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RESEARCH ARTICLE
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FUNGAL INFECTION PREVALENCE IN CHRONIC RHINOSINUSITIS POST-SURGERY

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Abstract:
Background: Chronic rhinosinusitis (CRS) can be associated with fungal infections, particularly *Aspergillus* species. This study aimed to evaluate the clinical, radiological, and mycological features of fungal rhinosinusitis in patients undergoing treatment at a tertiary medical center.
Methods: This prospective observational study included 50 patients with CRS treated at GIMSH, Durgapur between June and July 2024. Nasal sinus tissue and secretion samples were collected during functional endoscopic sinus surgery (FESS) for mycological and bacteriological analysis. Fungal elements were identified using KOH mounts and cultured on Sabouraud dextrose agar. Bacterial cultures were grown on MacConkey agar and identified using biochemical tests.
Results: Fungal cultures were positive in 28% (14/50) of patients, with *Aspergillus* being the most frequently isolated genus. All sinuses were involved in 80% (40/50) of patients, and 48% (24/50) had nasal polyps, predominantly bilateral. A strong correlation was observed between KOH positivity and culture positivity, with 90% (9/10) of KOH-positive samples also culture-positive, and 97% (35/36) of KOH-negative samples also culture-negative.
Conclusions: Fungal infections, particularly *Aspergillus*, are significant contributors to CRS. KOH microscopy serves as a reliable preliminary diagnostic tool for fungal rhinosinusitis. FESS followed by appropriate antifungal therapy is essential for effective management.

Keywords: Chronic Rhinosinusitis, Fungal Rhinosinusitis, *Aspergillus*, Functional Endoscopic Sinus Surgery (FESS), KOH Microscopy.

Introduction:

Chronic rhinosinusitis (CRS) represents a spectrum of inflammatory conditions affecting the nasal and paranasal sinuses. Despite significant advancements in our understanding of its pathogenesis, the precise etiology remains elusive, likely arising from a complex interplay of host susceptibility and environmental exposures. Fungi, ubiquitous environmental constituents, are increasingly recognized as significant contributors to various respiratory pathologies, including rhinosinusitis.

Estimates suggest that 5-10% of chronic sinusitis cases involve fungal elements, underscoring the clinical relevance of fungal rhinosinusitis (FRS). FRS is broadly categorized into invasive and non-invasive forms. Invasive FRS encompasses granulomatous, acute (fulminant), and chronic invasive subtypes, while non-invasive FRS includes saprophytic fungal infestations, fungal balls, and fungus-related eosinophilic conditions, notably allergic fungal sinusitis (AFS). These distinct subtypes

manifest in diverse clinical scenarios and affect heterogeneous patient populations. AFS, a non-invasive entity, accounts for 6-9% of rhinosinusitis cases requiring surgical intervention, highlighting its substantial clinical impact.

Radiologically, sinus computed tomography (CT) in FRS typically reveals features consistent with CRS, often characterized by areas of increased attenuation within the affected sinuses, indicative of fungal debris or mucin. Clinically, patients with FRS often present with a history of chronic sinusitis refractory to multiple courses of antibiotics. FRS affects individuals across all age groups, leading to significant socioeconomic burdens, including direct healthcare costs and indirect costs associated with lost productivity. Acute invasive FRS, in particular, carries a high risk of morbidity and mortality.

In developing countries like India, FRS remains a significant, yet often underdiagnosed and mismanaged, cause of CRS. Accurate diagnosis is crucial for appropriate management. Diagnostic methods involve the identification of fungal hyphae in sinus secretions using fungal stains, such as Gomori's methenamine silver (GMS) or 10% potassium hydroxide (KOH) wet mounts. Culture on Sabouraud dextrose agar (SDA) supplemented with antibiotics serves as the gold standard for fungal identification. The spectrum of fungi implicated in rhinosinusitis varies geographically. Dematiaceous fungi are more prevalent in Western countries, while *Aspergillus* species, particularly *A. flavus* and *A. niger*, are more commonly encountered in India. Other fungal species, such as *Bipolaris spicifera* and *Curvularia lunata*, may also be involved.

The cornerstone of treatment for AFS is the complete surgical removal of allergic mucin, coupled with the establishment of adequate sinus drainage and ventilation. Functional endoscopic sinus surgery (FESS), a minimally invasive procedure, is the preferred surgical approach for restoring sinus function.

This study aimed to comprehensively analyze the clinical and radiological findings, determine the prevalence and mycological profile of fungal rhinosinusitis, and evaluate the diagnostic efficacy of KOH wet mount microscopy and culture in patients undergoing FESS at a tertiary care hospital. By providing detailed insights into the clinical presentation, mycological characteristics, and diagnostic utility of different methods, this research seeks to improve the management of FRS in our patient population. This study will contribute to the understanding of the fungal burden in CRS patients within the specific geographical location of the study, and provide valuable data for clinicians managing these patients.

Material and Methods:

Study Design and Ethical Considerations:

This prospective observational study was conducted at the Department of Microbiology, Tirunelveli Medical College, between June and July 2017. A convenience sample of 50 patients was included. The study received ethical approval from the Institutional Ethics Committee prior to commencement, and informed consent was obtained from all participants.

Inclusion and Exclusion Criteria:

- **Inclusion Criteria:**
  - Patients of all ages and genders with radiologically confirmed sinusitis.
  - Symptoms persisting for more than 12 weeks.
  - Patients undergoing functional endoscopic sinus surgery (FESS).

- **Exclusion Criteria:**
  - Patients who had received topical or systemic steroids within one month prior to the study.

Data Collection and Sample Acquisition:

Following informed consent, patients were interviewed using a structured questionnaire, and clinical assessments were performed. During FESS, samples of nasal sinus tissue, sinus secretions, and allergic mucin were collected. Specimens were transported to the microbiology laboratory in sterile saline and processed on the same day.

Laboratory Procedures:

- **Direct Microscopy (KOH Mount):**
  - Specimen material was teased and placed on a glass slide.
  - A drop of 10% potassium hydroxide (KOH) was added, and a coverslip was applied.
  - The preparation was incubated at room temperature for tissue digestion.
  - Microscopic examination was conducted to identify fungal hyphal elements.

- **Gram Staining:**
  - Gram staining was performed after alcohol fixation to examine bacterial and fungal hyphal elements.

- **Fungal Culture:**
  - Specimens were inoculated in duplicate onto Sabouraud dextrose agar supplemented with gentamicin and chloramphenicol.
  - Inoculated media were incubated at 25°C and 37°C.
  - Cultures were observed daily for one week and twice weekly for an additional three weeks.
  - Fungal growth was identified based on macroscopic and microscopic morphology.
  - Lactophenol cotton blue staining was used for microscopic examination.
  - Slide cultures were performed for unclear morphologies to aid species identification.

- **Bacterial Culture:**
  - Samples were inoculated onto chocolate agar, blood agar, nutrient agar, and MacConkey agar.
  - Cultures were incubated at 37°C for 18-24 hours.
  - Bacterial species identification was performed using biochemical tests.

Statistical Analysis:

Data were entered and verified in Microsoft Excel and analyzed using SPSS version 27.0. Results are presented as frequencies and percentages.

Results:

Demographics and Clinical Presentation:

- **Age:** The most affected age group was 41-50 years (30%), followed by 21-30 years (24%) and 11-20 years (18%).
- **Sex:** Males comprised 58% of the patient population, while females represented 42%.
- **Occupation:** Coolies and housewives each accounted for 36% of the patients, followed by other occupations (18%) and farmers (10%).
- **Symptoms:** The most common symptoms were nasal obstruction (86%), headache (80%), allergies (70%), and sneezing (68%).
- **Comorbidities:** The majority of patients (36) had no diabetes or hypertension, while 10 patients had diabetes mellitus.

Clinical Findings:

- **Deviated Nasal Septum (DNS):** DNS was present in 43 patients, predominantly on the left side (29 patients).
- **Sinus Involvement:** Multiple sinus involvement was common, with 40 patients showing involvement of all sinuses.
- **Nasal Polyps:** 24 patients had nasal polyps, with bilateral polyps being more frequent (16 patients) than unilateral polyps (8 patients).
- **Maxillary and Sphenoidal Sinus Involvement:** Bilateral maxillary sinus involvement was observed in 6 patients, while unilateral maxillary and sphenoidal sinus involvement was found in 2 patients each.

Fungal Culture and KOH Microscopy:

- **Fungal Culture:** 28% of patients (14) had positive fungal cultures, while 72% (36) had negative cultures.
- **Fungal Species:** *Aspergillus flavus* was the most common isolate (8 patients), followed by *Aspergillus fumigatus* (3 patients), *Fusarium* species (2 patients), and *Rhizopus* (1 patient).
- **KOH Microscopy:**
  - 9 of 14 culture-positive patients were KOH-positive.
  - 35 of 36 culture-negative patients were KOH-negative.
  - KOH mount identified 64% of culture-positive and 97% of culture-negative patients correctly.
  - 90% of positive KOH results correlated with positive culture results.
  - 88% of negative KOH results correlated with negative culture results.
- **Correlation:** There was a high correlation between KOH positivity and culture positivity, and between KOH negativity and culture negativity.

Discussion:

This study examined 50 patients with chronic rhinosinusitis (CRS), revealing a predominance of males (58%) and individuals aged 41-50 years. The male-to-female ratio of 1.32:1 aligns with some previous studies, though variations exist, potentially due to environmental exposures. Nasal obstruction, headache, and sneezing were the most prevalent symptoms, consistent with other research.

Comorbidities like diabetes and hypertension were noted, with diabetes potentially underdiagnosed, a significant concern in India. The finding of multiple sinus involvement in a large proportion of patients underscores the complexity of CRS.

Fungal rhinosinusitis was identified in 30% of cases, with *Aspergillus flavus* being the most common isolate, mirroring findings from other Indian studies. The variability in culture positivity rates across studies highlights the challenges in diagnosing fungal CRS. The correlation between KOH microscopy and culture results was observed, though with limitations.

Limitations: This study has several limitations that affect the generalizability of its findings. The small sample size and convenience sampling may introduce bias. The exclusion of steroid users limits the applicability to a broader patient population. The reliance on KOH and culture, with a 72% negative rate, suggests potential diagnostic limitations, potentially due to specimen quality or the limitations of the methods. Lack of advanced diagnostic techniques, such as PCR or sequencing, and the absence of confounder adjustments further limit the study's depth and accuracy. Additionally, the short study duration restricts the assessment of long-term outcomes. Geographical variations in fungal distribution may also limit wider application of the data.

Clinical Implications: Despite these limitations, the study reinforces the importance of considering fungal etiology in CRS, particularly in patients with nasal obstruction, discharge, and polyps. CT scans, nasal endoscopy, and histopathology are crucial for diagnosis. Given the rising incidence of fungal infections, otolaryngologists should maintain a high index of suspicion. Unilateral sinus involvement, especially of the maxillary sinus, should raise suspicion for fungal causes. Endoscopic sinus surgery combined with antifungal therapy remains the cornerstone of management.

Future Directions: Future studies should employ larger, more representative samples, utilize advanced diagnostic techniques, and address potential confounders. Longitudinal studies are needed to assess long-term outcomes and the impact of different treatment strategies. Investigating the role of environmental factors and immune status in fungal CRS is also warranted.

Conclusion: CRS remains a complex condition with diverse underlying causes. Fungal rhinosinusitis represents a significant subset, and early diagnosis and appropriate management are essential. While this study provides valuable insights, its limitations necessitate further research to improve diagnostic accuracy and optimize treatment strategies.

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