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Diagnostic and therapeutic aspects of chronic maxillary sinusitis caused by fungal infections: A review of the literature

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SUMMARY

Relevance of the problem and aim of the work. Chronic fungal maxillary sinusitis is an increasingly diagnosed condition in clinical practice. The diagnostic and therapeutic processes remain complex due to the nonspecific nature of clinical manifestations and the absence of standardized management protocols. The objective of this study is to assess the reliability and efficacy of current diagnostic and therapeutic methods based on recent scientific evidence.

Materials and methods. A systematic literature review was conducted following PRISMA guidelines. PubMed, ScienceDirect, and Cochrane Library were searched for English-language articles (2016–2024) on diagnostic and therapeutic approaches for chronic fungal maxillary sinusitis.

Results. The analysis revealed that diagnostic and treatment strategies for chronic fungal sinusitis depend on the clinical form. MRI and histopathology proved most accurate for diagnosing invasive sinusitis, while CT was more suitable for non-invasive types. Clinical symptoms were common but not specific enough for definitive diagnosis. Surgical treatment alone was effective for non-invasive cases, whereas invasive forms required both surgery and antifungal therapy. Allergic fungal sinusitis was primarily managed with systemic corticosteroids.

Conclusions. Effective management of chronic fungal maxillary sinusitis relies on accurate classification of the disease form. Radiological imaging and histological analysis are the most reliable diagnostic methods. Treatment should be form-specific: surgery for non-invasive cases, combined surgical and antifungal therapy for invasive forms, and corticosteroids for allergic fungal sinusitis.

Keywords: maxillary sinus, fungal infection, chronic sinusitis, diagnosis, treatment.

INTRODUCTION

Chronic maxillary sinusitis, defined as inflammation lasting ≥12 weeks, is increasingly diagnosed and significantly affects patients' quality of life (1, 2). Its rising incidence is linked to immunosuppression, diabetes, malignancies, and extensive antibiotic use (1-4). Fungal pathogens are estimated to cause over one-third of chronic rhinosinusitis cases (3, 4).

Fungal rhinosinusitis (FRS) includes non-invasive forms – such as fungal ball (FB) and allergic fungal rhinosinusitis (AFRS) – and invasive forms, including chronic invasive and granulomatous types, based on tissue invasion (5). Although fungal sinusitis can involve any paranasal sinus, the maxillary sinuses are affected in nearly half of all cases (1).

Although radiological methods like CT and MRI are commonly used, they may not reliably distinguish fungal from bacterial infections (6-9). Culture sensitivity is variable, and immunologic or molecular tests are not yet standard (17-21). Clinical symptoms often overlap with bacterial sinusitis, complicating diagnosis (6, 7).

Treatment also depends on the disease form. FB is typically managed with endoscopic surgery alone, while invasive forms require surgery with systemic antifungal therapy (3, 5, 27, 28). AFRS is treated

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with surgery followed by corticosteroids to prevent recurrence (22-24).

The aim of this review is to assess the diagnostic accuracy and treatment effectiveness of current strategies for managing chronic fungal infections of the maxillary sinuses.

MATERIAL AND METHODS

Systematic Review Protocol and Registration

This systematic literature review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (11). The aim of the review was to evaluate the diagnostic accuracy and therapeutic effectiveness of current methods used in the management of chronic fungal maxillary sinusitis. The review protocol was developed using the PICO (Population, Intervention, Comparison, Outcome) framework. The full question formulation is presented in Table 1.

Search Strategy

The literature search was conducted in three electronic databases: PubMed, ScienceDirect, and The Cochrane Library. The search covered the period from July 27, 2016, to November 26, 2024, with the final search performed on March 4, 2024. Boolean operators (AND, OR) and Medical Subject Headings (MeSH) were used to refine the search. The search string was as follows: ((chronic fungal rhinosinusitis) OR (maxillary fungal infection)) AND ((diagnostics) OR (treatment)) AND ((sinus surgery) OR (antifungal therapy) OR (FESS)). After initial screening of titles and abstracts, eligible full-text articles were assessed for inclusion. Duplicates were removed using Mendeley software.

Eligibility Criteria and Study Selection

Studies were included if they: (1) were clinical (randomized or observational), (2) published in English between 2016 and 2024, (3) had full-text availability, and (4) included ≥10 patients with chronic fungal maxillary sinusitis. Excluded were reviews, case reports, in vitro or animal studies, and studies on acute or non-fungal sinusitis.

Data Extraction

Data extracted from each study included author, year, design, sample size, diagnostic methods (CT, MRI, histology, culture, immunology), treatment modalities (surgery, antifungals, corticosteroids), and outcomes.

Bias Assessment

Study quality was assessed using the Newcastle–Ottawa Scale (NOS) (6), evaluating selection, comparability, and outcome domains. Studies were classified as high (7–9 points), moderate (5–6), or low (<5) quality. Due to substantial heterogeneity in study designs, outcome measures, and follow-up periods, meta-analysis was not feasible, and only qualitative analysis was performed.

RESULTS

Study Selection

The initial database search yielded 388 articles. After removal of duplicates and application of eligibility criteria, 20 full-text clinical studies published between 2016 and 2024 were included in the qualitative synthesis. These studies collectively involved 2, 276 patients diagnosed with chronic fungal maxillary sinusitis. The study selection process is presented in the PRISMA flow diagram (Figure 1).

Study Characteristics

The included studies analyzed four subtypes of fungal sinusitis: fungal ball (FB), allergic fungal rhinosinusitis (AFRS), chronic invasive fungal sinusitis (CIFS), and granulomatous invasive fungal sinusitis (GIFS). Sample sizes ranged from 16 to 375 patients. Follow-up periods varied from 3 months to 5 years. Outcomes were evaluated through clinical

Table 1. Description of the research question formulated using the PICO framework

PICO element	Description
P (Population)	Patients with chronic maxillary sinusitis caused by fungal infections.
I (Intervention)	Diagnostic methods (radiological imaging, histopathology) and treatment strategies (surgical intervention – FESS – and conservative therapy).
C (Comparison)	Different diagnostic techniques (CT/MRI, histopathology) and treatment approaches (surgical, pharmacological, or combined).
O (Outcomes)	Accurate and early diagnosis, leading to effective treatment, reduced risk of complications, better prognosis, and improved quality of life.
Research question	How do different diagnostic methods (CT/MRI, histopathology) and treatment strategies (surgical and pharmacological) affect the diagnostic accuracy and treatment outcomes in chronic fungal maxillary sinusitis?

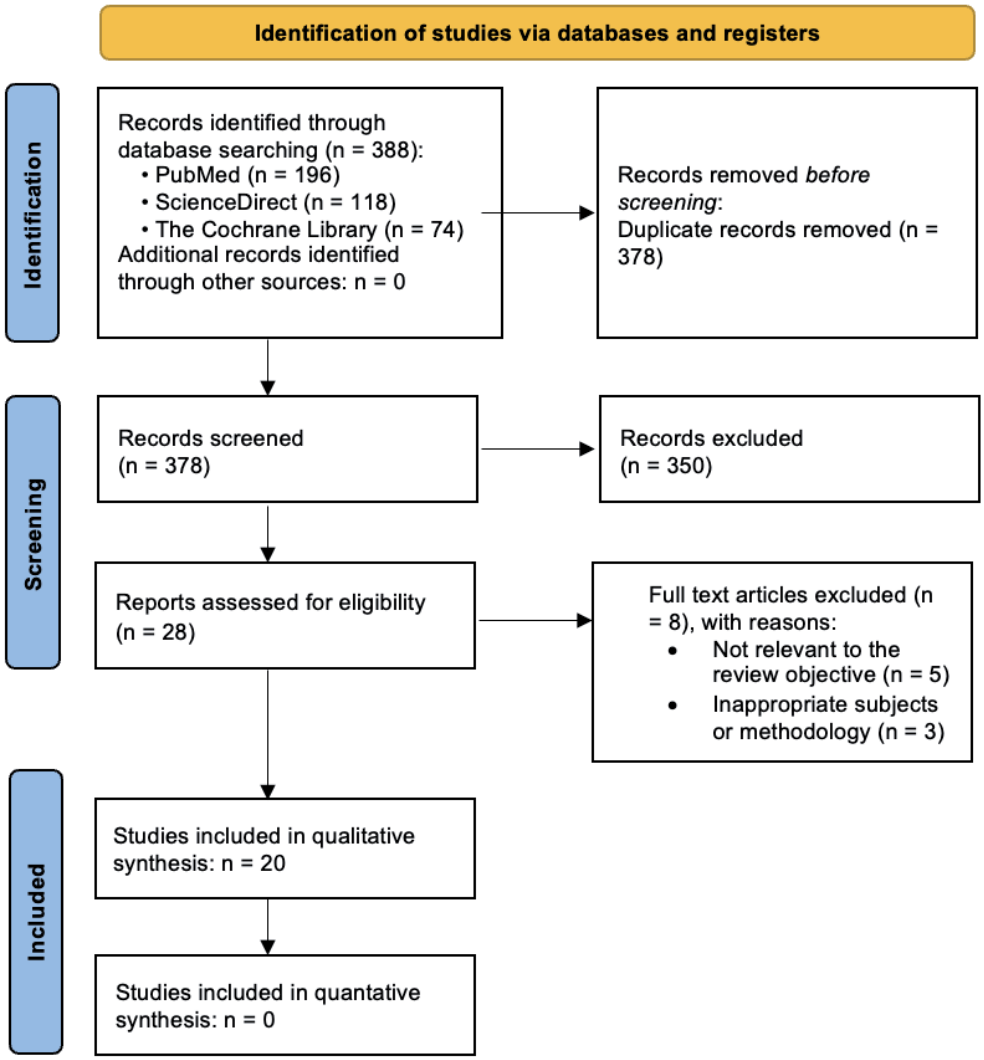

Fig. PRISMA flow chart

examination, imaging, histopathology, immunological markers, and recurrence rates.

Diagnostic Methods

Computed tomography (CT) and histopathological examination were the most frequently used diagnostic tools. CT was reported in all FB studies and in all CIFS and GIFS cases, primarily identifying unilateral sinus opacification with calcifications in FB and sinus expansion in AFRS (12-14). MRI was employed in six studies, mainly for AFRS and invasive forms, providing valuable information about soft tissue and intracranial involvement (18, 20, 25, 26, 28, 30). Histopathological confirmation was obtained in all invasive cases and in all FB studies (25-28). Fungal cultures were used in 13 studies, with sensitivity ranging from 13.7% to 84%. Immunologic tests, such as total or specific IgE, were performed in AFRS patients, with elevated levels noted in up to 100% of cases (17-21). AFRS was diagnosed using Bent and Kuhn criteria, often supported by nasal endoscopy findings (polyps, allergic mucin). Invasive forms were associated with bone erosion and tissue invasion confirmed histologically (18-20).

A summary of the diagnostic methods applied in each form of fungal sinusitis is presented in Table 2.

Treatment Outcomes

Treatment strategies varied depending on disease form. In all FB cases, endoscopic sinus surgery alone was effective, with recurrence rates between 1.1% and 1.9% (12-15). In AFRS, standard management consisted of surgery combined with systemic corticosteroids, reducing recurrence to 17–33% (22-24). CIFS and GIFS required surgical debridement combined with systemic antifungal agents, most commonly voriconazole or amphotericin B (27, 28). GIFS showed a more favorable response and recurrence rates below 25%. CIFS was associated

Table 2. Summary of risk of bias assessment for randomized study (Cochrane risk-of-bias tool)

Type of Infection	CT	MRI	Histology	Culture	IgE	PGR	Endoscopy
FB	+		+	±			
AFRS	+	+	+	+	+		+
CIFS	+	+	+	+		+	
GIFS	+	+	+	+			

Note: "±" indicates limited application; "+" indicates that the method was commonly used.

with poorer prognosis, especially in immunocompromised patients, with mortality reaching up to 52% in one multicenter study (25, 26, 28).

A comparative overview of treatment approaches by disease subtype is shown in Table 3.

Despite variability across studies, a consistent pattern emerged: diagnostic accuracy and treatment success were closely linked to correct classification of the fungal sinusitis subtype. These findings emphasize the need for individualized diagnostic and therapeutic approaches based on disease form.

DISCUSSION

This review demonstrated that accurate classification of fungal sinusitis subtypes is essential for effective diagnosis and treatment. The analysis of 20 clinical studies confirmed that FB, AFRS, CIFS, and GIFS differ in clinical features, diagnostic findings, and response to therapy.

Radiological imaging and histopathological analysis were the most reliable diagnostic methods. CT scans were particularly effective for identifying FB, with hyperdense opacities and calcifications observed in over 75% of cases (12-14). For AFRS, CT revealed sinus expansion and bone remodeling, while MRI offered superior sensitivity for identifying allergic mucin and soft tissue changes, especially in T2-weighted sequences (18, 20, 25, 26, 28, 30). Histopathology was critical for distinguishing invasive forms, with CIFS and GIFS characterized by hyphal invasion, necrosis, and vascular involvement (25-28). The granulomatous inflammation pattern specific to GIFS was confirmed in 59% of patients, enabling differentiation from CIFS (25).

Fungal culture, while commonly performed, showed inconsistent sensitivity due to variable sampling techniques and delayed processing. Immunologic tests, including IgE and eosinophil counts, were highly relevant in AFRS but lacked utility in invasive forms (17-21).

Therapeutically, FB responded well to surgical removal alone, with recurrence rates below 2%, consistent with previous large case series (12, 15). AFRS was best managed with surgery plus corticosteroids, which reduced recurrence significantly (22, 24). CIFS and GIFS required a combined approach; GIFS showed good outcomes with azole therapy, while CIFS was associated with high mortality in immunocompromised patients, reaching up to 52% (25, 26).

One of the strengths of this review is its structured comparison of treatment modalities across clearly defined fungal sinusitis subtypes. By systematizing diagnostic findings and correlating them with treatment outcomes, this study offers practical guidance for clinicians managing complex cases of fungal maxillary sinusitis.

Limitations of this review include methodological heterogeneity among the included studies, many of which were retrospective and single-center (12-31). AFRS diagnostic criteria were inconsistently applied, limiting data comparability. In addition, molecular diagnostic methods such as PCR or 1, 3-β-D-glucan testing were rarely employed despite their potential value (26, 28). Long-term outcome data were limited due to short follow-up periods in many studies.

In conclusion, subtype-specific diagnosis and treatment are critical for improving outcomes in chronic fungal maxillary sinusitis. Further multicenter prospective research with standardized diagnostic criteria and outcome measures is warranted.

CONCLUSIONS

Within the limitations of the included studies, this review concludes that accurate classification of fungal sinusitis is essential for optimal diagnosis and treatment. Computed tomography and histopathological examination remain the most reliable diagnostic tools. Treatment effectiveness is closely linked to disease subtype: surgical intervention is sufficient for non-invasive forms, systemic anti-

Table 3. Treatment Methods According to Type of Fungal Infection

Type of Infection	Surgical Treatment	Systemic Antifungal Agents	Corticosteroids	Other Notes
FB	Used in all cases (FESS, antrostomy)	Not used	Not used	Observation applied in selected cases
AFRS	Used in all cases (FESS)	Itraconazole used in some cases	Used	Postoperative therapy, recurrence prevention
CIFS	Required	Voriconazole, amphotericin B	Not used	Treatment depends on immune status
GIFS	Frequently used	Azoles (itraconazole, voriconazole); amphotericin B used in selected cases	Not used	Often presents with chronic progression

fungal therapy is necessary for invasive cases, and corticosteroids are effective in reducing recurrence in allergic fungal rhinosinusitis.

STATEMENT OF CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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