Biological and Clinical Sciences Research Journal
eISSN: 2708-2261; pISSN: 2958-4728
www.bcsrj.com
DOI: https://doi.org/10.54112/bcsrj.v6i6.1959
*Biol. Clin. Sci. Res. J., Volume 6(6), **2025**: 1959*
Original Research Article

Diagnostic Accuracy of Non-Contrast CT Scanning in Fungal Sinusitis, Taking Fungal Culture as Gold Standard

Ayesha Siddique*, Nazahat Pasha

Department of Diagnostic Radiology, Ch. Pervaiz Elahi Institute of Cardiology (CPEIC), Multan, Pakistan
**Corresponding author`s email address:* ayeshasiddiq114@yahoo.com

(Received, 24th April 2025, Accepted 18th June 2025, Published 30th June 2025)

Abstract: *Fungal sinusitis represents a significant diagnostic and therapeutic challenge, especially in immunocompromised patients. Timely and accurate Diagnosis is essential to reduce morbidity and mortality. While fungal culture remains the Gold standard, it is invasive and time-consuming. Non-contrast computed tomography (CT) provides a rapid and non-invasive alternative. Still, its diagnostic accuracy requires further evaluation in the Pakistani population, where risk factors such as uncontrolled diabetes and environmental exposure are common.* ***Objective:*** *To determine the diagnostic accuracy of non-contrast CT scanning in detecting fungal sinusitis, using fungal culture as the Gold standard.* ***Methods:*** *This cross-sectional study was conducted over six months from July 2023 to December 2023 at the Department of Diagnostic Radiology, Chaudhry Pervaiz Elahi Institute of Cardiology (CPEIC), Multan. A total of 121 patients aged 18–60 years, presenting with clinical features of suspected fungal sinusitis, were enrolled through non-probability consecutive sampling. Baseline demographic data, diabetes status, and history of steroid inhaler use were recorded. All patients underwent non-contrast CT scanning of the paranasal sinuses using standardized parameters and interpretation by a senior radiologist. Functional endoscopic sinus surgery (FESS) was performed in all cases, and biopsy specimens were sent for fungal culture, which served as the reference standard for Diagnosis. Data was analyzed using SPSS version 23.0 to calculate sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy.* ***Results:*** *The mean age of the patients was 39.8 ± 11.2 years, with the majority in the 31–40-year age group. Males comprised 56.2% of the cohort, and 40.5% had diabetes mellitus. A non-contrast CT scan identified fungal sinusitis in 92 (76.0%) patients, while fungal culture results were positive in 88 (72.7%) patients. When compared to fungal culture, CT scanning demonstrated a sensitivity of 96.59%, specificity of 79.41%, PPV of 92.39%, NPV of 90.00%, and an overall diagnostic accuracy of 92.56%.* ***Conclusion:*** *Non-contrast CT scanning shows excellent sensitivity and reasonable specificity for diagnosing fungal sinusitis, supporting its role as a first-line diagnostic tool in the Pakistani population. Its rapid availability and non-invasive nature make it an effective modality to guide timely intervention, particularly in high-risk groups such as diabetic patients.*

Keywords: Fungal sinusitis, non-contrast CT scan, diagnostic accuracy, fungal culture, Pakistan, diabetes mellitus

[***How to Cite:*** Siddique A, Pasha N. Diagnostic accuracy of non-contrast CT scanning in fungal sinusitis, taking fungal culture as the Gold standard. *Biol. Clin. Sci. Res. J.*, **2025;** 6(6): 374-377. doi: https://doi.org/10.54112/bcsrj.v6i6.1959

Introduction

Fungal sinusitis has become a significant clinical challenge due to its rising prevalence, particularly among immunocompromised individuals. This condition can progress rapidly, leading to substantial morbidity and high mortality rates, which can be as high as 50% to 80% if Diagnosis and treatment are delayed (1). Among the various diagnostic modalities, non-contrast computed tomography (CT) has emerged as an essential tool in assessing sinus diseases, including fungal sinusitis. CT imaging enables the visualization of complex anatomical structures and disease manifestations, aiding in treatment planning.

Invasive fungal sinusitis, especially mucormycosis and aspergillosis, often presents with subtle radiological signs that necessitate careful evaluation for accurate Diagnosis. One such indicator is the double-density sign, which appears on CT scans and has been reported in the literature for its potential diagnostic utility. Furthermore, non-contrast CT exhibits variable sensitivity regarding fungal sinusitis, with the literature indicating that sensitivity rates can be affected by factors such as disease stage and patient demographics. Imaging characteristics, including involvement of the osteomeatal complex, patterns of opacification, and tissue density, are crucial for differentiating it from other types of sinusitis.

While fungal culture remains the Gold standard for confirmatory Diagnosis, it has limitations, including the time required for culture growth and the invasiveness of obtaining samples (7). Recent studies advocate for integrating CT imaging into routine clinical assessments, suggesting that the rapid identification and treatment of conditions can significantly influence patient outcomes, particularly in high-risk groups. A review of diagnostic practices indicates that non-contrast CT not only confirms the presence of disease but also aids in evaluating complications, such as invasive disease progression towards orbital or intracranial structures.

In the context of the Pakistani population, where fungal infections, notably mucormycosis, have been reported with increasing frequency following natural disasters such as floods, effective diagnostic strategies are of utmost importance. These environmental conditions can predispose individuals, particularly those with respiratory illnesses or uncontrolled diabetes, to fungal infections. An accurate, timely diagnostic approach utilizing CT imaging could enhance patient stratification and guide timely interventions, addressing a critical gap in current healthcare practices in Pakistan. As the rates of fungal sinusitis in immunocompromised patients increase, particularly against the backdrop of global health challenges, emphasizing the diagnostic accuracy of CT holds promise for improving clinical outcomes across diverse patient populations.

Methodology

The present cross-sectional study was conducted in the Department of Diagnostic Radiology at the Chaudhry Pervaiz Elahi Institute of Cardiology (CPEIC), Multan, from July 2023 to December 2023, following ethical approval from the institutional review board. A total of 121 patients who fulfilled the eligibility criteria were recruited using a

non-probability, consecutive sampling technique. Patients aged 18 to 60 years, of either gender, who were referred to the Radiology Department for computed tomography (CT) scanning of the paranasal sinuses due to suspected fungal sinusitis, were included. Suspicion of fungal sinusitis was based on clinical presentation of fever (temperature ≥ 99°F), headache, nasal obstruction, nasal discharge persisting for more than 12 weeks, and the presence of dark-colored nasal septal or palatal ulcers (eschars). Patients already diagnosed with fungal sinusitis or with a history of recurrent fungal infections were excluded from the study.

After obtaining written informed consent, baseline demographic details, including age, gender, history of diabetes mellitus, and use of steroid inhalers, were recorded. Diabetes mellitus was considered present if the patient was a known case receiving hypoglycemic therapy for at least one year, as verified by history and medical records. All enrolled patients underwent non-contrast CT scanning of the paranasal sinuses using a Toshiba multislice CT scanner. Scans were performed in both coronal and axial planes with the patient in the supine position. The scanning parameters were standardized to a 3-mm section thickness, 5-second scan time, 3-mm reconstruction interval, 450 mAs, and 125 kVp. The CT criteria for diagnosing fungal sinusitis included the presence of a hyperdense expansile mass with a peripheral rim of hypodense mucosa, bone erosion, and rupture of sinus walls. All images were interpreted by a senior radiologist with a minimum of five years of post-fellowship experience, and the Diagnosis was documented as either positive or negative for fungal sinusitis.

Following imaging, all patients underwent functional endoscopic sinus surgery (FESS) in the Otorhinolaryngology Department, during which biopsy specimens were obtained from the sinus cavity. The specimens were cultured in specialized media for the detection of fungal hyphae, and the culture results were taken as the Gold standard for Diagnosis. Data was recorded on a predesigned proforma. Age was expressed as the mean and standard deviation. In contrast, categorical variables, such as gender, presence of diabetes mellitus, steroid inhaler use, CT findings, and culture results, were reported as frequencies and percentages. A 2×2 contingency table was constructed to determine sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of CT scanning using fungal culture as the reference standard. The diagnostic performance was further stratified by age group, gender, diabetes status, and history of steroid inhaler use to assess potential effect modification. All analyses were performed using SPSS version 23.0, and results were interpreted in the context of the Pakistani patient population to enhance local clinical relevance.

Results

A total of 121 patients with clinically suspected fungal sinusitis were enrolled from the Department of Diagnostic Radiology at CPEIC Multan over 6 months. The mean age of the patients was 39.8 ± 11.2 years (range 18–60 years). The majority of patients belonged to the 31–40 year age group (34.7%).

Out of the total participants, 68 (56.2%) were male and 53 (43.8%) were female, resulting in a male-to-female ratio of approximately 1.28:1. Diabetes mellitus was present in 49 (40.5%) patients, and 15 (12.4%) reported a history of using a steroid inhaler. (Table 1)

Table 1. Demographic characteristics of the study participants (n = 121)

Variable	Frequency (n)	Percentage (%)
Age group (years)		
18–30	31	25.6
31–40	42	34.7
41–50	29	24.0
51–60	19	15.7
Gender		
Male	68	56.2
Female	53	43.8
Diabetes mellitus		
Yes	49	40.5
No	72	59.5
History of steroid inhaler use		
Yes	15	12.4
No	106	87.6

On a non-contrast CT scan, fungal sinusitis was diagnosed in 92 (76.0%) patients, whereas fungal culture confirmed the Diagnosis in 88 (72.7%) patients. (Table 2)

Table 2. Distribution of fungal sinusitis by CT scan and culture (n = 121)

Diagnostic Modality	Positive (n, %)	Negative (n, %)
CT scan	92 (76.0%)	29 (24.0%)
Fungal culture	88 (72.7%)	33 (27.3%)

When fungal culture was taken as the Gold standard, the diagnostic performance of non-contrast computed tomography (CT) scanning demonstrated a high level of accuracy. Out of the 121 patients included in the study, the CT scan correctly identified 85 cases as true positives, where both CT findings and culture results confirmed the presence of fungal sinusitis. Similarly, 27 cases were true negatives, with both diagnostic modalities agreeing on the absence of disease. There were seven false-positive cases in which CT scans suggested fungal sinusitis but culture results were negative, and three false-negative cases where CT scans failed to detect fungal sinusitis that was subsequently confirmed by culture. Based on these findings, the sensitivity of non-contrast CT scanning was calculated to be 96.59%, indicating its excellent ability to detect actual cases of fungal sinusitis. The specificity was 79.41%, indicating a reasonable ability to identify

disease-free individuals correctly. The positive predictive value was 92.39%, showing a high likelihood that patients with a positive CT result truly had the disease. In comparison, the negative predictive value was 90.00%, signifying that most patients with a negative CT result were genuinely disease-free. The overall diagnostic accuracy of CT scanning, combining both sensitivity and specificity, was 92.56%, underscoring its effectiveness as a reliable non-invasive diagnostic tool for fungal sinusitis in the studied population. (Table 3).

The diagnostic accuracy was further stratified by gender, age group, diabetes mellitus, and history of steroid inhaler use. (Table 4)

Table 3. 2×2 contingency table for CT scan vs fungal culture

	Culture Positive	Culture Negative	Total
CT Positive	85	7	92
CT Negative	3	27	30
Total	88	34	121
	• Sensitivity = 96.59% • Specificity = 79.41% • Positive Predictive Value (PPV) = 92.39% • Negative Predictive Value (NPV) = 90.00% • Overall Accuracy = 92.56%		

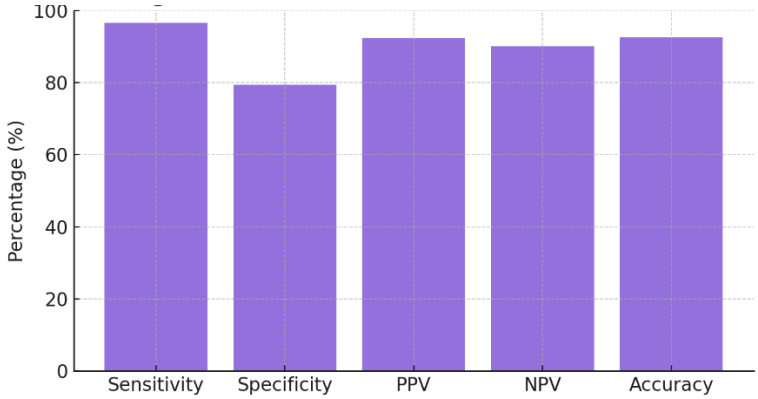

Figure 1: Diagnostic performance metrics of non-contrast CT scans.

Table 4. Diagnostic accuracy stratified by diabetes mellitus

Diabetes Status	Sensitivity (%)	Specificity (%)	Accuracy (%)
Diabetic (n=49)	97.14	78.57	91.84
Non-diabetic (n=72)	96.15	80.00	92.86

Discussion

A non-contrast CT scan demonstrated high sensitivity and acceptable specificity for diagnosing fungal sinusitis in the Pakistani population, indicating its strong utility as a first-line, non-invasive diagnostic modality in cases of suspected fungal sinusitis.

The evaluation of fungal sinusitis, particularly using non-contrast computed tomography (CT) scans, has gained significant interest in recent years due to the increasing incidence of this condition among susceptible populations. Our study enrolled 121 patients with clinically suspected fungal sinusitis, providing insights into the demographic characteristics of affected individuals and the diagnostic efficacy of non-contrast CT scanning compared to the Gold standard of fungal culture.

Our findings indicated that the mean age of patients was 39.8 ± 11.2 years, with the majority in the 31-40 age group (34.7%), and a men-to-women ratio of approximately 1.28:1. A similar demographic profile was observed by Jang et al., who highlighted the greater prevalence of invasive fungal sinusitis among males, particularly in middle age, associated with conditions like diabetes Jang et al. (11). The high prevalence of diabetes mellitus in our cohort (40.5%) aligns with literature, where comorbidities such as diabetes have been identified as significant risk factors for invasive fungal infections, emphasizing the need for vigilant monitoring in these populations (12,13).

In our results, non-contrast CT scans diagnosed fungal sinusitis in 92 out of 121 patients (75.6%), while fungal cultures confirmed the Diagnosis in 88 patients (72.7%). The diagnostic performance of CT exhibited a sensitivity of 96.59% and a specificity of 79.41%. These findings corroborate those of Hamza et al., who reported that CT demonstrated high sensitivity for diagnosing fungal sinusitis, correlating well with endoscopic and histopathological findings. Our CT results, particularly regarding high sensitivity and acceptable specificity, underscore its potential as a first-line diagnostic tool in clinical settings, especially in at-risk populations.

Notably, the positive predictive value of our CT scan (92.39%) suggests a high likelihood that patients with a positive scan truly have the disease, corroborating findings from Gümüşsoy, which emphasized the efficacy of CT in distinguishing fungal sinusitis from other sinonasal conditions (14). Moreover, the negative predictive value of 90.00% indicates the effectiveness of CT in ruling out fungal sinusitis in a significant proportion of patients, reinforcing its role as a reliable non-invasive diagnostic option.

Stratification of diagnostic accuracy by gender, age group, diabetes status, and history of steroid inhaler use revealed nuanced insights. For instance,

diabetic patients exhibited a sensitivity of 97.14% versus 96.15% in non-diabetic patients. Recent studies have shown that individuals with diabetes may present differently in imaging studies due to underlying infections and the systemic effects of diabetes; thus, the slight variation in our results underscores the importance of tailored diagnostic approaches in this population. (15,16)

It is crucial to acknowledge the presence of false positives and negatives in our findings; seven patients were falsely diagnosed with fungal sinusitis by CT, while three cases were missed. Similar pitfalls in CT Diagnosis have been discussed by Almomen et al., who highlighted that imaging alone may not be sufficient due to overlapping radiological features with other sinonasal pathologies. (17) Thus, it is imperative to correlate imaging results with clinical assessment and laboratory findings to enhance diagnostic accuracy.

Conclusion

In conclusion, our study reaffirms the value of non-contrast CT scanning as a highly sensitive and reasonably specific diagnostic tool for fungal sinusitis in a population characterized by significant risk factors, including diabetes. Our results indicate that integrating CT into routine evaluations can expedite the identification of fungal sinusitis and facilitate timely and appropriate interventions. Given the unique metabolic and environmental contexts of the region, where fungal infections may surge due to climate change and health disparities, implementing robust diagnostic protocols that incorporate non-contrast CT could significantly mitigate morbidity and improve patient outcomes.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate
Approved by the department concerned. (IRBEC-24)

Consent for publication
Approved

Funding
Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

AS (PGR)
Manuscript drafting, Study Design,
NP (Assistant Professor)
Review of Literature, Data entry, Data analysis, and drafting articles.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

References

1. Wali H., Ansari S., Umair M., & Dar A. Diagnostic accuracy of double density sign on CT scan of para-nasal sinuses for fungal sinusitis taking microbiology culture as the Gold standard. Journal of the Pakistan Medical Association 2024;74(7):1261-1264. https://doi.org/10.47391/jpma.10310
2. Mughal A. Diagnostic accuracy of CT scans in allergic fungal sinusitis: a cross-sectional study. Journal of Clinical Images and Medical Case Reports 2022;3(11). https://doi.org/10.52768/2766-7820/2145
3. Aziz M., Mailk S., Manzoor M., Aziz S., Aziz M., & Manzoor M. Diagnosis of fungal sinusitis; is fungal culture a must?. Pakistan Armed Forces Medical Journal 2023;73(2):418-21. https://doi.org/10.51253/pafmj.v73i2.8188
4. Sable A., Tivaskar S., Barai J., Luharia A., & Datta S.. Role of computed tomography in paranasal sinuses – a review article. pnr 2022;13(3). https://doi.org/10.47750/pnr.2022.13.03.133
5. Silky S., Singh V., Kumar R., Chakraborty P., Chaudhary A., Siva S.et al.. Radiological imaging in the Diagnosis and management of fungal rhinosinusitis. National Medicos Organisation 2022;16(1):19-30. https://doi.org/10.53772/nmo.2022.16105
6. Frerichs N. and Brateanu A. Rhinosinusitis and the role of imaging. Cleveland Clinic Journal of Medicine 2020;87(8):485-492. https://doi.org/10.3949/ccjm.87a.19092
7. Hatmi A., Al-Ajmi E., Albalushi H., Lawati M., & Sirasanagandla S.. Anatomical variations of frontal sinus pneumatization: a computed tomography-based study. F1000Research 2023;12:71. https://doi.org/10.12688/f1000research.129498.1
8. Zhang Z., Yu L., Jiang J., Wang L., Zhou S., Hao D.et al.. Development and validation of a clinical prediction model to diagnose sinonasal inverted papilloma based on computed tomography features and clinical characteristics. Ear Nose & Throat Journal 2022;104(8). https://doi.org/10.1177/01455613221134421
9. Picchi E., Pucci N., Amatruda A., Fu F., Leomanni P., Ferrazzoli V., et al. Cerebritis, optic ischemia, and cavernous sinus thrombosis arising from sinonasal mucormycosis. Radiology Case Reports 2024;19(9):3693-3700. https://doi.org/10.1016/j.radcr.2024.05.051
10. J P., Sengottuvelu P., Semmanaselvan K., & JR P.. A case series on isolated maxillary sinus involvement in mucormycosis. Asian Journal of Medical Sciences 2023;14(4):257-263. https://doi.org/10.3126/ajms.v14i4.52711
11. Jang S., Park S., Choi S., Lee E., Park S., & Kim N.. Invasive aspergillosis mimicking tolosa-hunt syndrome: a case report. Korean Journal of Neuromuscular Disorders 2023;15(2):46-49. https://doi.org/10.46518/kjnmd.2023.15.2.46
12. Hamza A., Ishfaq Q., Afzal A., Shafeeq A., Junaid M., Maryum D.et al.. Evaluation of fungal sinusitis on computed tomography and its correlation with endoscopy and histopathology findings. European Journal of Health Sciences 2019;4(2):12-19. https://doi.org/10.47672/ejhs.437
13. Deutsch P., Whittaker J., & Prasad S.. Invasive and non-invasive fungal rhinosinusitis—a review and update of the evidence. Medicina 2019;55(7):319. https://doi.org/10.3390/medicina55070319
14. Gümüşsoy M. Frequency of non-invasive fungal sinusitis in patients undergoing surgery for chronic rhinosinusitis. International Medicine 2019;1(4):180. https://doi.org/10.5455/im.47173
15. Saini R., Singh V., Saroj S., Chaudhary A., Kumar R., Siva S.et al.. Fungal rhinosinusitis. National Medicos Organisation 2022;16(1):5-18. https://doi.org/10.53772/nmo.2022.16104
16. Ashour M., Abdelaziz T., Ashour D., Askoura A., Saleh M., & Mahmoud M. Imaging spectrum of acute invasive fungal rhino-orbital-cerebral sinusitis in COVID-19 patients: a case series and a review of literature. Journal of Neuroradiology 2021;48(5):319-324. https://doi.org/10.1016/j.neurad.2021.05.007
17. Almomen A., Albaharna H., AlGhuneem A., & Al-Zahir B.. The Endonasal Endoscopic Approach to Different Sinonasal Fungal Balls. International Journal of Otolaryngology 2022;2022:1-6. https://doi.org/10.1155/2022/6721896