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Case Report

Preventing Denture Stomatitis: A Case Study on the Antifungal Properties of Denture Base Resins Against Candida albicans Adhesion

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The objective of this case report was to investigate whether *Candida albicans* adhesion to the poly(methyl methacrylate) (PMMA) denture surface is reduced by surface modifications in two innovative methods. Three experimental groups on the tissue surface of a maxillary denture consisted of a control (pure PMMA), negatively surface-charged modified-PMMA (*m*PMMA), and application of a self-bonding polymer (SBP). The results of the clinical report revealed that both *m*PMMA and SBP groups had reduced amounts of adherent *C. albicans* on the resin surfaces compared to the control. Interestingly, the SBP demonstrated a reduced amount of *C. albicans* adherence up to 21 days follow-up, where the *m*PMMA group exhibited a longer effect till 30 days.

Key words: Surface-charged resin, self-bonding polymer, *Candida albicans*.

INTRODUCTION

Denture stomatitis (DS) is a pathogenic condition of the denture-bearing palatal mucosa and is the most common form of candidal infection in the oral cavity (Regezi and Sciubba, 1989). In denture wearers, *Candida albicans,* a prevalent fungus in the mouth, has been the predominant species identified in cases with clinical signs of DS, which occurrence is often increased almost 3- fold, in geriatric populations (Reichart, 2000; Shulman et al., 2004; MacEntee et al., 1998; Cumming et al., 1990; Frenkel et al., 2000). Candidiasis, a fungal infection, is aggravated by the adhesion of *C. albicans* to the tissue-fitting surface of a maxillary denture, which serves as an effective reservoir of microorganisms (Budtz-Jorgensen, 1981; Samaranayake et al., 1980; Vasilas et al., 1992; Thein et al., 2006).

In clinical situations, attempts have been made to inhibit candidal adhesion and subsequent colonization on the denture resin surface through the use of a wide range of antifungal agents. Mechanical plaque control by daily cleansing of denture surfaces and appropriate denture-wearing habits are considered important steps in preventing and treating the disease clinically. The exact

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Table 1. Polymerization of experimental surface-charged resin.

Chemical	Action	Ratio
PMMA : MMA	Polymer: Monomer	3:1 by weight
mPMMA (16% methacrylic acid)	Polymer: Monomer	3:1.5 by weight
Benzoyl peroxide	Initiator	1% weight of PMMA
2-Hydroxyethyl methacrylate	Cross-linker	0.5% volume of MMA
N,N dimethylaniline	Activator	0.5% volume of MMA

mechanism of adhesion of *Candida* species to the denture is yet to be elucidated, however, studies have shown that surface characteristics resulting from chemistry are significant in the initial adherence of *C. albicans* to the denture resin and offer an opportunity for further bonding and colonization (Lazarin et al., 2014; Wady et al., 2012; Park, 2007). Polymeric biomaterials feature an inherent advantage of their capacity for modification and dentures are made of poly(methyl methacrylate) (PMMA).

In this report, a patient's maxillary complete denture surface characteristics were modified with two different methods by: (1) incorporation of surface charge, and (2) application of a self-bonding polymer (SBP). The patient was followed up to 30 days after delivery of the surface modified maxillary complete denture.

CLINICAL REPORT

A 76-year-old male patient presented to the clinic with chief complaint of needing a new maxillary complete denture. The patient was completely edentulous in the maxilla and partially edentulous in the mandible. A review of the patient's health questionnaire and medical progress notes, as well as verbal communication, revealed that the patient had an ASA physical status II health history with a pre-diabetic condition. The patient had no known drug allergies or hypersensitivities. The patient's current medical and dental health was non-contributory to his dental treatment.

Upon fabrication of a new permanent maxillary complete denture, the new maxillary complete denture was duplicated to fabricate an experimental denture. The tissue-fitting surface of a maxillary complete denture was divided into three sections according to the type of surface treatment. Figure 1 describes the three different experimental area sections [Group 1: Control (pure PMMA), Group 2: Surface-charged modified-PMMA (mPMMA), and Group 3: SBP].

Group 1: Control

No surface modification or surface coating application, made of pure PMMA (0% methacrylic acid: 100% MMA).

Group 2: Surface-charged resins (mPMMA)

Surface-modification was achieved by incorporating methacrylic acid in a ratio of 16% methacrylic acid: 84% methyl methacrylate (Sigma-Aldrich Chemical Co., Inc., Milwaukee, Wisconsin), as shown in Table 1. Polymerization of the specimens was carried out in water at 55 ± 1°C under air pressure of 20 psi for 15 min. The specimens were rinsed and stored in sterile distilled water for 24 h before use to remove any residual monomer after polymerization.

Group 3: Self-bonding polymers (SBP)

KISSCARE® Concentrated Gel (KISS-COTE Inc., Florida, USA) was applied according to manufacturer's instructions. For each resin sample, 10 mg of the KISSCARE® Dental Concentrated Gel was applied to spread completely over the experimental surface. Patient was given the duplicated maxillary complete denture and follow-up visits were done at 0, 3, 7, 10, 14, 17, 21, 24, and 30 days. The patient was instructed to follow up with regular denture hygiene procedures and was advised to remove the denture at night. On each follow-up visit, *C. albicans* swabs were done; each swab was transferred to a differential culture medium, CHROMagar® Candida (BD), and incubated at 37°C for 48 h. Growth was revealed as light to medium green colonies in Figure 2. The study protocol was reviewed by the Harvard Medical School/Harvard School of Dental Medicine Human Studies Committee.

The results of the present study revealed that both *m*PMMA and SBP groups had reduced amount of adherent *C. albicans* on the resin surfaces as compared to the control. Interestingly, SBP group demonstrated significantly reduced amount of *C. albicans* adherence up to 21 days follow-up, where the *m*PMMA group exhibited a longer effect till 30 days.

DISCUSSION

The etiology for edentulism is multifactorial; however, a study by Douglass et al. (2002) showed that the need of complete dentures would increase due to edentulism from 33.6 million adults in 1991 to 37.0 million adults in 2020, with a 79% increase in adult population over 55 years of age. In denture wearers, *C. albicans* have been the predominant species identified in most or all cases with clinical signs of denture stomatitis (McMullan-Vogel et al., 1999; Schou et al., 1987; Budtz-Jorgensen et al., 1975; Cardash et al., 1989; Marcos-Arias et al., 2009).

The present clinical report first identified that a novel negatively charged denture resin material could potentially reduce the adhesion of *Candida* on denture resin surfaces *in vivo*. Moreover, SBP showed to be an effective method of surface-coating in reducing staining of resin materials *in vivo* as previously demonstrated in

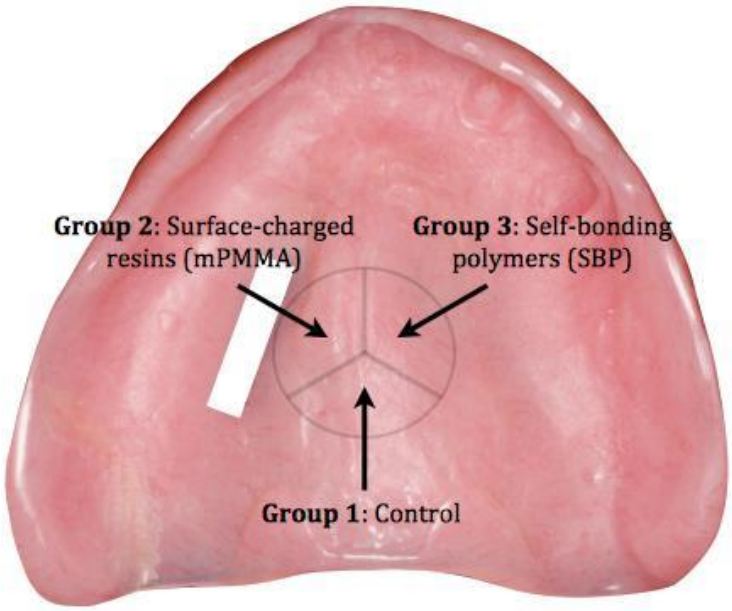

Figure 1. Tissue-fitting surface of maxillary complete denture.

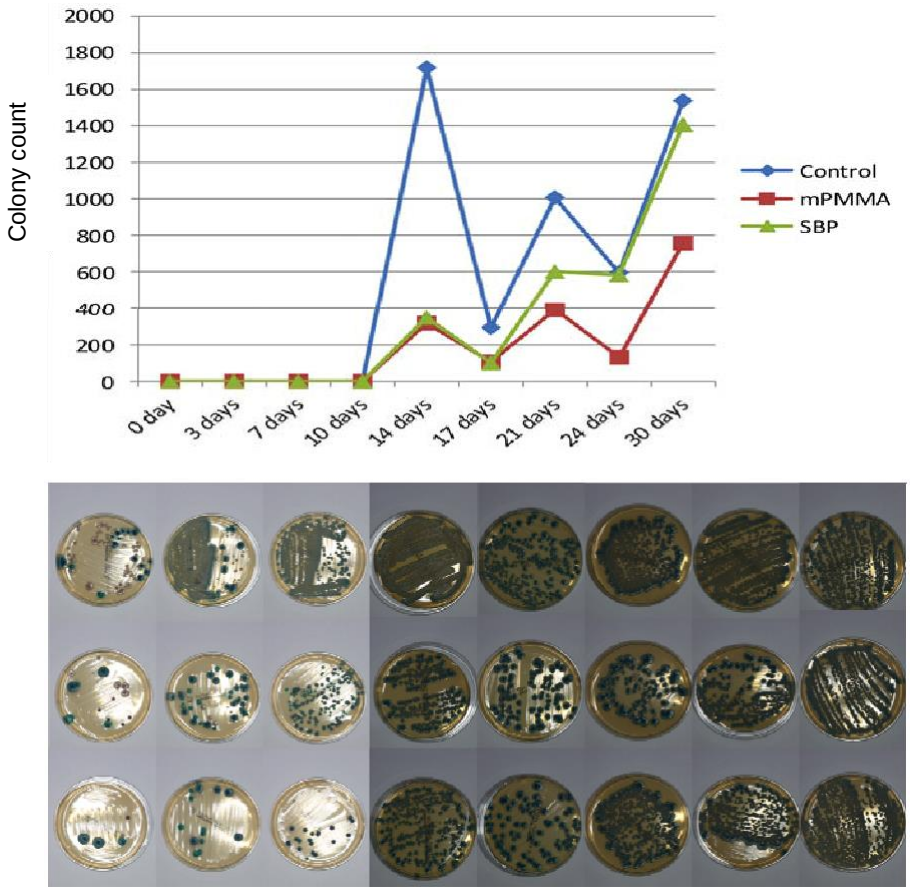

Figure 2. *Candida albicans* colony counts up to 30 days.

an *in vitro* study model (Park et al., 2006). The results of this case report were inherently influenced by the fluctuation of *C. albicans* counts attributed to the dynamic oral environment and patient's oral hygiene compliance. Other limitations of this study include the operator's techniques in sample collection and transfer to the medium.

Understanding the effect of electrostatic interactions in the adhesion of *Candida* to mPMMA reduces the adhesion of *C. albicans* to the denture surface. PMMA is a negatively surface-charged denture resin modified by interacting polymerization of methacrylic acid to PMMA. This study had demonstrated the ability of this new surface-modified denture resin to reduce adhesion of *C. albicans* to the denture surface, showing significant correlation between the amount of methacrylic acid incorporated in resin and adhesion of *C. albicans* to the resin samples. This study supports the role of electrostatic interaction in adhesion, and introduced an effective method of reducing adhesion of *C. albicans* to PMMA surfaces through modification of the surface charge of polymeric biomaterials.

Another method to prevent the microbial adhesion to dental restorative materials is the application of a non-stick protective coating made of a pure poly(dimethyl siloxane). This SBP provides a mono-molecular layer of an inert non-stick finish to deter microbial attachment and growth (Park et al., 2003, 2008, 2009). Although, the SBP group demonstrated a short-term (21 days) efficacy, the feasibility of the duration of the SBP coating needs to be explored to determine whether multiple applications are required to maintain the continuing effect.

Modification of surface characteristics of polymeric biomaterials is an effective method in reducing adhesion of *C. albicans* to PMMA surfaces. Future studies should encompass the physiochemical properties of the acquired salivary pellicle layer formed on denture base surfaces and their roles in regulating microbial colonization to surface-charged biomaterials. Saliva composition, including calcium ion concentration and its pH value, is of importance in understanding microbial adhesion. Varying ratios of methacrylic acid need to be investigated to the surface charged polymers to find the optimal ratio for a dynamic oral environment.

Conflict of Interests

The author(s) have not declared any conflict of interests.

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