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Effect of immersion cleansers on the bond strength between a denture base resin and acrylic resin teeth

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ABSTRACT

The aim of the present study was to assess the shear bond strength between a heat-polymerized denture base resin and acrylic resin teeth after immersion in different denture cleansers by simulating a 180-day use. Two acrylic teeth (Biotone, Biotone IPN, Dentsply Ind. e Com., Rio de Janeiro, RJ, Brazil) were chosen for bonding to a heat-polymerized denture base resin (Lucitone 550- Dentsply Ind. e Com., Rio de Janeiro, RJ, Brazil). Eighty specimens were produced and divided into eight groups ($n=10$) according to their experimental condition (distilled water, 2% chlorhexidine digluconate, 1% sodium hypochlorite and Corega Tabs). Shear bond strength tests (MPa) were performed with a universal testing machine at a crosshead speed of 0.5 mm/min. Data were analyzed by two-way analysis of variance (ANOVA) and Student-Newman–Keuls' multiple comparisons post hoc analysis ($\alpha=.05$). The shear bond strength results revealed statistically significant differences between the groups. For the Biotone IPN tooth, significantly lower shear bond strength values were found for the group immersed in sodium-perborate solution (4.48 ± 2.18 MPa) than for the group immersed in distilled water (control group) (10.83 ± 1.84 MPa). For Biotone, significantly higher bond strength values (10.04 ± 3.28 MPa) were found for the group immersed in Corega Tabs than for the control group (5.45 ± 2.93 MPa). The immersion in denture cleanser solutions was more detrimental to the conventional acrylic denture tooth (Biotone) than to the highly cross-linked denture tooth (Biotone IPN). However, this effect was not observed for the groups immersed in Corega Tabs solution, regardless of the type of denture tooth.

1. Introduction

Denture care is essential for the greater longevity of the prosthesis and the maintenance of a healthy oral mucosa. A lack of denture hygiene can cause a proliferation of microorganisms on the denture surface and the development of oral infections, [1] since denture materials may act as reservoirs for microorganisms and have the potential to support biofilm formation [2].

In an attempt to prevent this condition and improve the quality of life of denture wearers, hygiene instructions should be emphasized to the patients by dental professionals. The most common method of denture cleaning is the mechanical method associated with detergent, soap or dentifrice [3,4]. However, many elderly patients cannot effectively brush their dentures because of advanced senility or debilitating diseases. [4]

An alternative approach to solve this problem could be the use of chemical cleansers associated to mechanical methods [1,5] of denture cleaning. These denture cleanser solutions include sodium hypochlorite, chlorhexidine, alkaline peroxides, enzymes and diluted acids [6]. The immersion of dentures in sodium hypochlorite solutions has been indicated [5,7] and is effective in reducing *Candida albicans* in patients with denture stomatitis [8]. Chlorhexidine has been shown to be effective by inhibiting the proliferation of a broad spectrum of microorganisms, including *C. albicans* and Gram-positive bacteria [7]. It has been reported that effervescent tabs (alkaline peroxide solutions) do not exhibit satisfactory antimicrobial activity, but must be useful in association with mechanical cleaning [7].

Denture cleaning by immersion in chemical solutions should not cause deleterious effect to the denture materials [4,6,9] and should not affect the bond strength between acrylic teeth and denture base resins. Debonding acrylic teeth from denture base resins remains a common clinical problem in prosthodontic practice. [10]

Different types of acrylic denture teeth have been introduced with claims of increased abrasion resistance, improved esthetics and more convenient curing methods [11]. A conventional acrylic denture tooth is essentially composed of polymethyl methacrylate (PMMA) beads and color pigments in a polymer matrix, whereas a cross-linked resin denture tooth contains an Interpenetrating Polymer Network (IPN), described as the outer layer of the polymer

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beads into which the monomers of the matrix have diffused during the processing of the tooth [12]. A number of factors may affect the bond strength between artificial acrylic teeth and denture base resins. These include the action of the water and the degree of cross-linking in the polymer [10,12,13]. Thus, the nature of the acrylic resin polymer tooth and the immersion of dentures in an aqueous medium, such as a cleansing agent, should be investigated. However, there are no records of the effects of the immersion of dentures in denture cleansers and the type of acrylic denture tooth on the bond strength between acrylic teeth and denture base resins.

The aim of the present study was to assess the shear bond strength between a heat-polymerized denture base resin and acrylic resin teeth after successive cleansing protocols of immersion in different denture cleansers, simulating a 180-day use. The null hypothesis tested was that neither the immersion in denture cleansers nor the type of acrylic denture tooth would have an effect on the shear bond strength between a denture base resin and acrylic denture teeth.

2. Materials and methods

2.1. Experimental design

A conventional acrylic resin denture tooth (Biotone, Dentsply Ind. e Com., Rio de Janeiro, RJ, Brazil) and a cross-linked resin denture tooth (Biotone IPN—Interpenetrating Polymer Network, Dentsply) were chosen for bonding to a denture base resin (Lucitone 550—Dentsply Ind. e Com., Rio de Janeiro, RJ, Brazil). Eight experimental groups ($n=10$) were formed according to each acrylic resin denture tooth (Biotone or Biotone IPN)/denture cleanser immersion solution (2% chlorhexidine digluconate, 1% sodium hypochlorite, Corega Tabs or distilled water—control) combination.

2.2. Specimen fabrication

The specimens were composed of denture base resin cylinders (5.0 mm diameter × 2.5 mm length) bonded to the ridge-lap surface of the acrylic denture teeth (Fig. 1). All of the acrylic resin denture teeth were maxillary molars. The specimen fabrication was performed as described in previous studies [14,15]. The ridge-lap surfaces of the denture teeth were reduced using 320-, 400-, and 600-grit silicon carbide paper (Norton, Saint-Gobain Abrasivos Ltd., Vinhedo, SP, Brazil) in a polishing machine (Arotec Ind. e Com. Ltd., Cotia, SP, Brazil) at 300 rpm. This was done to obtain a flat surface for bonding to the denture base resin. Each denture tooth was embedded in autopolymerizing polymer (poly)methyl methacrylate (PMMA) (Jet, Artigos Odontológicos Clássico Ltd., Sao Paulo, SP, Brazil) using an embedding machine (Arotec Ind. e Com. Ltd., Cotia, SP, Brazil). The ridge-lap surface of the embedded tooth was then polished with 600-grit silicon carbide paper. Silicone patterns (Zetalabor/Indurent—Zhermack, Badia Polesine, Rovigo, Italy), with a circular opening (5.0 mm diameter × 2.5 mm length), were obtained from a stainless steel mold to standardize the dimensions of the denture base resin cylinders. Cyanoacrylate glue (Super Bonder, Loctite Henkel Ltd., Diadema, SP, Brazil) was applied to the silicone pattern PMMA/polymer interface so that the silicone pattern opening position coincided with the prepared ridge-lap surface. The circular opening of the silicone pattern was then sealed with a small amount of silicone before proceeding. The embedded tooth and the silicone pattern were then placed in denture flasks using dental stone (Herodent, Vigodent S.A. Ind. Com., Rio de Janeiro, Brazil). After the dental stone was set, the flask was opened and the silicone was carefully removed from the silicone pattern circular opening. The heat-polymerized denture base resin (Lucitone 550) was mixed, packed and processed according to the manufacturer's instructions and polymerized in an automatic polymerization water tank (Solab Equipamentos para Laboratórios Ltda., Piracicaba, SP, Brazil). The temperature and time used were 73 °C for 90 min, followed by 30 min at 100 °C. These procedures were carried out to simulate the usual laboratorial procedures for denture fabrication. After polymerization, each flask was bench cooled at room temperature overnight. The specimens were carefully deflasked, cleaned, and stored in distilled water at 37 °C for 50 ± 2 h before the immersion procedure [16].

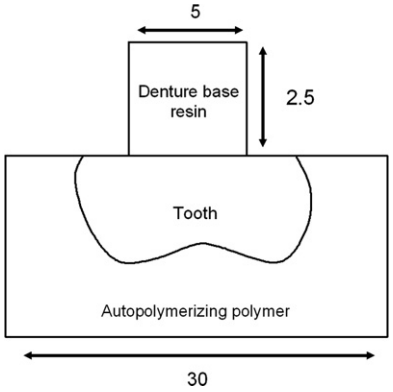

Fig. 1. Schematic drawing of the specimen with the dimensions in millimeters [15].

2.3. Immersion procedure

The present study simulated immersion in different denture cleansers for 180 days. The time needed to simulate the 180 day-period was based on a previous report [4]. The effervescent solution (Corega Tabs, Stafford Miller Ind., Rio de Janeiro, RJ, Brazil) was prepared according to the manufacturer's instructions, by adding one tablet to 200 mL of warm tap water (40 °C). The specimens were submitted to thirty immersion cycles daily (5 min each) over a period of 6 days, simulating a 180-day use [4]. After each cycle, the soaking solution was discarded and the specimens were thoroughly washed in running water. These specimens were stored in distilled water at room temperature (23 ± 2 °C) when the immersion cycles were not carried out in the effervescent denture cleanser solution [4,17].

For the groups immersed in 200 mL of 2% chlorhexidine digluconate, 1% sodium hypochlorite, or distilled water (control group), the total immersion period was 15 h to simulate the same 5 min of daily immersion for 180 days before the shear bond strength tests.

2.4. Shear bond strength test

A universal testing machine (EMIC-DL 3000, EMIC Ltd., Curitiba, PR, Brazil) was used at a crosshead speed of 0.5 mm/min. The maximum stress (MPa) required to shear the denture base resin off the acrylic tooth was considered as the shear bond strength [14,15]. The data were analyzed by two-way analysis of variance (ANOVA) and Student-Newman–Keuls' multiple comparisons post hoc analysis ($\alpha=.05$).

3. Results

The two-way ANOVA detected significant differences in the factor acrylic denture tooth ($p<.001$) and in the interaction of the