



Original Article

Diagnostic Accuracy of CT PNS in Diagnosing Fungal Sinusitis and its Relation with Endoscopy and Histopathological Findings

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Abstract

Objective: To assess the diagnostic accuracy of CT PNS in diagnosing fungal sinusitis and its relation with endoscopy and histopathology

Methods: This cross sectional retrospective study was conducted at Benazir Bhutto Hospital, Rawalpindi from July 2022 to July 2023. Data of 153 individuals was collected who underwent CT PNS, Endoscopy and histopathology. Data was analyzed in SPSS version. 26.

Results: The mean age of individuals was 39.38 ± 7.05 years. Out of 153 individuals, 87 (56.9%) were males and 66 (43.1%) were females. On CT PNS, out of 153 individuals, 122 (79.7%) individuals were positive for fungal sinusitis but 31 (20.3%) were found negative. On histopathology, results were almost same as results obtained on CT, on histopathology i.e. 119 (77.8%) positive and 34 (22.2%) negative. Against endoscopy as well as against histopathology, CT PNS showed sensitivity and specificity of 95% and 73.5%, respectively. The overall diagnostic accuracy of CT PNS was 90.2% against endoscopy.

Conclusion: Thus CT PNS serves as a good diagnostic tool for detection of fungal sinusitis and a reliable guide for the surgeon, since diseases confined to the nose and paranasal sinuses may be effectively done under endoscopic techniques.

Keywords: computed tomography, fungal sinusitis, endoscopy, histopathology, paranasal sinus.

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Introduction

Fungal rhinosinusitis comprises a broad range of fungal infections that vary in severity from minor symptoms to potentially lethal outcomes. The upper and lower airways often experience fungal colonization due to the widespread distribution of fungal spores in the atmosphere. Aspergillus species are the most common organisms that inhabit the sinuses.¹ In Pakistan, reported prevalence of allergic fungal sinusitis was 23.7%.² Fungal sinusitis is a rare condition that occurs in individuals with weakened immune systems. While acute and chronic invasive fungal sinusitis exhibit distinct clinical characteristics and radiological imaging findings, both conditions are associated with equally elevated rates

of mortality and morbidity in patients. Hence, timely recognition and proactive intervention are crucial. Utilizing diagnostic techniques and accurately interpreting imaging results aids in averting lethal consequences.³

The significance of CT PNS in fungal sinusitis is crucial for ENT surgeons and has been extensively debated in the literature. Sinusitis is a very widespread illness, and a significant proportion of cases are caused by fungal infection, contrary to the conventional perception that fungal sinusitis is seldom observed. Fungal sinusitis may be categorized into two groups: invasive and non-invasive, based on the presence of fungal hyphae inside or beyond the mucosa.⁴ In the invasive type, hyphae may be seen infiltrating the mucosa. Depending on the

intensity and length, it is categorized as acute invasive fungal sinusitis, chronic invasive fungal sinusitis, and granulomatous invasive fungal sinusitis.⁵ The non-invasive type of hyphae does not penetrate the mucosa. This category covers conditions such as allergic fungal sinusitis and sinus fungal mycetoma. Mucormycosis is the causal organism of the invasive variant, although both invasive and non-invasive forms are present in aspergillus.⁶

The typical sequence of sinus involvement typically begins with the maxillary and ethmoid sinuses, and is then followed by the sphenoid sinus. Most of these individuals have unilateral involvement of several sinuses. Involvement of the posterior ethmoid air cells or sphenoid sinus increases the likelihood of intracranial extension.⁷ Diagnostic imaging of paranasal sinuses is essential for accurately diagnosing and planning surgery for sinusitis, since a comprehensive clinical examination of the sinuses is difficult due to the presence of surrounding bony structures.⁸ Cross-sectional imaging (CT/MRI) not only helps in diagnosing fungal sinusitis but also maps out intra-orbital and/or intracranial spread which is crucial for medical/surgical management. In addition, it guides about the prognosis of the disease.⁹

The primary methods used to identify fungal sinusitis are computed tomography (CT) and magnetic resonance imaging (MR). CT is the most effective method for assessing changes in bone structure, whereas MRI is more suitable for detecting alterations in soft tissues.¹⁰ The computed tomography (CT) features of fungal sinusitis consist of either unilateral or bilateral opacification of the sinuses, thickening of the soft tissues in the sinuses and the mucosa of the lateral nasal wall, together with erosion of the bone. In more severe cases, the infection may extend into the intracranial and/or intra-orbital regions.

Methods

This cross sectional retrospective study was conducted at Benazir Bhutto Hospital, Rawalpindi from July 2022 to July 2023. Sample size of 153 cases was estimated with 95% confidence level, 7% absolute precision required and prevalence of fungal sinusitis was 23.7%.² All the individuals were enrolled through non-probability, consecutive sampling, who fulfilled selection criteria. Data of 153 individuals was collected who underwent CT PNS, Endoscopy and histopathology. Clinical information and relevant medical records were collected. Endoscopy and histopathology record of these patients was collected through collaboration of ENT Department of Benazir Bhutto Hospital. Inclusion criteria included all the individuals with clinical diagnosis of fungal sinusitis.

Ct Imaging Protocol: A CT scan is conducted with

narrow collimation ranging from 0.5 to 1 mm in the axial plane, and multiplanar reconstructions are obtained in the coronal and sagittal planes. To thoroughly evaluate the sinuses and nearby structures, we do reconstructions of both the soft tissue and bone windows. This allows us to analyze any expansion beyond the sinuses and any erosion of the bones. Data of CT PNS was retrieved from computerized database of the Radiology and Medical Imaging department and reports were interpreted by highly qualified Radiologist. Data was analyzed in SPSS version 26. 2×2 tables were developed to calculate accuracy of CT PNS against endoscopy and histopathology.

Results

The mean age of individuals was 39.38 ± 7.05 years. Out of 153 individuals, 87 (56.9%) were males and 66 (43.1%) were females. In about 90 (58.8%) individuals, the disease was unilateral whereas, in 63 (41.2%) individuals, the disease was bilateral. Out of 153 individuals, 57 (37.3%) belonged to rural area, 39 (25.5%) were residing in urban area, 42 (27.5%) were coming from semi-urban region while 15 (9.8%) had residence in industrial area. Out of 153 individuals, 34 (22.2%) were doing either high scale or low scale business, 59 (38.6%) were doing job or working as maid or servants, 22 (14.4%)

Table 1: Basic information of patients enrolled in the screening (n=153)

Characteristics		n	%
Age (Mean & SD)		39.38 ± 7.05	
Gender	Males	87	56.9
	Females	66	43.1
Lateral side involved	Unilateral	90	58.8
	Bilateral	63	41.2
Area of residence	Rural	57	37.3
	Urban	39	25.5
	Semi-urban	42	27.5
	Industrial area	15	9.8
Occupation	Business	34	22.2
	Job / servant	59	38.6
	Farmer	22	14.4
	Housewife	38	24.8
Season	Summer	44	28.8
	Winter	38	24.8
	Spring	42	27.5
	Autumn	29	19.0
Social Class	Low	76	49.7
	Middle	56	36.6

were farmers and 38 (24.8%) were housewives. Forty four (28.8%) individuals presented during summer season, 38 (24.8%) presented during winter season with symptoms, 42 (27.5%) presented during spring season and 29 (19.0%) individuals presented in autumn season. Out of 153 individuals, 76 (49.7%) belonged to low socioeconomic class, 56 (36.6%) belonged to middle class and 21 (13.7%) from high socioeconomic class. Table 1

On CT PNS, out of 153 individuals, 122 (79.7%) individuals were positive for fungal sinusitis but 31 (20.3%) were found negative. On endoscopy, out of 153 individuals, 119 (77.8%) individuals were positive for fungal sinusitis but 34 (22.2%) were found negative. On histopathology, 119 (77.8%) were positive and 34 (22.2%) were negative. (Table 2)

Thus, against endoscopy, CT PNS showed sensitivity and specificity of 95% and 73.5%, respectively. CT PNS also showed PPV and NPV of 92.6% and 80.6%, respectively. The overall diagnostic accuracy of CT PNS was 90.2% against endoscopy. (Table 3)

Similar findings were observed with histopathology. Against histopathology, CT PNS showed sensitivity and specificity of 95% and 73.5%, respectively. CT PNS also showed PPV and NPV of 92.6% and 80.6%, respectively. The overall diagnostic accuracy of CT PNS was 90.2% against histopathology. Table 4

Table 2: Findings on Radiological and histopathological examination (n = 153)

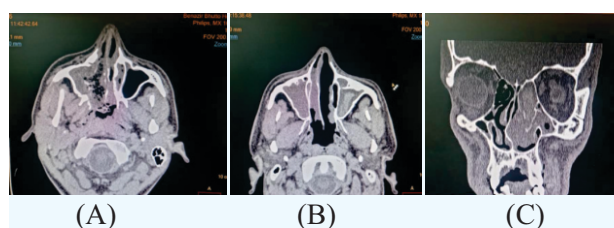
	CT PNS	Endoscopy	Histopathology
n	153	153	153
Positive	122(79.7%)	119(77.8%)	119 (77.8%)
Negative	31 (20.3%)	34 (22.2%)	34 (22.2%)

Table 3: Accuracy of CT PNS versus endoscopy for diagnosis of fungal sinusitis

		Endoscopy		Total
		Positive	Negative	
CT PNS	Positive	113	9	122
	Negative	6	25	31
	Total	119	34	153

Table 4: Accuracy of CT PNS versus histopathology for diagnosis of fungal sinusitis

		Histopathology		Total
		Positive	Negative	
CT PNS	Positive	113	9	122
	Negative	6	25	31
	Total	119	34	153



CT PNS of 38 years (A) , 42 years (B) and 45 years (C) old males showing predominantly unilateral disease with superadded fungal infection each with positive endoscopy and histopathology findings. Axial image (A) shows erosion of medial wall of sinus with extension of disease into nasal cavity and nasopharyngeal space. Axial Image (B) shows bilateral sinus disease with left sided super-added hyperdensity (C) Coronal reformatted images with left sided disease with sinus expansion with super-added hyperdensity, suggestive of fungal sinusitis

Discussion

The fungi are common saprophytic micro-organisms and fungal sinusitis is usually acquired by inhalation of fungal spores.¹¹ Any age group may get infected, however symptoms vary depending upon the immunity status of the diseased individual.¹² Unilateral paranasal sinus involvement is a typical occurrence in cases of fungal sinusitis. The maxillary sinus is often affected in cases of fungal rhinosinusitis, perhaps due to its lower location in the middle meatus compared to other sinus openings, which facilitates the entry of germs.¹²

For timely diagnosis and accurate characterization of PNS fungal infection, role of CT scan is pivotal. It is also helpful in establishing the extent of disease process which further guides the surgeon for better approach to be used.¹³ CT scan is the imaging modality of choice for sinonasal structures either for the assessment of congenital variation or for infective etiologies, for benign or sinister causes and for their spread and complications. CT scan is, so far, the best modality in determination of skeletal involvement including bone expansion, thinning or destruction.¹⁴ PNS Endoscopy is superior in the evaluation of localized disorders like thickened mucosa, polyps, blocked secretion, intranasal/sinus masses while CT scan gives much better evaluation and assessment of the osteomeatal complex , skeletal erosions, intra-orbital and/or intra cranial extension of the disease processes.¹⁵

On imaging soft tissue opacification with areas of hyperdense attenuation and bony expansion is a major clue to diagnosis out of 153, 128 individuals showed sinus expansion. All of the individuals had soft tissue attenuation with hyperdense areas on CT scan. Results were compared to a similar study conducted by Nicolai. A total of 160 individuals diagnosed with sinonasal fungal

ball underwent treatment using an exclusively endoscopic method in this research. Preoperative computed tomography (CT) and/or magnetic resonance imaging was performed on all individuals. The research determined that Endoscopic surgery is a secure and efficient therapy for paranasal sinuses fungal ball. An accurate imaging examination using magnetic resonance imaging and/or CT may determine the diagnosis by detecting fungal hyphae in histology.¹⁶

In our study, we observed that CT PNS had sensitivity and specificity of 95% and 73.5%, respectively for diagnosis of fungal sinusitis. The overall diagnostic accuracy of CT PNS was 90.2% against endoscopy. All these findings are comparable to similar study conducted by Khattar. Approximately half the cases occur unilaterally. The sinuses are expanding, causing a decrease in the space of the surrounding compartments like the orbit. This expansion may also lead to changes in the structure or weakening of the bone edges around the lesion.¹⁷

In a study in 2015 by Middlebrooks et al., a seven variable model of imaging findings was devised on CT to diagnose acute invasive fungal rhinosinusitis. They found that the presence of abnormality in a single variable in the model had an 87% PPV, 95% NPV, 95% sensitivity, and 86% specificity. The presence of abnormality in two variables increased PPV and specificity to 100%.¹⁸

In another earlier study, Iqbal et al., found that the CT PNS had sensitivity, specificity, PPV and NPV of 96.19%, 93.33%, 99.01%, 77.77%, respectively. The diagnostic accuracy was 95.83% for diagnosis of fungal sinusitis.¹³ Recently, Aziz et al., conducted a study and found that CT PNS had sensitivity, specificity, PPV, NPV and diagnostic accuracy of CT scan Paranasal sinuses were 96.72%, 95.0%, 96.20%, 95.68% and 95.98%, respectively.⁸

Conclusion

Thus CT PNS serves as a good diagnostic tool for detection of fungal sinusitis and a reliable guide for the surgeon, since diseases confined to the nose and paranasal sinuses may be effectively done under endoscopic techniques. So in future, we can recommend and implement use of CT PNS as first line diagnostic tool and replace invasive methods that require expertise, specific environment and expenses.

Ethical Approval: The IRB/EC approved this study via letter no. 630/IREF/RMU/2024 dated 01-03-2024.

Conflict of Interest: None

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Authors' Contribution: Role and contribution of authors followed ICMJE recommendations

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