



REVIEW ARTICLE

Candidiasis and Oral Health

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ABSTRACT

Candidiasis, primarily caused by *Candida albicans*, poses significant oral health concerns. This review highlights its clinical manifestations, diagnostics, and management strategies. Predisposing factors include poor oral hygiene and systemic conditions like HIV/AIDS and diabetes. Clinical presentation varies from asymptomatic colonization to symptomatic mucosal infections, with complications such as denture stomatitis. Diagnostics encompass clinical examination and various laboratory methods, guiding tailored treatment with topical or systemic antifungals. Prevention strategies targeting modifiable risk factors are crucial. Despite challenges like antifungal resistance, interdisciplinary collaboration among healthcare providers is essential for the effective management of oral candidiasis and its impact on overall health.

Keywords: Candidiasis; *Candida albicans*; Oral health; Diagnostics; Antifungals; Prevention strategies

1 INTRODUCTION

Oral candidiasis, a mycosis primarily caused by the *Candida albicans* poses a health concern as it can affect individuals of all age groups. Other species that can also cause this infection include *Candida krusei*, *Candida glabrata*, *Candida parapsilosis*, *Candida tropicalis*, *Candida dubliniensis*, *Candida kefyr*, *Candida pseudotropicalis*. Culturing methods have identified 20 different genera and 80 species from the samples. Understanding the various facets of this condition, from its causes to its clinical diagnosis and management, is essential for both healthcare professionals and patients alike. The general symptoms experienced include a burning sensation and soreness in the mucosa which occurs due to the damage caused. In addition to this, progressive periodontal diseases and dentinal caries can be seen due

to additional yeast colonization. Chronic mucocutaneous candidiasis is a type of candidiasis that is often found in connection, with oral cancer. This occurs due to the production of aldehyde⁽¹⁾.

Individuals with compromised systems can serve as a fount for *Candida* infection⁽²⁾. Many local and systemic factors cause *Candidal* infection, the use of dentures, xerostomia, and corticosteroid inhalers are a few local factors while immunosuppressed conditions like infection with human immunodeficiency virus (HIV), malnutrition, diabetic patients, patients undergoing systemic chemotherapy and radiotherapy are few systemic factors. Recent studies have shown that psoriasis is also a factor that causes oral candidiasis⁽³⁾.

The increase in temperature of the oral cavity makes it easier for the pseudohyphal invasion of *Candida*. The

conveyance of *Candida* is asymptomatic in healthy children and adults. Greater encampment of *Candida* can occur on the palate, posterior surface of the dorsal tongue, and buccal mucosa. In healthy infants, the conveyance of *Candida* is 45-65%, and in normal adults, it is about 30-55%. During passage through the vagina or uterus, infants are habitually disclosed to *Candida*⁽⁴⁾. Individuals with a history of coronavirus disease show greater receptiveness for the occurrence of oral candidiasis due to long periods of hospitalization, use of steroids, immunodeficiency, and long-term use of broad-spectrum antibiotics⁽⁵⁾.

Women, especially during the summer climate and their pregnancy, and individuals with a higher concentration of acidity in saliva, tend to experience a higher incidence of *Candida*. In the morning the *Candidal* counts are raised and a decline can be seen after meals and brushing⁽⁶⁾. Nevertheless, in denture prosthetic users, this pattern is countermand with *Candidal* conveyance being low in the morning and upraised all through the day in proportion to the use of the prosthesis. In overnight denture users, the *Candida* counts are upraised in the morning and a decline is seen all through the day. The aforementioned findings provide support for the theory that *Candida* coheres to prostheses rather than their mucosa. The attachment of *Candida* on the polymethyl methacrylate base of the prosthetic surface is the chief reservoir of *Candidal* encampment seen in these patients. There are numerous alternatives for treating and managing candidiasis and these compromise ointments, mouthwashes, suspensions, pastilles, tablets, and pills. In healthy patients or immunocompromised individuals, if the infection is at an early stage, topical treatments are preferred. Systemic treatments are restrained for perilous conditions which lowers the concentration of therapeutic drugs^(4,7).

2 CAUSATIVE AGENTS OF ORAL CANDIDIASIS

Oral candidiasis is nearly a frequent form of infection caused by fungi *Candida albicans*. Numerous variants of *Candida* species and few of them are *Candida tropicalis*, *Candida glabrata*, *Candida parapsilosis* and *Candida krusei*. The encroachment and sensitivity to antifungals differ in each *Candida* species even though they cause familiar fungal infections. *Candida* possesses several virulence factors that come to the development of candidiasis, these also include its ability to adhere to mucosal tissue in the host, transform its shape, and produce enzymes outside of its cells. These characteristics are crucial for the formation of biofilms. Most *Candida* species form structures called hyphae when inside the body, which helps them attach to the mucosal surface and penetrate the epithelial tissue of the oral cavity. Even though hyphal structures are not formed by *Candida glabrata*, it is still an important reason for bloodstream contamination or poisoning, especially in individuals with weakened immune systems. *Candida glabrata* and *Candida krusei* show significant hospitality to azole antifungals, this

highlights the consequences of treating oral candidiasis, especially in patients who have undergone long-term use of azole antifungals. Suitable alternative antifungal medications should be prescribed to these individuals^(1,2).

3 CLINICAL PRESENTATION

Oral candidiasis is a habitual opportunistic condition that is chiefly brought about by species of *Candida* and exerts influence on the mucous membranes mainly the buccal mucosa and tongue of the oral cavity⁽⁸⁾. *Candida* can subsist in either yeast or hyphal phase since it can represent two distinct forms. Pathogenicity, treatment plan, and investigation of candidiasis are pertinent to the dimorphism of *Candida* species⁽⁹⁾. Invasion and infection of *Candida albicans* can cause localized erythema, soreness, tenderness, loss of taste, irritation, and pain in the oral cavity⁽¹⁰⁾.

Acute pseudomembranous candidiasis, which is frequently acknowledged as oral thrush, is a definitive donation among the several variants of oral candidiasis. Other variants include median rhomboid glossitis, acute atrophic candidiasis, chronic hyperplastic candidiasis, circumoral dermatitis, angular cheilitis, and chronic atrophic candidiasis⁽¹¹⁾.

3.1 Acute Pseudomembranous candidiasis (Oral thrush)



Fig. 1: A. Pseudomembranous candidiasis left cheek. B. Pseudomembranous candidiasis infant⁽¹⁾

Acute pseudomembranous candidiasis typically affects newborns and the immunocompromised, often linked to steroid treatments and dry mouth. While initially asymptomatic, patients with autoimmune conditions using steroids may later suffer worsened symptoms due to *Candida*. The infection risk varies, with a general 20% risk from intraoral steroids. Antifungals may be pre-emptively prescribed for those at higher risk. Treatment usually involves clotrimazole troches, with a recommended 14-day regimen. However, patient compliance can be challenging, so a flexible dosing schedule is acceptable, ensuring no food or drink is consumed for 30 minutes post-application. Patients with tender mouths should moisten the troche with water to ease dissolution. In cases where ongoing treatment risks fungal infection, a preventive antifungal routine is essential. Clotrimazole troches, taken nightly, can help

prevent *Candida* overgrowth. Nystatin is typically reserved for newborns. Long-term use of nystatin suspension is not recommended for patients with natural teeth because it contains a high amount of sucrose, ranging from 30% to 50%^(1,9).

3.2 Acute atrophic candidiasis



Fig. 2: A. Atrophic area over the tongue. B. Erythematous lesions on the palate

Acute atrophic candidiasis is typically diagnosed based on antibiotic utilization or other unintentionally induced curative agents. This state of infection can be localized or generalized, and an erythematous area is observed on the mucosa. The aching condition of this form prompts patients to seek medical attention. The mucous membrane of the oral cavity and tongue becomes tender and an upraised reactivity to food and mainly spicy flavoring agents is observed⁽¹⁾.

The tongue appears to be intense red almost identical to the ones observed in folate deficiency anemia, cobalamin deficiency, and iron deficiency anemia⁽¹⁰⁾. An empiric clinical identification is frequently ample to commence therapy, while a cytologic identification test can be still carried out. The same curative method used for acute pseudomembranous candidiasis is prescribed, which involves administering 10mg troches of Clotrimazole, with systemic options available as secondary choices⁽¹⁾.

3.3 Chronic atrophic candidiasis

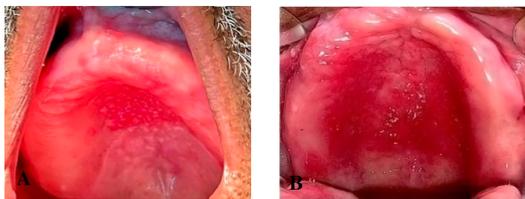


Fig. 3: A & B. Erythematous lesion over the denture-fitting areas of the oral cavity

Chronic atrophic candidiasis is mainly correlated with the use of prosthetic denture appliances⁽¹²⁾. The main causative agent for this condition is the infection and invasion by *Candida albicans*. Various other factors such as improper fitting of prosthetic dentures, poor oral hygiene, overnight

use of dental prostheses, and even dry mouth contribute to causing chronic atrophic candidiasis⁽¹³⁾.

Chronic atrophic candidiasis is often seen with numerous types of red macules, petechia, and reticulated erythema and these are occasionally tagged along with micro papules⁽¹⁴⁾. An erythematous lesion is observed on the surface where the dental prosthesis is placed where hyphae structure enter the outmost epithelium⁽¹⁾. Maxillary tissue and palate are the common sites where chronic atrophic candidiasis is seen, but it can also exert influence on mandibular tissue⁽¹⁰⁾. The surface is usually erythematous, inflamed, and oedematous, and commonly the dentists are the first ones to recognize the condition.

Medications for oral mucosa as well as dental prosthesis are required to reduce the changes in the mucous membrane of the oral cavity. Topical antifungal applications such as clotrimazole 1% are the first choice of treatment. Nystatin ointment is also prescribed for long-term medication. Regardless of the treatment used, patients are instructed to apply a thin film of topical application like nystatin ointment onto the denture about three times per day. The molecule size of nystatin suspension is much bigger than acrylic pores, so using nystatin suspension for cleaning dentures is not efficacious. It is very important to clean the dental prosthesis by using a brush before the topical application of any antifungals and overnight sanitation of the dental prosthesis. Inflammatory papillary hyperplasia and chronic atrophic candidiasis can also be correlated. Inflammatory papillary hyperplasia is mainly due to the ill-fitting of dental prostheses^(1,9).

3.4 Chronic hyperplastic candidiasis

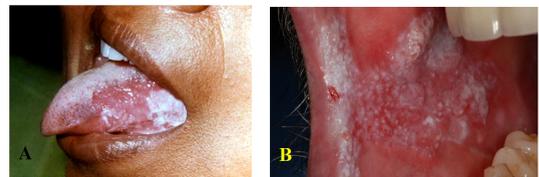


Fig. 4: A. On the lateral border of the tongue, B. On the right buccal mucosa

There are many variants of oral *Candida* infections, and among them, one is chronic hyperplastic candidiasis also known as *Candidal leucoplakia*, which is visible as a white patch or lesion on mucous membrane. Infection by *Candida albicans* is the chief causative agent but also factors like deficiencies of nutrients and vitamins and suppression of immunity contribute to this condition⁽¹⁵⁾.

Diagnosing chronic hyperplastic candidiasis can sometimes be challenging, as any uneven or irregular area in the mucosa of the oral cavity is a perfect place for *Candida* invasion. Histologically, hyphal elements are

often correlated with squamous papillomas. Additionally, *Candida* hyphae are accompanied by other conditions like verrucous carcinoma, epithelial dysplasia, and squamous cell carcinoma. Although affirming the species would require culture methods, it is assumed that these hyphae are of candidal origin^(1,9).

It is very difficult to find out whether the reactive changes that have occurred due to the invasion of hyphae are reactive or dysplastic. Chronic hyperplastic candidiasis is commonly acknowledged in areas that have upraised friction such as lateral tongue and buccal mucosa of the oral cavity. This area with upraised friction aids in the invasion and colonization of *Candidal* species. Resolution of the lesion by antifungal therapy is needed to diagnose chronic hyperplastic candidiasis. An entire solution for the lesion is required for precise recognition of chronic hyperplastic candidiasis. If the lesion does not resolve with antifungal therapy, further investigation into an underlying cause is necessary^(1,9,15).

If any changes such as dysplastic or reactive are observed then a retake of biopsy along with antifungal medication is required. Clotrimazole troches five times per day for about two weeks are prescribed for chronic hyperplastic candidiasis and two troches together at night are prescribed as abiding therapy. As long as the susceptible factors endure, the treatment should not be stopped⁽¹⁾.

3.5 Angular cheilitis



Fig. 5: A & B. Bilateral angular cheilitis seen at the angle of mouth

Angular cheilitis, which is a prevalent lesion could be treated effectively. Nevertheless, the patient should be enlightened that a solitary medication won't be enough to prevent the condition completely and a long-term therapeutic regimen is compulsory. While candidiasis is the main causative factor, there are also additional factors such as the loosening of firmness and structure of skin due to aging that contribute to this condition⁽¹⁶⁾.

It is inevitable to prevent salivary contamination for these individuals. Factors such as the large-scale opening of the mouth, and cheek retraction seen in long dental treatments also contribute to angular cheilitis, and initially, at the angle of the mouth an erythematous, tender area is seen. The presence of intraoral candidiasis may or perhaps not be correlated with angular cheilitis⁽¹⁾. Oftentimes, angular

cheilitis is observed on the buccal mucosa of both sides of the oral cavity rather than on the angle of mouth in individuals who are diagnosed with AIDS⁽¹⁷⁾.

A productive and foreseeable approach to the application of the combination of 1% clotrimazole and 2% mupirocin in a 1:1 proportion is observed. The combination mixture of nystatin and steroid always brings about a dilemma even though the use of a single antifungal is productive. The steroid helps in lessening inflammation but on the other hand, it acts as a source for colonization of bacteria and fungus. Nystatin manages the invasion of fungal organisms but there is to worry about bacterial invasion, so topical corticosteroids are prescribed for angular cheilitis. Despite this, triamcinolone acetonide 0.1% cream along with nystatin 100,00 U/g is still prescribed as a treatment for angular cheilitis by many doctors. Nevertheless, this may increase bacterial colonization and the patient can be susceptible to circumoral/perioral dermatitis⁽¹⁾.

3.6 Median rhomboid glossitis

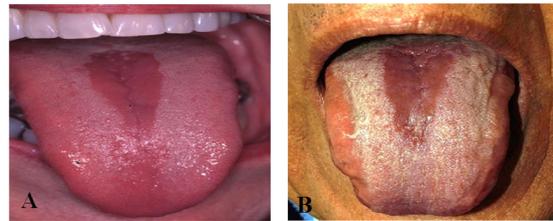


Fig. 6: A & B. Erythematous and depapillated patch of atrophic mucosa in the middle of the tongue

Median rhomboid glossitis is expounded as atrophy of the papilla on the central portion of the tongue⁽¹⁰⁾. Antibiotic sore mouth is another name for median rhomboid glossitis⁽¹⁸⁾. It exerts influence on less than one percent of the population and is an infrequent form of *Candidal* infection⁽¹¹⁾. Earlier it was put forward that the non-success development of branchial arches to cover tuberculum impar was the reason for the formation of median rhomboid glossitis and later through histological investigations and microbiological confirmations, it was found that invasion and infection of *Candidal* species caused this condition⁽¹⁹⁾.

This aspect of lesion outcomes from the waste away of the filiform papillae of the tongue and an ably defined, symmetric atrophy of papillae is observed which emerges anterior to the circumvallate papillae⁽¹¹⁾. *Candidal* infection of the oral cavity, dental prosthesis users, use of inhaled steroids, and smoking are a few reasons that correlate to this condition⁽²⁰⁾. In immunocompromised individuals a "kissing lesion" which is mainly an erythematous lesion is associated with median rhomboid glossitis and seen in the palate right opposite to the atrophied lesion of the tongue. Additional examination should be carried out as this "kissing

lesion" is an important marker of AIDS⁽¹¹⁾.

3.7 Circumoral dermatitis

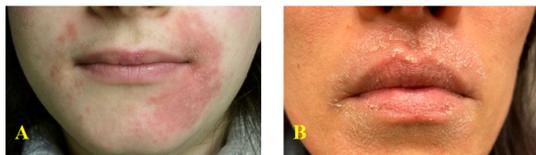


Fig. 7: A & B. Circumoral dermatitis seen around the vermilion border of lips

Circumoral dermatitis is a minimal erythematous lesion seen on the dermal tissue all over the sides of the mouth, accompanied or unaccompanied by vermilion participation. The changes over the erythematous lesion and skin involvement around the mouth are typically consistent and constant. In contrast, an irregular form of circumoral dermatitis is seen when it expands beyond the vermilion border of lips⁽¹⁾.

Despite some controversy clinical investigation suggests that angular cheilitis and circumoral dermatitis have a familiar origin. The infection of these conditions can be due to the invasion of fungus, bacteria, or even both of their participation and it is better to give medications for all three probabilities. Long-term application of steroids on the affected area of circumoral dermatitis and angular cheilitis should be avoided as it worsens the condition. A combination of 1% clotrimazole and 2% mupirocin in a proportion of 1:1 is the chief option for treating perioral dermatitis or circumoral dermatitis and it should be applied over the surface more than two times per day. A nonsteroidal anti-inflammatory medication can be included in the therapy if the erythematous lesion is still present⁽²¹⁾.

0.1% tacrolimus or pimecrolimus can be included in the ongoing medication if the condition is unmanageable and should be applied either before or after applying clotrimazole and mupirocin for more than 10 minutes. Application of the mixture of clotrimazole and mupirocin alone is way better and the first choice as tacrolimus and pimecrolimus has a high risk of causing lymphoma⁽¹⁾.

4 DIAGNOSIS

Based on signs and symptoms, we can easily identify and investigate oral candidiasis and the first choice of treatment for the infected patients would be antifungal medications. Biopsy, exfoliative cytology, culturing of the microorganism, oral rinses, and imprints are a few other diagnostic techniques. Cells that shed inherently or scraped off from lesioned tissue are used as illustrative for exfoliative cytology. The sample can be air dried but it is preferably better to fix it with alcohol fixatives and then smear it onto a glass slide. By using the periodic acid-schiff (PAS) technique,

the sample is stained^(22,23).

The glycogen present in the cells of the lesioned tissues is favorably stained by the PAS method and the causative *Candida* turns magenta. A chairside investigation method can be incorporated as an option, and for this, a glass slide with a single drop of potassium hydroxide of 10% can be taken. The causative *Candida* is easily identified under the microscope as lyses of keratinocytes have taken place due to the action of KOH. The dearth of a lasting record is the chief drawback of KOH preparation when contrasted with the PAS staining method⁽¹²⁾. Mediums like Sabouraud dextrose agar are used for culturing and, the specimens are incubated aerobically for about 48 hours at 37 degrees Celsius. Numerous colonies of cream or white-colored *Candida* species are observed. By discovering the number of CFU per 1mL of whole saliva which is unstimulated, a significant evaluation of *Candida* organism is recorded. If the count of *Candida* is raised up to 50,000 per mL, then the individual is infected by candidiasis and if the count is in the range from 0 to 1000 per mL, then the individual is in a healthy state^(22,23).

Recognition of nearly all fungal and bacterial species with adequate accuracy, replicability, and responsiveness can be done by Matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) which is speedy and much more errorless likewise conventional recognition^(24,25).

5 MANAGEMENT OF ORAL CANDIDIASIS

The first choice for treating fungal infection caused by *Candida albicans* are mainly topical applications of nystatin, clotrimazole, amphotericin, and polyenes. Nevertheless, for the complete cure of the condition, it is important to get rid of all the fundamental factors that are responsible for the conation. Discontinuation of broad-spectrum antibiotics such as doxycycline, and ampicillin reduces the intensity of this infection. However, nystatin suspension and amphotericin suspension (100 mg/mL) are very efficacious in treating oral candidiasis and are prescribed four times per day for about two weeks. Both nystatin and amphotericin suspensions are very productive in treating variants like angular cheilitis and chronic atrophic candidiasis and should be noted that prosthetic dentures should be removed while undergoing the medications. The application of miconazole gel (20mg/mL) on the denture-fitting areas of the oral cavity about three times per day is an alternative treatment for chronic atrophic candidiasis.^(1,13)

Oral and denture hygiene is the first measure to be taken to reduce the intensity of chronic atrophic candidiasis. The patient is advised to avoid the overnight use of prosthetic dentures and to soak them in 0.1% hypochlorite. Even though the topical application is cheap, secure, and sufficiently good, fluconazole or itraconazole are prescribed in resistant cases of oral candidiasis where the

application of topical medication won't be productive, especially in immunocompromised patients, one's undergoing chemotherapy or radiotherapy and a decline in the count of fungal colonies is seen in a successful therapy⁽²⁶⁾.

6 PREVENTION OF ORAL CANDIDIASIS

The presence of biofilm of *Candida* is the causative origin of the fungal infection of oral candidiasis. Consequently, it is crucial to thoroughly clean the teeth and dentures using a toothbrush as a primary method for preventing oral yeast infections. If the oral hygiene practice by the patient is bad or poor and if it cannot be simply refined then using alcohol-free mouth rinses is advised. It is also important to effectively manage any underlying diseases. Significant reduction in the circumstance of infections caused by *Candida* is observed when treated with highly active antiretroviral therapy, especially in immunocompromised individuals. However, the infection remains a complication in these individuals. Furthermore, there has been a notable improvement in the receptiveness of *Candida* to antifungal therapy mainly in HIV patients responding to HAART⁽²⁷⁾.

6.1 Probiotics and Alternate Substances

There is finite substantiation supporting the effectiveness of probiotics in turning aside oral candidiasis. Nevertheless, in immunocompromised patients, bloodstream and septic infections are mainly due to the invasion of *Candida* through the injured mucous membrane. The use of antifungal agents is an unconventional approach to impede the growth of microbes. Xylitol, a sugar alcohol, can be comprised of chewing gums, mouth rinses, and dentifrices to impede microbial growth in the oral cavity. Antifungal activities against *Candida* are indicated in components of tea tree oil and black tea polyphenols. In addition, farnesol and ethylenediamine tetraacetic acid have the property of impeding *Candidal* infection⁽²⁾.

7 CONCLUSION

Oral candidiasis, caused by *Candida*, affects the oral and perioral membranes and often arises due to weakened immune defenses, hormonal imbalances, and poor oral hygiene. Management involves topical medications like nystatin, clotrimazole, and amphotericin B, alongside proper denture care and chlorhexidine use. Prevention includes regular denture cleaning, avoiding overnight wear, and maintaining good oral hygiene. For systemic treatment, fluconazole is preferred, especially in immunocompromised patients due to its lower toxicity. Overall, prioritizing oral hygiene and addressing predisposing factors are crucial in preventing and managing oral candidiasis, and enhancing overall oral health and well-being.

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