

Management of Fungal Infections in Oral and Maxillofacial Surgery in Cameroon: Literature Review and Clinical Experience

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Abstract

Introduction: Fungal infections of the oral and maxillofacial region represent a major clinical challenge in Cameroon. This study aims to analyze the epidemiological characteristics, diagnostic and therapeutic approaches to mycoses encountered in this context. **Materials and Method:** A systematic review of the literature was carried out, supplemented by a retrospective analysis of 87 cases of fungal infections of the orofacial region managed in three Cameroonian hospitals between 2018 and 2023. **Results:** The most frequently identified mycoses were candidiasis (58.6%), aspergillosis (17.2%) and mucormycosis (9.2%). A higher prevalence was observed in immunocompromised (43.7%) and diabetic (28.7%) patients. The mycological diagnosis was confirmed in 73.6% of cases. Therapeutic protocols combining surgery and systemic antifungal agents showed a cure rate of 81.6%. **Conclusion:** Effective management of orofacial fungal infections in Cameroon requires a multidisciplinary approach, early and accurate diagnosis, and therapy adapted to the local context, taking into account available resources and frequent comorbidities.

Keywords

Management, Fungal Infections, Oral and Maxillofacial Surgery, Cameroon, Literature Review

1. Introduction

Fungal infections of the orofacial region constitute a major concern in oral and

maxillofacial surgery, particularly in sub-Saharan African countries like Cameroon [1]. These infections, often opportunistic, present considerable diagnostic and therapeutic challenges due to their variable clinical presentation, frequent association with underlying conditions, and limited resources for their management [2].

Given the significant burden of orofacial fungal infections in resource-limited settings and the lack of comprehensive data on their management in Cameroon, this study seeks to address the following research question: What are the epidemiological patterns, diagnostic challenges, and optimal therapeutic approaches for managing orofacial fungal infections in the Cameroonian healthcare context? We hypothesize that a combined medical-surgical approach, when implemented early, will result in superior treatment outcomes compared to single-modality therapy, particularly in immunocompromised patients who constitute a significant proportion of the affected population.

Orofacial fungal infections can lead to extensive tissue damage, permanent facial disfigurement, and, in severe cases, death. The species most frequently involved in these infections include *Candida* spp. (notably *C. albicans*, *C. glabrata*, *C. tropicalis*), *Aspergillus* spp. (*A. fumigatus*, *A. flavus*, *A. niger*), mucormycosis agents (*Rhizopus* spp., *Mucor* spp., *Lichtheimia* spp.), *Cryptococcus neoformans*, *Histoplasma capsulatum*, and *Coccidioides immitis*.

In Cameroon, epidemiological data concerning these infections remain fragmentary despite their significant impact on patient morbidity and mortality [3]. Tropical climate conditions, high prevalence of HIV/AIDS, malnutrition, and limited access to healthcare contribute to the incidence and complexity of these pathologies [4]. This study aims to fill this gap by providing a comprehensive analysis of the epidemiological, clinical, diagnostic, and therapeutic aspects of orofacial fungal infections in Cameroon, integrating both a systematic literature review and clinical data from three major hospital centers in the country.

2. Materials and Methods

2.1. Literature Review

A systematic search was conducted in PubMed, EMBASE, African Index Medicus, and African Journals Online databases for the period from January 2000 to December 2023. Search terms included: “fungal infections”, “mycoses”, “oral”, “maxillofacial”, “Cameroon”, “Central Africa”, as well as names of specific fungal infections. Only publications in English or French were retained.

2.2. Retrospective Clinical Study

A retrospective analysis was performed on 87 cases of orofacial fungal infections diagnosed and treated in three hospital centers in Cameroon (Yaounde Central Hospital, Douala General Hospital, and Bamenda Regional Hospital) between January 2018 and December 2023.

For the purposes of this study, “confirmed fungal infection” was defined as meeting at least two of the following criteria: 1) positive direct microscopic examination (KOH test) showing fungal elements, 2) positive mycological culture with species identification, 3) characteristic histopathological findings consistent with fungal infection, or 4) positive molecular testing (PCR) when available. A standardized diagnostic protocol was implemented across the three participating hospitals, requiring documentation of clinical presentation, collection of appropriate specimens for laboratory analysis, and systematic imaging evaluation for suspected invasive infections.

Inclusion criteria were:

- Patients of any age with a confirmed fungal infection of the orofacial region
- Complete medical records including demographic, clinical, diagnostic, and therapeutic data

Patients were followed for a minimum period of 6 months post-treatment completion to assess treatment outcomes and recurrence rates. Follow-up evaluations were conducted at 1, 3, and 6 months after treatment completion, with additional visits scheduled as clinically indicated.

Collected data included demographic characteristics, risk factors, clinical manifestations, diagnostic methods, identified pathogens, therapeutic approaches, and treatment outcomes.

Detailed documentation of surgical interventions was performed as follows: Debridement procedures involved the systematic removal of necrotic and infected tissue using sharp dissection, with samples sent for histopathological examination. Limited excisions were performed for localized lesions with clear margins, while extensive resections were reserved for invasive infections with bone involvement. Reconstructive procedures included primary closure for small defects, local flaps for moderate defects, and free tissue transfers for extensive defects requiring functional and aesthetic restoration. All surgical procedures were performed under general anesthesia with appropriate perioperative antifungal prophylaxis.

2.3. Statistical Analysis

Data were analyzed using SPSS software version 25.0. Continuous variables were expressed as means \pm standard deviations, and categorical variables as frequencies and percentages. Chi-square test and Fisher’s exact test were used to compare categorical variables. A p-value < 0.05 was considered statistically significant.

3. Results

3.1. Patient Demographics

Of the 87 patients recruited from Yaoundé Central Hospital (48.3%), Douala General Hospital (35.6%), and Bamenda Regional Hospital (16.1%), 58.6% were male and 41.4% female. Their ages ranged from 8 to 76 years, with a mean age of 43.7 ± 15.3 years. The distribution of patients by age and gender is presented in **Table 1**.

Table 1. Patient demographics (N = 87).

Characteristics	n (%)
Gender	
Male	51 (58.6)
Female	36 (41.4)
Age group (years)	
0 - 15	6 (6.9)
16 - 30	15 (17.2)
31 - 45	28 (32.2)
46 - 60	23 (26.4)
>60	15 (17.2)

3.2. Comorbidities and Risk Factors

Nine main risk factors were observed among the patients who presented for consultation. HIV/AIDS (43.7%) and diabetes (28.7%) were the most frequent comorbidities. The complete distribution of risk factors is presented in **Table 2**.

Table 2. Comorbidities and risk factors identified in patients (N = 87).

Comorbidities/Risk Factors	n (%)
HIV/AIDS	38 (43.7)
Diabetes	25 (28.7)
Immunosuppressive therapy	17 (19.5)
Malnutrition	14 (16.1)
Recent facial trauma	12 (13.8)
History of maxillofacial surgery	11 (12.6)
Cervicofacial radiotherapy	8 (9.2)
Neoplasia	7 (8.0)
Tuberculosis	5 (5.7)
No identified factor	10 (11.5)

3.3. Identified Pathogens

The distribution of identified pathogens is presented in **Table 3**. *Candida albicans* was the most frequently isolated pathogen (41.4%), followed by other *Candida* species (17.2%), *Aspergillus* spp. (17.2%), and mucormycosis agents (*Rhizopus* spp. and *Mucor* spp.) (9.2%).

Table 3. Diversity of identified pathogens (N = 87).

Type of Infection and Pathogen	n (%)
Candidiasis	
<i>Candida albicans</i>	36 (41.4)
Non-albicans <i>Candida</i>	15 (17.2)

Continued

Aspergillosis	15 (17.2)
<i>Aspergillus fumigatus</i>	9 (10.3)
<i>Aspergillus flavus</i>	4 (4.6)
<i>Aspergillus niger</i>	2 (2.3)
Mucormycosis	8 (9.2)
<i>Rhizopus</i> spp.	5 (5.7)
<i>Mucor</i> spp.	3 (3.4)
Cryptococcosis	5 (5.7)
Histoplasmosis	4 (4.6)
Coccidioidomycosis	2 (2.3)
Mixed infections	2 (2.3)

3.4. Biological Localization of Fungal Infections

Fungal infections were localized to 7 different anatomical sites, as presented in **Table 4**. The oral cavity was the most frequently affected site (49.4%), followed by the maxillary sinuses (18.4%) and the mandible (12.6%).

Table 4. Biological localization of fungal infections (N = 87)

Localization	n (%)
Oral cavity	43 (49.4)
Maxillary sinuses	16 (18.4)
Mandible	11 (12.6)
Ethmoidal sinuses	7 (8.0)
Palate	5 (5.7)
Cheeks	3 (3.4)
Pharynx	2 (2.3)

3.5. Clinical Presentation

The main clinical manifestations observed in patients were varied and depended on the type of fungal infection and the anatomical site involved. Mucosal ulcerations (43.7%), pain (40.2%), and facial swelling (33.3%) were the most frequent manifestations. Tissue necrosis, present in 25.3% of cases, was particularly associated with mucormycosis and invasive forms of aspergillosis. Removable white plaques (24.1%) were characteristic of oropharyngeal candidiasis. The complete clinical picture is presented in **Table 5**.

Clinical manifestations showed distinct patterns according to infection type: Candidiasis predominantly presented with removable white plaques (76.5% of candidiasis cases), mucosal erythema (68.6%), and pain (52.9%). Aspergillosis was characterized by facial swelling (86.7% of aspergillosis cases), paresthesia (53.3%), and trismus (46.7%). Mucormycosis consistently presented with tissue necrosis

(100% of mucormycosis cases), severe pain (87.5%), and cutaneous fistulas (62.5%). These pattern differences were statistically significant ($p < 0.001$) and may serve as clinical indicators for early differential diagnosis.

Table 5. Clinical manifestations of orofacial fungal infections (N = 87).

Clinical Manifestation	n (%)
Mucosal ulcerations	38 (43.7)
Pain	35 (40.2)
Facial swelling	29 (33.3)
Tissue necrosis	22 (25.3)
Removable white plaques	21 (24.1)
Trismus	17 (19.5)
Cutaneous fistulas	15 (17.2)
Paresthesia	12 (13.8)
Dysphagia	11 (12.6)
Dental mobility	9 (10.3)
Fever	8 (9.2)
Dysphonia	6 (6.9)
Cervical lymphadenopathy	5 (5.7)

3.6. Diagnostic Methods

Various diagnostic methods were used to confirm orofacial fungal infections. Direct KOH examination was performed for all patients, but its sensitivity was limited (60.9%). Mycological culture and histopathology demonstrated better diagnostic performance with positivity rates of 79.0% and 79.7%, respectively. Imaging (CT/MRI) played a crucial role in evaluating the extension of infections, particularly in cases of sinus aspergillosis and mucormycosis, with a positivity rate of 83.8%. Molecular methods such as PCR showed excellent sensitivity but their use was limited due to restricted availability. Details of the diagnostic methods used and their yield are presented in **Table 6**.

Table 6. Diagnostic methods used and their yield (N = 87).

Diagnostic Method	Number of Cases Tested (n)	Positive results n (%)
Direct exam (KOH)	87	53 (60.9)
Mycological culture	81	64 (79.0)
Histopathology	59	47 (79.7)
PCR	2	2 (100)
Serological tests	35	23 (65.7)
Imaging (CT/MRI)	68	57 (83.8)

The mean time between symptom onset and diagnosis was 14.3 ± 6.2 days (range: 3 - 42 days).

3.7. Therapeutic Approaches

Three main therapeutic approaches were implemented: medical alone, surgical alone, or combined (medical and surgical). The combined approach was the most frequently used (55.2%), followed by medical treatment alone (35.6%). The most commonly used antifungals were fluconazole (20.7%) and itraconazole (8.0%). Amphotericin B was primarily reserved for cases of mucormycosis and invasive aspergillosis. Details of the therapeutic approaches are presented in **Table 7**.

Table 7. therapeutic approaches used for the management of orofacial fungal infections (N = 87).

Therapeutic Approach	n (%)
Medical treatment alone	31 (35.6)
Fluconazole	18 (20.7)
Itraconazole	7 (8.0)
Amphotericin B	4 (4.6)
Voriconazole	2 (2.3)
Surgical treatment alone	8 (9.2)
Debridement	5 (5.7)
Excision	3 (3.4)
Combined treatment (medical + surgical)	48 (55.2)
Debridement + antifungals	31 (35.6)
Resection + reconstruction + antifungals	17 (19.5)

The mean duration of antifungal treatment was 27.4 ± 11.3 days (range: 10 - 56 days).

3.8. Treatment Outcomes

Treatment outcomes showed a complete cure rate of 81.6%. Partial improvement was observed in 9.2% of patients, while 5.7% experienced recurrence. The overall mortality rate was 3.4%, primarily associated with cases of mucormycosis and invasive aspergillosis in immunocompromised patients. Details of treatment outcomes are presented in **Table 8**.

Table 8. Treatment outcomes (N = 87).

Treatment outcome	n (%)
Complete cure	71 (81.6)
Partial improvement	8 (9.2)
Recurrence	5 (5.7)
Death	3 (3.4)

The mean hospital stay was 18.3 ± 8.7 days (range: 5 - 42 days).

3.9. Factors Associated with Treatment Outcomes

Several factors were identified as significantly influencing treatment outcomes.

Time to diagnosis, type of infection, therapeutic approach, and immunological status of patients were all statistically associated with cure rates ($p < 0.05$). Patients diagnosed within the first 14 days after symptom onset had a significantly higher cure rate (90.7%) than those diagnosed later (66.7%). Candidiasis was associated with the best cure rate (88.2%), while mucormycosis had the lowest rate (62.5%). The combined therapeutic approach (medical and surgical) was associated with the best cure rate (89.6%) compared to exclusively medical (71.0%) or surgical (75.0%) approaches. Immunocompetent patients had a significantly higher cure rate (93.2%) than immunocompromised patients (69.8%). Details of these associations are presented in **Table 9**.

Table 9. Factors associated with treatment outcomes (N = 87).

Factor	Cure n (%)	Non-cure n (%)	P-value
Time to diagnosis			0.003
<14 days	49 (90.7)	5 (9.3)	
≥14 days	22 (66.7)	11 (33.3)	
Type of infection			0.018
Candidiasis	45 (88.2)	6 (11.8)	
Aspergillosis	12 (80.0)	3 (20.0)	
Mucormycosis	5 (62.5)	3 (37.5)	
Others	9 (69.2)	4 (30.8)	
Therapeutic approach			0.004
Medical alone	22 (71.0)	9 (29.0)	
Surgical alone	6 (75.0)	2 (25.0)	
Combined	43 (89.6)	5 (10.4)	
Immunological status			<0.001
Immunocompetent	41 (93.2)	3 (6.8)	
Immunocompromised	30 (69.8)	13 (30.2)	

4. Discussion

4.1. Epidemiological Aspects and Risk Factors

Our results confirm the predominance of oral candidiasis among orofacial fungal infections in Cameroon (58.6%), followed by aspergillosis (17.2%) and mucormycosis (9.2%). This distribution is comparable to that reported in other African studies [5] [6]. However, the prevalence of mucormycosis (9.2%) in our series is slightly higher than that reported by Diallo *et al.* [7] in Senegal (5.3%), which could be explained by the high prevalence of diabetes in our study population.

Immunosuppression related to HIV/AIDS constitutes the main risk factor (43.7%) in our study, followed by diabetes (28.7%). This preponderance of HIV is consistent with the epidemiological data from Cameroon, where the national HIV prevalence is estimated at 2.7% [8]. Several studies have demonstrated that HIV-

induced immunosuppression promotes colonization and infection by opportunistic fungal agents [9] [10].

Ndip *et al.* [11] reported that 68.4% of HIV-positive patients in Cameroon had oral candidiasis, highlighting the importance of this association.

4.2. Diagnostic Challenges

The diagnosis of orofacial fungal infections in Cameroon still faces several challenges, notably the often prolonged diagnostic delay (14.3 ± 6.2 days in our study). This diagnostic delay can be attributed to several factors, including non-specific clinical presentation, lack of awareness among practitioners, and limited access to specialized diagnostic methods, particularly in rural areas [12].

Our results indicate that direct KOH examination, although accessible, reveals limited sensitivity (60.9%) for the detection of fungal infections, compared to more effective techniques such as PCR (100%). However, access to PCR remains restricted in our study context, highlighting inequalities in modern diagnostic technologies. These observations are consistent with the work of Tchinda *et al.* [13], who have already highlighted the challenges related to mycological diagnostic infrastructure in Cameroon.

Imaging, primarily computed tomography, has proven useful for evaluating the extension of infections, particularly in cases of sinus aspergillosis and mucormycosis, with a positivity rate of 83.8%. These results corroborate those of Njunda *et al.* [14], who demonstrated the significant contribution of imaging in the diagnosis of deep facial mycoses in Cameroon.

4.3. Therapeutic Approaches and Outcomes

Our study reveals that the combined therapeutic approach (medical and surgical) is associated with a better cure rate (89.6%) compared to exclusively medical (71.0%) or surgical (75.0%) approaches. This observation is statistically significant ($p = 0.004$) and is consistent with international recommendations for the management of invasive fungal infections [15].

Fluconazole remains the most used antifungal in monotherapy (20.7%), followed by itraconazole (8.0%). This predominance can be explained by their relative availability and affordable cost compared to newer antifungals such as voriconazole or echinocandins [16].

The economic impact of antifungal selection is significant in our resource-limited setting. Fluconazole costs approximately \$2 - \$3 per day compared to voriconazole at \$45 - \$60 per day, making the former more accessible despite potential efficacy limitations. However, treatment failure with less expensive agents often results in prolonged hospitalization and secondary complications, ultimately increasing overall treatment costs. Implementation of antifungal stewardship programs could optimize cost-effectiveness by ensuring appropriate drug selection based on susceptibility patterns and infection severity.

Although formal antifungal susceptibility testing was not systematically per-

formed in our cohort due to resource limitations, clinical response patterns suggest emerging resistance concerns. Among the 9 treatment failures with fluconazole monotherapy, 6 cases required escalation to amphotericin B, suggesting possible azole resistance. The absence of systematic susceptibility testing represents a significant limitation in our study and highlights the urgent need for improved laboratory infrastructure to guide optimal antifungal selection. However, the emergence of azole resistance, reported by Ngouana *et al.* [17] in *Candida* isolates in Cameroon, underscores the need for regular mycological surveillance and adaptation of therapeutic protocols.

The overall mortality in our series (3.4%) is relatively low compared to rates reported in other African studies [18] [19]. This difference could be explained by the significant proportion of superficial candidiasis in our cohort, generally associated with a better prognosis. Nevertheless, invasive infections such as mucormycosis present a more guarded prognosis, with a cure rate of 62.5% versus 88.2% for candidiasis ($p = 0.018$).

4.4. Implications for Clinical Practice in Cameroon

Our results highlight several practical implications for improving the management of orofacial fungal infections in Cameroon.

Early diagnosis appears as a significant prognostic factor ($p = 0.003$), highlighting the importance of increased awareness among healthcare professionals regarding suggestive clinical presentations. A diagnosis established within the first 14 days following symptom onset is associated with a significantly higher cure rate, which justifies the implementation of continuing education programs for frontline practitioners.

The multidisciplinary approach proves essential for optimizing the management of these complex infections. Collaboration between maxillofacial surgeons, infectious disease specialists, mycologists, and radiologists allows for the development of personalized therapeutic strategies and improved clinical outcomes, particularly in cases of invasive infections.

Adaptation of therapeutic protocols to the local context is crucial given economic constraints and the variable availability of antifungals. The development of specific national guidelines, taking into account local realities, could contribute to standardizing and improving the quality of care.

Prevention, notably screening and management of underlying risk factors such as HIV and diabetes, constitutes an essential measure to reduce the incidence of these infections. Public health programs targeting these comorbidities could have a significant indirect impact on the prevalence of orofacial fungal infections.

5. Conclusions

This study provides valuable data on the epidemiology, diagnostic challenges, and therapeutic approaches of orofacial fungal infections in Cameroon. The predominance of candidiasis, the significant impact of HIV-related immunosuppression,

and the superior efficacy of combined therapeutic approaches constitute the main observations.

Persistent challenges include diagnostic delay, limited access to advanced diagnostic methods, and restricted availability of certain antifungals. Improving the management of these infections requires increased awareness among healthcare professionals, strengthening mycological diagnostic capabilities, and developing therapeutic protocols adapted to the local context.

Future research priorities should include prospective multicenter studies with systematic antifungal susceptibility testing, economic analysis of treatment strategies, and evaluation of antifungal stewardship program implementation in resource-limited settings.

Prospective multicenter studies are needed to evaluate the impact of targeted interventions and the evolution of antifungal resistance profiles in Cameroon.

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Authors' Contributions

Nkolo Tolo FD designed and directed the study, participated in the data collection and analysis, and wrote the first draft of the manuscript.

Essono MD and Hamit contributed to the study design, data collection, and critical revision of the manuscript.

Hamit participated in the data collection and interpretation of the results.

Eteme Enama S. contributed to the data analysis and revision of the manuscript.

All authors read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest in relation to this study.

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