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Diagnosis of Fungal Sinusitis; Is Fungal Culture a Must?

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ABSTRACT

Objective: To determine the diagnostic accuracy of computed tomography (CT) of paranasal sinuses (PNS) in detecting fungal sinusitis keeping fungal culture as the gold standard.

Study Design: Cross-sectional validation study.

Place and Duration of Study: Department of Radiology, Combined Military Hospital, Rawalpindi Pakistan, from Jun 2018 to Jun 2019.

Methodology: A total of 323 patients of either gender were included in the study (aged from 10-70 years). All the patients underwent plain CT scans of paranasal sinuses, and the CT scan findings were reported and recorded on pre-designed proforma. Results were then compared with the culture report of each patient respectively.

Results: Among all the patients undergoing CT scans, paranasal sinuses 177 were True Positives, while 07 were False Positives. Out of a total of 139 CT scan-negative patients, 6 (False Negative) had fungal sinusitis on culture, whereas 133 (True Negative) had no fungal sinusitis on culture (p=0.001). Overall sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of CT scan Paranasal sinuses were 96.72%, 95.0%, 96.20%, 95.68% and 95.98%, respectively.

Conclusion: CT scan of paranasal sinuses is a highly sensitive and accurate non-invasive investigation in detecting fungal sinusitis.

Keywords: Computed tomography, Functional endoscopic sinus surgery, Fungal sinusitis.

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INTRODUCTION

Fungal sinusitis, previously an uncommon condition, is one of the leading sinonasal diseases encountered in the otolaryngology outpatient department in recent times.[1] Fungal spores commonly found in the atmosphere form a part of the normal flora of the nose. However, they are significantly destroyed in active young adults with normal immune status.[2,3] However, risk factors which impair drainage lead to the pooling of mucous and are commonly followed by colonization of the fungus. These might include anatomic abnormalities, nasal polyps or chronic inflammatory states leading to areas of mucosal injury.[4]

Clinical examination of the paranasal sinuses is difficult due to bony structures forming the sinuses; hence diagnostic radiology is of utmost importance in the visualization and diagnosis of the sinus pathology before any invasive procedure like FESS is undertaken for the tissue sampling.[5,6]

Plain X-rays, CT scans, and MRIs can all demonstrate findings suggestive of fungal sinusitis. X-ray of paranasal sinuses may show a non-specific opacification of the involved sinuses. Plain radiography is limited as it fails to image ethmoid sinuses, the upper two third of the nasal cavity, the frontal recess and the osteomeatal complex and may give false results.[7] MRI provides a limited evaluation of osseous destructions. However, a CT scan has the advantage of providing accurate soft tissue involvement, bony details, anatomical variations, and the extent of pathology.[8,9]

Knowing the particular radiologic features of different types of fungal sinusitis makes the radiologist play an important role in the early and correct diagnoses and alerting the clinician to use appropriate treatment modalities.[10]

This study aims to determine the diagnostic accuracy of CT scan paranasal sinuses in fungal sinusitis with fungal culture kept as the gold standard. In addition, this study would help us establish a non invasive modality for accurately diagnosing fungal sinusitis and preventing invasive tissue sampling technique

METHODOLOGY

The cross-sectional validation study was conducted at the Radiology Department, Combined

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Military Hospital, Rawalpindi Pakistan, from June 2018 to June 2019 after getting prior approval from the Ethical Review Committee of the Hospital (Certificate no. 463/2018/IRB). The sample size was calculated using the sample size calculator of WHO taking prevalence 20%, sensitivity 96.16 %, specificity 93.33% and precision 4-7%.[11]

Inclusion Criteria: Patients who had symptoms (at least three) of post-nasal drip, nasal blockage, lightheadedness, dull ache over sinuses, or some degree of anosmia, along with constitutional symptoms like myalgias, fever etc. were included in the study. Few patients were referred for paranasal pathologies diagnosed on conventional imaging.

Exclusion Criteria: Patients with prior history of facial trauma or prosthesis on the face were excluded from the study sample.

Three hundred twenty-three patients of age range 10 to 70 years, of either gender, were included using non-probability, consecutive sampling in the study. Informed written consent was obtained from all study participants, and all relevant demographic details and brief history were documented on specified proformas. CT scan paranasal sinuses of all these patients was done on a 160-slice multi-detector Toshiba CT scan machine (Canon Medical Systems). CT protocol included data acquisition in axial and coronal planes with 3-5mm slice thickness. Images were acquired on bone and soft tissue window settings. Post-processing reformats were obtained for different views in different planes according to requirements. Consultant radiologists reported all cases. Findings reported on CT scan characteristic of fungal sinusitis include one or all of the complete opacification in sinuses with or without internal hyper densities (hyperdensities when present were typically centrally surrounded by a peripheral rim of hypodense mucosa), hyperdense expansile mass (fungus ball), polyp formation, remodelling or thinning of bone sinus wall, erosions of sinus wall, nasal septal ulceration, fat strandings outside sinus parameter along with intraorbital, intracranial or soft tissue extension of the lesions in invasive cases.

Patients were then followed up in the ENT department of the same institute where FESS or diagnostic endoscopy was done, and the sample was taken for fungal culture. Finally, the sample was sent to the Armed Forces Institute of Pathology (AFIP) for culture reporting. Findings in fungal culture include grey-green-blue colonies of fungi, septate or aseptate hyphae with acute angles or 90 degrees angle branching, fan or tree-like branching, wide or ribbon-like hyphae, or hyphae with brown pigmentation.

Data were analyzed in Statistical Package for the Social Sciences (SPSS) Version 23.00. The histopathological reports were compared with the CT scan reports for diagnostic efficacy. Sensitivity, specificity, and positive and negative predictive values were calculated by a two by two table.

RESULTS

Of the 323 patients, the mean age of the study patients was 47.40±9.64 years. All the patients were subjected to CT scan PNS and 177 were found to be True Positive, and 07 were False Positive. Among 139 CT scan-negative patients, 06 (False Negative) had fungal sinusitis on culture, whereas 133 (True Negative) did not show fungal sinusitis on culture (p=0.001), as described in Table-I.

Table-I: Diagnostic accuracy of CT Paranasal sinuses in detecting Fungal Sinusitis among Patients with history of Chronic Sinusitis symptoms keeping Fungal Culture as Gold Standard (n=323)

	Positive result on culture	Negative result on culture	*p*-value
Positive result on CT scan	177(TP)*	07(FP)***	0.001
Negative result on CT scan	06(FN)**	133(TN)****	

-TP=True positive **-FP=False positive *-FN=False negative ****-TN=True negative*

The calculated sensitivity, specificity, positive predictive value, and negative predictive value, along with diagnostic accuracy of CT scan Paranasal sinuses in diagnosing fungal sinusitis among patients with a history of chronic sinusitis symptoms keeping fungal culture as the gold standard was 96.72%, 95.0%, 96.20%, 95.68% and 95.98% respectively.

Table-II: Diagnostic Accuracy of CT Scan for Fungal Sinusitis (n=323)

Diagnostic Test Validity Parameter	Value(%)
Sensitivity	96.72%
Specificity	95.0%
Positive predictive Value (PPV)	96.20%
Negative Predictive Value (NPV)	95.68%
Diagnostic Accuracy	95.98%

In our study, the maxillary sinus was the most common sinus, i.e. in 258 cases (79.8%), followed by ethmoidal air cells in 45 cases (14%). The frontal sinus was least frequently involved only in 8 cases (2.55%). The most common finding on the CT scan was diffuse

opacification of sinuses with internal flocculent hyperdensities (Figure). Only a few cases show the formation of well-defined fungus balls in the maxillary sinus. Bone remodelling was seen in one-third of the cases. The intraorbital extension was seen in 5 cases with the erosion of lamina papyracea.

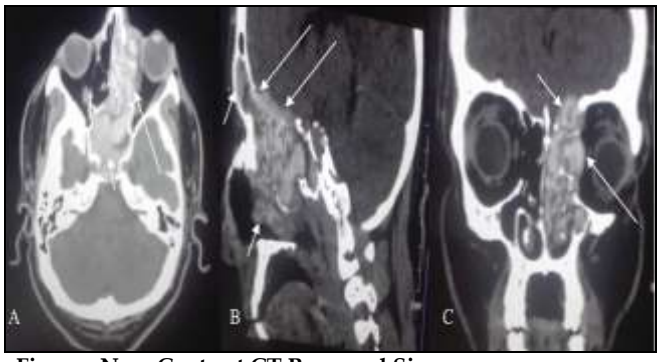

Figure: Non–Contrast CT Paranasal Sinuses

[A- axial view shows diffuse opacification of bilateral sphenoid(short arrow) and left ethmoidal air cells (Long arrow)with intense internal calcifications, B-Sagittal view shows extension into left frontal sinus, nasal cavity(short arrows) and destruction of cribriform plate and planum ethmoidale(Long arrows) ,C-Coronal view showing extension of the disease process in left anterior cranial fossa with associated erosion of left cribriform plate (short arrow) and left orbit with associated erosion of lamina papyracea (Long arrow)]

DISCUSSION

Fungal sinusitis is mostly clinically suspected in difficult-to-treat cases or those presenting with recurrent unilateral sinusitis .In such situations especially, a CT scan is emerged as a necessary imaging modality before proceeding with any surgical intervention.[12,13] Falworth *et al*. have clearly defined the diagnostic criteria of fungus ball.[14] CT scan findings of ncomplete or partial opacification of the affected sinus with internal flocculent calcifications have a high specificity almost the same as that of culture reports.[15] First of all, a case of non-invasive fungal sinusitis was probably reported by Mackenzie in 189.[16] Dhong *et al*. have reported 62 % sensitivity of CT scans in fungal sinus balls.[17]

Based on their research, Middlebrooks *et al*. formulated a seven-variable, CT scan-based diagnostic model for acute invasive fungal rhinosinusitis. They concluded that finding any abnormality in paranasal sinuses with one of the model's variables i.e. bone, dehiscence, septal ulceration, periantral fat invasion, orbital invasion, involvement of pterygopalatine fossa, nasolacrimal duct or lacrimal sachas shown a sensitivity of 95%, specificity of 86%, positive predictive value of 87% and negative predictive value of 95% while the involvement of two variables gives specificity of 100% and a positive predictive value of 100%.[18]

One study reported the sensitivity and specificity of CT scans in diagnosing fungal sinusitis to be 96.16% and 93.33%, respectively,[10] which were comparable to the results of our study.

In another study by using the coronal CT scan as a screening method, found the sensitivity to be 93% and specificity as 89%.[12] However, in another study using a 4-slice CT scan technique, 81% sensitivity, 89% specificity, 74% NPV and 92% PPV was calculated, much less than 160 slice CT scan.[15]

Local studies showed similar comparable statistics. Sarfraz *et al*. showed that the sensitivity of CT scan was calculated to be 80% with a specificity of 77%, diagnostic accuracy of 79%, positive predictive value of 86% and negative predictive value of 70%.[10] Another local study by Iqbal *et al*. demonstrated 96.16% sensitivity, 93.33% specificity, 99.01% positive predictive value and 77.77% negative predictive value on CT scan with a diagnostic accuracy of 95.83% and Kappa statistics showing 82% agreement beyond chance.[9] This study showed that the results were comparable. The few differences in our study compared with international studies could be because of the different demographics and cultures of patients presenting in those centres with different comorbidities and chronicity of the disease.

Non-invasive CT scan imaging can be used as an effective diagnostic modality for diagnosing fungal sinusitis hence eliminating the need for many cases of invasive biopsy specimens to identify the fungal aetiology on cultures.[18] At the same time, it also provides immediate identification of the fungal aetiology without waiting and preparing the patient for diagnostic sample taking for tissue diagnosis.

LIMITATION OF STUDY

The study was done on 160 slice CT scanner. However, the results of this study cannot be accurately reproduced on four-slice or 16-slice CT scanners due to the limited resolution of these scanners. In addition, the sampling technique for fungal culture was different due to interpersonal procedural skill variations. In addition, the imaging findings were known to create bias in the study.

CONCLUSION

Our study emphasized the CT scan of paranasal sinuses as a highly sensitive and accurate imaging modality in detecting fungal sinusitis without incorporating any invasive procedure.

Conflict of Interest: None.

Author's Contribution

Following authors have made substantial contributions to the manuscript as under:

MA: Conception, interpretation of data, drafting the manuscript, approval of the final version to be published.

SM: Study design, data analysis, drafting the manuscript, critical review, approval of the final version to be published.

MM:, SA: Data acquisition, interpretation of data, approval of the final version to be published.

MA:, MM: Study design, Drafting the manuscript, interpretation of data, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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