive	Negative
CT		
Positive	4	2
Negative	2	12

Table 5: The true positive and false positive values of the study (*n*=58)

Parameters	True positive	False positive	True negative	False negative
Maxillary antrum status	41	08	09	00
Osteomeatal complex patency	43	09	06	00
Mucosal thickening	44	00	09	05
Pus	09	03	37	03
Fungus	08	02	39	09
Polyp	32	06	20	00
Ethmoid sinus status	36	04	10	08
Total	213	35	130	25

Two-sided $P = 0.0374$, considered significant. Row-column association is statistically significant.

6. For polyp

Positive	Operative findings	
	Positive	Negative
CT		
Positive	10	1
Negative	0	9

Two-sided $P = 0.0001$, considered extremely significant. Row-column association is statistically significant.

7. For pathologic variations in ethmoid sinus

Positive	Operative findings	
	Positive	Negative
CT		
Positive	13	1
Negative	1	5

Two-sided $P = 0.0022$, considered very significant. Row-column association is statistically significant.

The consolidated *P* values for different observations were tabulated in Table 7.

$P < 0.05$ in six of the seven parameters compared in the computed tomographic findings with operative findings in the sinonasal diseases. Inference: The row-column association, i.e., the association between the findings in CT and operative findings in sinonasal diseases correlated well in the parameters included in the study in our group.

DISCUSSION

The present study entitled "pre-operative computed tomographic findings and per-operative findings in sinonasal diseases-comparative study" was conducted in the tertiary teaching Hospital of Kannur Medical College, Anjarakandy, Kannur, Kerala between August 2015 and July 2017. Out of the 20 patients, all underwent middle meatal antrostomy and an anterior ethmoidectomy. While posterior ethmoidectomy was done in 19 cases and sphenoidotomy was done in 13 patients. All the cases have undergone diagnostic nasal endoscopy and CT before the operation. Age distribution: As shown in Table 1, in our study age of patients varied between 14 and 63. More than 50% of the patients were between 24 and 43 years age groups. In a similar study conducted by Kumari *et al.*,[11] the ages ranged from 16 to 52, with the majority of patient's cases (46.7%) in the third decade. Sex distribution: In this study among the 58 patients 44 (75.86%) were males and the remaining 14 (24.13%) were female patients with a male to female ratio of 3.4:1. In a similar study by Kumari *et al.*,[11] there were 19 males (59.37) and 13 females (40.62%) with a ratio of 1.46:1. Symptoms: As shown in Table 3, in the present study, the most common symptom in the study observed was nasal obstruction in 43 (74.13%) followed by nasal discharge in 38 (65.51%), headache in 23 (39.65%), and post-nasal drip in and sneezings in 8 (13.79%). In the majority of patients, duration of the symptom was present more than 6 months. In the study conducted by Kumari *et al.*,[11] the most common complaint was nasal discharge occurring in 25 patients (78.1%), followed by headache in 22 patients (68.7%) and nasal obstruction in 22 patients (68.7%). The other complaint was sneezing in 6 patients (18.7%), Anosmia and cacosmia in 2 patients each (6.25%).The duration of symptom varied from 3 months to 30 years. In the study conducted by Gandotra *et al.*[12]

Table 6: The positive and negative predictive values of the study of CT scans and intraoperative findings (*n*=58)

Parameters	Positive predictive value	Negative predictive value
Pathological variations in maxillary sinus	76	100
Osteomeatal complex patency	82	100
Mucosal thickening	100	83
Pus	60	86.66
Fungus	66.6	85.71
Polyp	90.9	100
Pathological variations in ethmoid sinus	92	83.33

CT: Computed tomography

Table 7: The *P* values for different observations in the study (*n*=58)

Parameter	*P*
Pathologic variations in maxillary antrum	0.0307
Osteomeatal complex	0.0175
Mucosal thickening	0.0004
Pus	0.0726
Fungus	0.0374
Polyp	0.0001
Pathologic variations in Ethmoid sinus	0.0022

the nasal discharge and headache were the most common symptoms, and the next common symptoms were post-nasal drip and nasal obstruction. The result of the present study is comparable with regard to nasal obstruction, headache, and post-nasal drip and sneezing. Nasal discharge was 65.51% in our study which is less when compared to the studies mentioned above. Signs: In the present study, clinical signs taken were the presence of polyp on DNE and sinus tenderness. Sinus tenderness was present in 47 patients (81.03%) among the 58 patients included in the study. Polyp was identified clinically identified in 34 patients out of 58 (58.62%). In the study conducted by Venkatachalam and Bhat[13] clinical findings such as hypertrophied inferior turbinate (10%), hypertrophied middle turbinate (17.14%), congested mucous membrane (15.71%), sinus tenderness (58%), and ethmoidal polyp (12.8%) were reported. Diagnosis: Among the 58 patients chronic sinusitis was observed in 23 patients (39.65%) and sinonasal polyposis in 35 (60.34%) patients. In the study conducted by Gandotra *et al*.[13] 60.8% had chronic sinusitis 40% had sinonasal polyposis was reported. While in a study conducted by Jones *et al*.,[14] 75% had chronic sinusitis and 25 % had diffuse polyposis. The present study was comparable with the study conducted by Gandotra *et al*.[13] Pre-operative CT scan findings and per-operative findings in sinonasal diseases: Elahi and Elahi[15] were of the opinion that a standardized pro forma for reporting CT images has to be followed, with pre-operative imaging and endoscopic intervention relationship can be consolidated and further enhanced. In the present study, computed tomographic scan of the patient was taken, and several parameters were compared with operative findings, namely, pathological variations of maxillary antrum, osteomeatal patency, mucosal thickening, pus, fungus, and pathological variations of ethmoid sinus. Specificity of the computed tomographic scan findings pertaining to mucosal thickening, fungus, polyp and ethmoid sinus status was good. Sensitivity for pathological variation was good for osteomeatal complex patency, pathological variation of maxillary antrum and ethmoid sinus in our study osteomeatal unit was involved in 74.13% of the cases. According to Lund and Mackay,[16] the osteomeatal complex acts as a drainage pathway for maxillary, anterior ethmoids and frontal sinuses. Posterior osteomeatal unit is considered as a part of the sphenoid sinus. In several areas of osteomeatal complex two mucosal areas come into contact causing local impairment of mucociliary clearance leading to stagnation of secretion, creating the potential for infection even without osteal closure. Anatomically, the area of contact is mostly in narrow mucosa lined channels of middle meatus and infundibulum. In a study conducted by Zinreich *et al*.,[7] osteomeatal unit was involved in 72 % of patients with chronic sinusitis. CT with its excellent capability for displaying bone and soft tissue is the current diagnostic modality of choice for evaluating the osteomeatal complex (Zinreich *et al*., 1987). Sensitivity of fungus in the modality of CT scan in our study was 66.6%, which is good. The demonstration of focal or diffuse areas of increased attenuation in paranasal sinus soft tissue masses on unenhanced CT scans strongly suggests fungal involvement;[17] in the study conducted by Zinreich *et al*. the sensitivity was found to be 80% for fungus. Sensitivity was good for pathological variations in maxillary antrum and ethmoid sinus (>90%). Similar observation was made by Kaluskar and Patil[9] when they compared the sinus diseases radiologically and peroperatively. CT finding of sinus opacification and mucosal thickening are all findings of acute sinusitis. Many non-specific CT findings, including thickened turbinate (nasal cycle vs. allergic process vs. inflammation) or diffusely thickened sinus mucosa (allergic disease vs. chronic sinusitis), may be associated with several sinonasal conditions. CT of the PNS has improved the visualization of paranasal sinus anatomy and has allowed greater accuracy in evaluating paranasal sinus disease.

Drawbacks in this Study

CT scan may show overemphasis of the diseases if CT scan had been taken in the acute state. Secretions can show homogenous opacity without any mucosal changes in the CT scan; CT scan changes poorly correlate with patient symptoms.

Recommendation

Ideally pre-operative CT scan should be immediately followed by endoscopic sinus surgery to actually predict the sensitivity and specificity of CT scan modality. Sagittal cuts of CT should also be included in the study. CT guided sinus surgeries should be included in the study. Sampling should be done to ascertain the sensitivity and specificity of the CT with high confidence.

CONCLUSION

Specificity of the CT scan findings pertaining to mucosal thickening, fungus, polyp and pathologic variations in ethmoid sinus was good (>80%). CT with its excellent

capability for displaying bone and soft tissue is the current diagnostic modality of choice for evaluating the osteomeatal complex. Sensitivity was good for pathological variations in maxillary antrum and ethmoid sinuses (>90%).

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