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Original Research Article

Fungal infection among patients with chronic rhinosinusitis who underwent endoscopic sinus surgery

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ABSTRACT

Background: Chronic rhinosinusitis (CRS) involves persistent inflammation of the nasal passages and sinuses, often attributed to Aspergillus species as a primary etiological agent. Effective treatment involves complete eradication of fungal pathogens and restoration of sinus function, commonly achieved through functional endoscopic sinus surgery (FESS). This study aimed to evaluate the clinical and radiological features, assess the prevalence and identify the mycological profile of fungal rhinosinusitis.
Methods: This study was a prospective observational analysis involving a cohort of 50 patients treated at the Tirunelveli Medical College between June 2017 and July 2017. Nasal sinus tissues and secretions were collected for mycological and bacteriological analysis. Samples were processed on the same day, with fungal elements identified via KOH mount and cultured on Sabouraud dextrose agar. Bacterial cultures were grown on MacConkey agar and species identification was performed using biochemical tests.
Results: Fungal culture results showed that 72% of the patients had a negative culture, while 28% had a positive culture. Among the 50 patients, 36 did not have diabetes or hypertension. All sinuses were involved in 40 patients and 24 had nasal polyps, with bilateral polyps being the most common. The most frequently isolated fungal species was Aspergillus. KOH positivity was strongly correlated with culture positivity, with 9 out of 10 KOH-positive patients also being culture-positive, while KOH negativity was associated with culture negativity in 35 out of 36 patients.
Conclusions: CRS significantly affects quality of life, with fungal infections being a notable cause, especially in patients with unilateral sinus involvement. Effective treatment requires endoscopic sinus surgery, followed by antifungal therapy.

Keywords: Aspergillus, Allergic fungal sinusitis, Chronic rhinosinusitis, Endoscopic sinus surgery, Fungal infection

INTRODUCTION

Chronic rhinosinusitis (CRS) incorporates a range of conditions marked by persistent inflammation of the nasal and paranasal sinuses. Despite significant advances in understanding its pathophysiology over the past two decades, the precise cause remains unclear, likely influenced by a combination of host and environmental factors. Fungi, which are ubiquitous in the environment, are increasingly recognized as contributors to various diseases, including rhinosinusitis.[1,2] It is estimated that 5-10% of chronic sinusitis cases involve some form of fungal sinusitis.[3] Fungal rhinosinusitis (FRS) is classified as invasive and non-invasive. Invasive FRS includes granulomatous invasive, acute invasive (fulminant) and chronic invasive forms, while non-invasive FRS comprises saprophytic fungal infestation, fungal balls and fungus-related eosinophilic conditions such as allergic

FRS. Both types of FRS occur in different clinical settings and affect various patient populations. Allergic fungal sinusitis (AFS), a non-invasive subtype, accounts for 6-9% of rhinosinusitis cases requiring surgical intervention.[4] Sinus computed tomography (CT) typically reveals features of CRS, often characterized by central areas of increased contrast (hyper-attenuation) within the abnormal paranasal sinuses.[2]

Patients with fungal rhinosinusitis (FRS) frequently present with a history of chronic sinusitis that has failed to respond to multiple courses of antibiotics. FRS is increasingly recognized across all age groups, leading to significant socioeconomic impact, including direct and indirect costs to society. These patients experience high morbidity, with acute invasive FRS posing a risk of high mortality.[5] In developing countries like India, FRS remains a major, yet often overlooked and misdiagnosed, cause of CRS.

Diagnostic methods involve identifying fungal hyphae in sinus secretions using fungal stains such as Gomori's methenamine silver (GMS) or 10% potassium hydroxide (KOH). Confirmation can be achieved through culture on Sabouraud dextrose agar (SDA) supplemented with antibiotics. The fungi implicated in rhinosinusitis vary demographically: dematiaceous fungi are more common in the West, while Aspergillus species, such as A. flavus and A. niger, are more prevalent in India. Other organisms, like *Bipolaris spicifera* or *Curvularia lunata*, may also be involved.[6,7]

The preferred treatment for AFS is the complete removal of allergic mucin, along with establishing permanent drainage and ventilation of the affected sinuses. This is typically accomplished through functional endoscopic sinus surgery (FESS), a procedure designed to restore the function of the diseased paranasal sinuses.[1] This study aimed to analyse the clinical and radiological findings, determine the prevalence and mycological profile of fungal rhinosinusitis and compare the diagnostic efficacy of KOH wet mount and culture in patients undergoing FESS at a tertiary care hospital.

METHODS

This was a prospective observational study that included 50 patients at the Department of Microbiology, Tirunelveli Medical College, conducted between June and July 2017. Convenient sample size was taken. This study was approved by the Institutional Ethics Committee prior to the commencement of the study and informed consent was obtained from all patients.

Inclusion criteria

Patients of all age groups, both male and female, with radiologically confirmed sinusitis, symptoms persisting for more than 12 weeks and undergoing FESS were included in the study.

Exclusion criteria

Patients who had been on topical or systemic steroids within one month prior to the study period were excluded.

Methods

After informed consent was obtained, patients were interviewed using a structured questionnaire and clinically assessed.

Sample collection and processing

Over the two months, samples of nasal sinus tissue, sinus secretions and allergic mucin were collected from patients undergoing FESS. These samples were subjected to both mycological and bacteriological cultures.

Specimens were collected in sterile saline, at the appointed time transported to the microbiology laboratory and processed the same day. Samples were analysed via direct microscopy using 10% KOH and culture.

KOH mount

The specimen material was teased and placed on a glass slide, followed by the addition of a drop of 10% KOH. A coverslip was then applied and the preparation was left at room temperature to allow tissue digestion. Microscopic examination was subsequently performed, during which fungal hyphal elements were identified.

Gram staining

This method was performed after alcohol fixation and the bacterial and fungal hyphal elements were examined.

Fungal culture

Specimens were inoculated in duplicate on Sabouraud dextrose agar supplemented with Gentamicin and Chloramphenicol. The inoculated media were incubated at 25°C and 37°C, with daily observations made for one week, followed by twice-weekly checks for an additional three weeks.

Fungal growth was identified based on macroscopic and microscopic morphology and lactophenol cotton blue mount was used to examine the microscopic structure. When morphology was unclear, slide cultures were performed to assist in species identification.

Bacterial culture

Samples were also inoculated onto chocolate agar, blood agar, nutrient agar and MacConkey agar, followed by incubation at 37°C for 18-24 hours. Bacterial species identification was performed using a range of biochemical tests.

Statistical analysis

The collected data were entered and verified in a Microsoft Excel spreadsheet, then analyzed using SPSS software version 27.0. Results are presented as frequencies and percentages.

RESULTS

The most frequently affected age group was 41-50 years, accounting for 30% of the patients, followed by 21-30 years (24%) and 11-20 years (18%). The majority of the patients were male, comprising 58%, while females accounted for 42%. In terms of occupation, both coolies and housewives are equally represented, each comprising 36% of the patients, followed by others (18%) and farmers (10%).

The predominant symptom was nasal obstruction, reported by 86% of the patients, followed by headache (80%), allergy (70%) and sneezing (68%). Fungal culture results showed that 72% of the patients had a negative culture, while 28% had a positive culture (Table 1).

The majority of patients (36 patients) did not have diabetes or hypertension. Ten patients were diagnosed with diabetes mellitus. The most common finding, with 43 patients with DNS, was predominantly on the left side (29 patients). A significant majority (40 patients) were involved in all the sinuses. 24 patients had nasal polyps, with bilateral polyps being more common (16 patients) than unilateral polyps (eight patients). Six patients had bilateral maxillary sinus involvement, while unilateral maxillary and sphenoidal sinus involvement was observed in two patients. *A. flavus* was the most frequently isolated fungal species, identified in eight patients.

This was followed by *Aspergillus fumigatus* in three patients, Fusarium species in two patients and Rhizopus in one patient (Table 2).

Among the 14 culture-positive patients, 9 patients were KOH-positive, indicating a high correlation between KOH positivity and culture positivity. Among the 36 culture-negative patients, 35 patients were KOH negative, showing that KOH negativity strongly correlates with culture negative.

Of the 50 patients, 10 were KOH-positive and the majority (9 of 10) were culture-positive. Forty patients were KOH-negative, with the majority (35 of 40) being culture-negative (Table 3). The KOH mount correctly identified 64% of culture-positive patients. The KOH mount accurately identified 97% of culture-negative patients. Among the positive KOH results, 90% were truly positive according to culture results. Among the negative KOH results, 88% were truly negative according to culture results (Table 4).

Table 1: Demographic, occupational, symptomatic and fungal culture profile.

Variables		Number of patients (%)
Age (in years)	0-10	0
	11-20	9 (18)
	21-30	12 (24)
	31-40	8 (16)
	41-50	15 (30)
	51-60	5 (10)
	61-70	0
	71-80	2 (4)
Sex	Male	29 (58)
	Female	21 (42)
Occupation	Coolie	18 (36)
	Housewife	18 (36)
	Farmers	5 (10)
	Others	9 (18)
Symptoms	Headache	40 (80)
	Nasal discharge	20 (40)
	Nasal obstruction	43 (86)
	Sneezing	34 (68)
	Cough	5 (10)
	Wheeze	9 (18)
	Hyposmia	15 (30)
	Allergy	35 (70)
Fungal culture	Culture positive	14 (28)
	Culture negative	36 (72)

Table 2: Prevalence of systemic diseases, nasal polyps, deviated nasal septum, sinus involvement and fungal isolates.

Variables		Number of patients
Systemic diseases	Diabetes mellitus	10
	Hypertension	2
	Both diabetes and hypertension	2
	Neither diabetes nor hypertension	36
Polyp and deviation	Unilateral polyp	8
	Bilateral polyps	16
	Total patients with polyp	24
	Deviated nasal septum to the right	14
	DNS to the left	29
	Total patients with DNS	43
Involvement of sinuses	Bilateral maxillary sinuses	6
	Unilateral maxillary sinus	2
	Sphenoidal sinus	2
	All sinuses	40
Fungal isolates	*A. flavus*	8
	A. fumigatus	3
	Fusarium species	2
	Rhizopus	1

Table 3: Evaluation of KOH mount versus culture techniques.

Variables	Culture positive	Culture negative	Total
KOH (positive)	9	1	10
KOH (negative)	5	35	40
Total	14	36	50

Table 4: Sensitivity and specificity of KOH mount and culture.

Variables	%
Sensitivity	64
Specificity	97
True predictive value	90
False predictive value	88

DISCUSSION

We have evaluated 50 patients with CRS with ages ranging from 11 to 80 years. The majority of patients fell within the 40–60-year age group, followed by those aged 20-40 years (mean age: 45.5 years). Males predominated at 58%, compared to 42% of females, resulting in a male-to-female ratio of 1.32:1. Montone et al, reported a similar finding in the USA, with a mean age of FRS patients at 45 years with a male-to-female ratio of 1.2:1.8. Male preponderance in this study aligns with findings reported by Prateek et al, (1.33:1), though Dufour et al, observed a female predominance.[9,10] This disparity may be attributed to greater exposure of males to environmental pollutants such as traffic, dust and industrial emissions. The most prevalent symptoms included in our study were nasal obstruction (86%), headache (80%), nasal discharge (40%) and sneezing (68%). Shivani et al, found nasal obstruction to be the leading complaint in 90.74% of their 216 patients, followed by posterior nasal discharge at 74.07%, anterior nasal discharge at 58.33%, headache at 45.37% and aural symptoms at 17.59%.[11] Among the patients, 24 had nasal polyps, 43 had deviated nasal septa, 12 had diabetes and 4 had hypertension. Shivani et al, identified nasal allergy as the most common risk factor in 19.44% of patients, followed by deviated nasal septum and nasal polyps, each 11.11%. Other reported risk factors were hypertension (5.55%), bronchial asthma (4.62%) and diabetes (4.16%).[11] Michael et al highlighted that uncontrolled diabetes was present in 38.8% of patients with invasive fungal sinusitis, suggesting the potential for undiagnosed diabetes mellitus in the study population, a common issue in India.[12] Mohapatra et al, noted hyperglycaemia in 44.8% of patients. Diabetes Atlas 2006 by the International Diabetes Federation projected that the number of individuals affected by diabetes in India could rise from 40.9 million to 69.9 million by 2025 without preventive measures. Thus, increased vigilance is essential for identifying fungal rhinosinusitis in the

future.[13] We have observed that a CT scan of the paranasal sinuses revealed that 40 patients had multiple sinus involvement. Alrajhi et al, reported that all patients exhibited abnormalities in their paranasal sinuses, with 61% showing involvement in all sinus regions.[14] We have found that the prevalence of fungal rhinosinusitis was 30% with fungal positivity detected in 15 patients (30%). Of these, 14 (56.52%) were culture-positive, while one was KOH-positive but culture-negative, potentially due to inadequate specimen quality. The KOH mount revealed fungal hyphal elements in 9 out of the 14 culture-positive patients.

Ragini et al, reported that 21.2% of patients were culture-positive and 78.8% of patients were culture-negative.[15] Klossek et al, presented that 30% of patients were culture-positive and 69.7% were culture-negative.[16] Das et al, indicated that 61.7% of patients were culture-positive while 38.28% of patients were culture-negative.[17] Similarly, Prateek et al, demonstrated that 21% of patients were culture-positive whereas 79% of patients were culture-negative.[9] In the present study, the majority of isolated fungi were Aspergillus species (79%), primarily *A. flavus*. Among the 11 Aspergillus isolates, 8 were *A. flavus* and 3 were A. fumigatus. Saravanan et al, reported that *A. flavus* was the most common isolate (81%), followed by *A. fumigatus* (9%).[18]

No dematiaceous fungi were isolated in this study, which may reflect geographical variations in fungal distribution based on local climate and humidity. These findings are consistent with those of Michael et al, in Tamil Nadu, who reported A. flavus as the most common isolate at 47.61%, followed by A. fumigatus at 14.28%.[12]

The study's small sample size, short duration and convenience sampling limit generalizability. Exclusion of steroid users narrows applicability and reliance on KOH and culture, with a 72% negative rate, may reflect diagnostic limitations. Advanced techniques and confounder adjustments were lacking, reducing depth and accuracy.

CONCLUSION

CRS is a prevalent health condition that considerably affects the quality of life, but its heterogeneous nature complicates the identification of underlying causes. Fungal sinonasal infections represent a subset of CRS cases. The age group most affected was 41 to 50 years, with a male-to-female ratio of 1.32:1. Fungal sinusitis should be suspected in CRS patients exhibiting nasal obstruction, discharge and polyps. Diagnosis is facilitated by CT, direct nasal endoscopy and histopathological examination of sinus specimens. Endoscopic sinus, surgery along with antifungal therapy is crucial in managing fungal sinusitis. Given the recent rise in fungal infections affecting the nose and paranasal sinuses, otorhinolaryngologists need to consider fungal aetiologies in their practice. Unilateral sinus involvement is more suggestive of a fungal cause, with the maxillary sinus being mostly affected, likely due to its anatomical position that facilitates microbial access.

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REFERENCES

1. Benninger MS, Ferguson BJ, Hadley JA, Hamilos DL, Jacobs M, Kennedy DW, et al. Adult chronic rhinosinusitis: Definitions, diagnosis, epidemiology and pathophysiology. Otolaryngol Head Neck Surg. 2003;129:3463-8.
2. Fokkens W, Lund V, Mullol J. European position paper on rhinosinusitis and nasal polyps. Rhinol. 2007;20:56-9.
3. Lane AP. The role of innate immunity in the pathogenesis of chronic rhinosinusitis. Curr Allergy Asthma Rep. 2009;9:205–12.
4. Meltzer EO, Hamilos DL, Hadley JA, Lanza DC, Marple BF, Nicklas RA, et al. Rhinosinusitis: Establishing definitions for clinical research and patient care. J Allergy Clin Immunol. 2004;114:155–212.
5. Ponikau JU, Sherris DA, Kephart GM, Kern EB, Congdon DJ, Adolphson CR, et al. Striking deposition of toxic eosinophil major basic protein in mucus: Implications for chronic rhinosinusitis. J Allergy Clin Immunol. 2005;116:362–9.
6. Wang X, Moylan B, Leopold DA, Kim, Rubenstein R C, Togias A et al. Mutation in the gene responsible for cystic fibrosis and predisposition to chronic rhinosinusitis in the general population. JAMA. 2000;284(14):1814–9.
7. Ostrowski LE, Yin W, Rogers TD, Busalacchi KB, Chua M, O'Neal WK, et al. Conditional deletion of Dnaic1 in a Murine model of primary ciliary dyskinesia causes chronic rhinosinusitis. Am J Respir Cell Mol Biol. 2010;43:55–63.
8. Montone KT, Livolsi VA, Feldman MD, Palmer J, Chiu AG, Lanza DC, et al. Fungal rhinosinusitis: A retrospective microbiologic and pathologic review of 400 patients at a single university medical center. Int J Otolaryngol. 2012;1:1–9.
9. Prateek S, Banerjee G, Gupta P, Singh M, Goel MM, Verma V. Fungal rhinosinusitis: A prospective study in a University hospital of Uttar Pradesh. Indian J Med Microbiol 2013;31:266–9.
10. Dufour X, Kauffmann-Lacroix C, Ferrie JC, Goujon JM, Rodier MH, Klossek JM. Paranasal sinus fungal ball: epidemiology, clinical features and diagnosis. A retrospective analysis of 173 cases from a single medical centre in France, 1989-2002. Med Mycol. 2006;44:61-7.
11. Shivani, Bimla Devi, Sharma K, Pushpa. Mycological profile of fungal rhinosinusitis in a

tertiary care hospital. Int J Contemp Med Res. 2016;3(4):1001-6.
12. Michael RC, Michael JS, Ashbee RH, Mathews MS. Mycological profile of fungal sinusitis: An audit of specimens over a 7-year period in a tertiary care hospital in Tamil Nadu. Indian J Pathol Microbiol. 2008;51:493-6.
13. Mohapatra S, Jain M, Xess I. Spectrum of zygomycoses in North India: An institutional experience. Indian J Med Microbiol. 2010;28(3):262-70.
14. Alrajhi AA, Enani M, Mahasin Z, Al-Omran K. Chronic invasive aspergillosis of the paranasal sinuses in immunocompetent hosts from Saudi Arabia. Am J Trop Med Hyg. 2001;65:83-6.
15. Ragini T, Vikas K. Clinico-mycological spectrum of fungal rhinosinusitis from a university hospital. J Clin Diagn Res. 2012;6(4):4285-8.
16. Klossek JM, Serrano E, Peloquin L. Functional endoscopic sinus surgery and 109 mycetomas of the paranasal sinuses. Laryngoscope. 1997;107:112-7.
17. Das A, Bal A, Chakrabarti A, Panda NK, Joshi K. Spectrum of fungal rhinosinusitis: Histopathologist's perspective. Histopathol. 2009;54:854-9.
18. Saravanan K, Panda NK, Chakrabarti A, Das A, Bapuraj RJ. Allergic fungal rhinosinusitis: An attempt to resolve the diagnostic dilemma. Arch Otolaryngol Head Neck Surg. 2006;132(2):173-8.

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