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Study of *Candida albicans'* proliferation on acrylic dentures: A Systematic review of the literature

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Abstract
Purpose: The aim of this systematic review was to determine the factors that influence the proliferation of *Candida albicans* on the resins used in removable denture.
Material and methods: The bibliographic search was carried out on Pubmed. Factors related to *Candida Albicans* proliferation at the prosthetic surface were extracted from articles obtained by the equation ((("Candida"[Mesh]) OR "Candida albicans"[Mesh]) AND "Acrylic Resins"[Mesh]))
Results: After applying the inclusion and exclusion criteria, 23 articles were retained and analyzed. The main factors influencing the proliferation of *candida albicans* were the composition of the acrylic resin, its surface condition, the use of prosthesis disinfection products and saliva.
Conclusion: the proliferation of *Candida Albicans* was increased when the material is hydrophobic and the surface condition is rough. The use of disinfectants can reduce it as well as special coatings modifying the surface.

Keywords: Candida, Candida albicans, Acrylic resin, Denture

Introduction

The oral cavity in partially edentulous patients is an ecosystem open to the outside comprising several elements including saliva, dental restorative materials and prosthetic materials (Pereira et al., 2013). *Candida Albicans* is the most widespread species in the oral cavity (Valentini et al., 2013). It has a strong capacity for adhesion and proliferation on all biotic and abiotic surfaces (Li et al., 2012). Following an imbalance of the microbial flora of the oral cavity, oral candidiasis sets in.

In this work, we propose to study through a systematic review of the literature, the proliferation of *Candida Albicans* on prosthetic resins and the factors that could influence it.

Material and methods

Research protocol

A systematic review of the literature was carried out, according to the criteria published by the international PRISMA recommendations (Preferred Reporting Items for Systematic reviews and Meta-Analysis) (Page et al., 2021).

An online search was performed through Pubmed. The research was carried out using the following research equation:

(("Candida"[Mesh]) OR "Candida albicans"[Mesh]) AND "Acrylic Resins"[Mesh]))

Eligibility criteria

- Inclusion criteria

The articles included in this review were articles in French or in English that dealt with the interaction between *Candida Albicans* (alone or in association with other species) and the acrylic resins used for prosthetic rehabilitations.

No restrictions were applied in terms of study design, setting, country or time period.

The literature research was started on February 2023, and the final update of the search was checked on April 2023.

- Exclusion criteria

Publications that did not comply with the objective of this systematic review as well as articles that presented resins used in the mouth for non-prosthetic reasons such as orthodontic splints were excluded.

All authors of this review have agreed on the articles to be included in this systematic review.

Search Strategy

Data collection

After selection of articles and elimination of duplicates, the following data were extracted: author, year of publication, type of study, objective of the study and results.

Results

The approach adopted in the selection of articles is presented in Figure 1. Twenty-three articles were included in this study. The articles and the data extracted from them are summarized in Table I.

Influence of the composition of the acrylic resin: The use of PMMA-based polymers, the use of elements incorporated into the composition that modify the surface charge and the application of a self-adhesive polymer can reduce related stomatitis to *Candida (*Murat, 2019; Park,2008).

Influence of surface condition: The surface condition of prosthesis can have a significant influence on the proliferation of *Candida albicans*. The surface coatings of prosthesis such as chitosan which is a natural polymer (Namangkalakul et al., 2020) sulfobetaine methacrylate, 3-hydroxypropyl methacrylate (Lazarin et al., 2013) and silica nanoparticles (Azuma et al., 2012) reduce the proliferation of *candida albicans*.

A rough surface can provide a favorable environment for the proliferation of *Candida* albicans (Koba, 2013; Huh, 2014; Taylor, 1998 and Radford,1998), while a smooth surface can reduce its proliferation.

Hydrophobic materials promote initial adhesion and biofilm formation (Radford et al., 1999). The more hydrophobic the surface of the material, the greater the adhesion of *Candida albicans* (Lazarin et al., 2013).

Influence of disinfectant products: Commercial solutions such as Clene®, Polident® and 3% NaHCO3 can inhibit the growth of *Candida albicans* (Han et al., 2020). As well as enzymatic

cleaners (Freitas-Fernandes et al., 2014), citric acid (Faot et al., 2014), 1% sodium hypochlorite, 4% chlorhexidine gluconate (Rodríguez Acosta, 2015; Pellizzaro, 2012), 0.12% chlorhexidine digluconate, 5% sodium bicarbonate (Sousa et al., 2009) and 10% vinegar (Pinto et al., 2008).

Relining resins such as GC RELINE™ and SOFRELINER TOUGH® require immersion in cleaning products such as Cleadent® while it is not recommended to immerse COE-SOFT™ in denture cleansers (Huh et al., 2014).

Role of saliva in the proliferation of *Candida albicans*

The presence of saliva improves the effectiveness of chemical cleaning methods aimed at reducing fungal adhesion (Rodríguez Acosta et al., 2015) and reduces the effects of a rough surface (Manikandan et al., 2022) which decreased the adhesion of *Candida albicans*.

Discussion

Candida Albicans is ubiquitous in the commensal flora of the oral cavity. It can cause oral candidiasis which is often favored by the wearing of dental prosthesis (Manikandan et al., 2022). The resins used in prosthesis interact with *Candida Albicans* and modify its proliferation and thus modify the balance of the oral microbiota. The proliferation of *Candida Albicans* on the thermo-polymerizable resin was subject to several studies. According to Mattos (2009), and Murat (2019) and Koba (2013), the acrylic resin would facilitate the adhesion, the formation of the biofilm and the virulence of *Candida albicans* following the presence of porosities. Hence the importance of polishing resins to reduce the adhesion of *candida albicans* (Satpathy et al., 2013).

The soft resin or relining resin promotes the proliferation of *Candida albicans*. Clinically, the bond established between the self-curing relining resin and the thermo-curing resin gradually deteriorates. It gives a chipped, stained and porous resin, which promotes the colonization of micro-organisms and the detachment of the thermo-curing resin (Koba et al., 2013).

The seniority of resin prosthesis can have an impact on the growth of *Candida albicans*. The older the prosthesis, the more there will be an increase in *Candida*. However, Candida-associated stomatitis can be reduced by incorporating elements into the composition of PMMA-based polymers to modify the surface charge and by using a self-adhesive polymer.

The surface coating of prosthesis can have a significant impact on the growth of *Candida albicans* since the surface tension of a material influences protein adsorption (Harkes et al., 1991), cell spreading on this surface and bacterial adhesion (Everaert et al., 1999). A strong surface tension is correlated with a strong adhesion of *Candida albicans* (Olsson et al., 1992).

It is possible to limit proliferation by coating the surface with substances such as chitosan, a natural polymer, sulfobetaine methacrylate and 3-hydroxypropyl methacrylate, or silica nanoparticles (Namangkalakul, 2020; Lazarin, 2013 and Azuma, 2012). However, a rough surface can provide a favorable environment for the growth of *Candida albicans* (Koba, 2013; Huh, 2014; Taylor, 1998 and Radford,1998), while a smooth surface can reduce its development. This is why it is important to polish the resins to minimize the adhesion of *Candida albicans*.

Work on PMMA 26 samples confirms that polishing with sandpaper with or without pumice powder reduces the roughness and adhesion of *Candida albicans* (Taylor, 1998 and Radford,1998). A rough surface allows bacteria to adhere better and colonize more. Especially in microcracks as demonstrated by Koba (2013).

Additionally, hydrophobic materials are favorable to initial adhesion and biofilm formation, with increased adhesion of *Candida albicans*. The more hydrophobic the surface of the material, the greater the adhesion of *Candida albicans*. In addition, electrostatic forces are involved in the adhesion of the parasite (Harkes, 1991; Uyen, 1989; Gottenbos, 2003) to the surface when the distance is sufficiently small (less than 20 nm) (Murat et al., 2019). Specific studies (Radford, 1998 and 1999) on the adhesion of *Candida albicans* to polymethylmethacrylate surfaces of different charges have corroborated these results.

Ten articles selected were interested in the study of the effect of disinfection and maintenance products for prosthesis on the proliferation of *Candida albicans*.

There are several commercial solutions that can reduce the growth of *C. albicans*, such as Clene®, Polident® and 3% sodium bicarbonate. Enzymatic cleaners, citric acid, 1% sodium hypochlorite, 4% chlorhexidine gluconate, 0.12% chlorhexidine digluconate, 5% sodium bicarbonate, and 10% vinegar can also have an inhibiting effect. (Freitas-Fernandes, 2014; Faot, 2014; Rodríguez Acosta, 2015; Pellizzaro, 2012; Sousa, 2009 and Pinto, 2008).

All studies confirm the benefits of disinfection and maintenance products on *Candida albicans*. However, for some products, there is an alteration of the prosthetic resin such as hypochlorite which discolors the resin (Rodríguez Acosta et al., 2015), chlorhexidine which colors it brown. Hydrogen peroxide is active on *Candida albicans* only at very high doses close to toxicity for the mucous membranes **(**Izumida et al., 2014).

According to Ahariz (2010), saliva protects the oral mucous membranes against candidiasis thanks to salivary histatins. From a clinical point of view, *Candida* colonization is greater in people with low salivary secretion compared to those with normal secretion. These patients frequently develop prosthetic stomatitis.

Saliva inhibits *candida albicans* adhesion through lysozymes, histatins, lactoferrin, calprotectin and IgA. However, it increases the adhesion of *candida albicans* to biomaterials thanks to mucins, statherins, proteins rich in proline (Johnson et al., 2012).

A link between the wearing of prostheses and *Candida albicans* infections, especially in the elderly and affected persons, has been shown (Pereira-Cenci et al., 2008). These patients most often suffer from xerostomia, which promotes the installation of prosthetic stomatitis (Ahariz et al., 2010). However, the importance of salivary flow with respect to effective disinfection methods is relatively low (Altarawneh et al., 2013).

Conclusion

The proliferation of *Candida Albicans* was increased when the material is hydrophobic and the surface condition is rough. The use of disinfection products makes it possible to reduce this proliferation as well as special coatings modifying the surface.

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