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ORIGINAL ARTICLE

Surface roughness of restorative materials after immersion in mouthwashes

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ABSTRACT

Objective: To evaluate the surface roughness of resin composite and ceramic material after immersion in mouthwashes. **Methodology:** Thirty specimens of resin composite and ceramic material were prepared with a stainless steel matrix (6 mm × 2 mm). The samples of each material were divided into three groups (n = 10), according to the mouthwashes: Distilled water (DW), chlorhexidine (CL) 0.12%, and cetylpyridinium chloride (CC). Specimens were individually submitted to the immersion cycle in 15 mL of mouthwash for 30 days, three times per day, for 1 min/cycle. Surface roughness measurements were performed at three different time intervals: Before the first cycle (T0), after 7 (T1), and 30 days (T2) of immersion. Data were analyzed by the two-way ANOVA and Tukey tests ($P \leq 0.05$). **Results:** There was no statistically significant difference in surface roughness of resin composite among mouthwashes (DW - 1.4 ± 0.13 μm; CL - 1.16 ± 0.13 μm; CC - 1.18 ± 0.13 μm). Surface roughness was statistically significantly lower after 30 days (T2-0.56 ± 0.60 μm) compared with the initial period (T0-1.63 ± 0.60 μm) and after 7 days (T1-1.57 ± 0.60 μm). For ceramic material, CC (3.75 ± 0.60 μm) caused a higher level of surface roughness compared with DW (2.57 ± 0.60 μm) and CL (3.39 ± 0.60 μm). There was no statistically significant difference among the different time intervals (T0-3.05 ± 0.18 μm; T1-3.41 ± 0.18 μm; T2-3.26 ± 0.18 μm). **Conclusion:** Mouthwashes did not promote a significant change in surface roughness of composite resin. Cetylpyridinium chloride promoted an increase in surface roughness of dental ceramic.

Key words
Dental materials, mouthwashes, surface properties

INTRODUCTION

Restorative dental materials are widely used in clinical practice due to their excellent esthetics and biocompatibility.[1-4] Contemporary composite resins have shown better physical properties due to improvement in resin monomers, fillers, and coupling agents, leading to high mechanical properties and superior esthetics.[1] Hence, composites may be recommended for both anterior and posterior restorations. However, these properties will be affected by adverse environmental conditions[2,5] considering that exposure to acidic solutions present in oral cavity may affect the surface gloss and microhardness,[1] leading to the degradation of the materials[2,6,7] and decreasing their longevity.[6]

Likewise, dental ceramic presents excellent physical and mechanical properties, such as biocompatibility with oral tissues, provided that the material is placed in an optimal environment. Thus, it has become the material of choice for replacing dental structures. Nevertheless, an aqueous environment and exposure to chemical solutions may create micro cracks, resulting in increasing surface roughness.[8]

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Surface features play a key role in the clinical longevity of restorative materials,[9] since superficial biodegradation resulting from chemical solutions will affect the material properties.[5,6,10-12] This process will allow plaque accumulation,[10] wear and discoloration of restorations.[5,13]

Even preventive media, such as oral hygiene products, are capable of damaging the surface of restorative materials. Although mouthwashes are widely recommended for chemical plaque control, their overuse may lead to damage of restorative composites[14] because of the low pH and alcohol present in the solutions.[15] Despite the different manufacturers' recommendations, mouthwashes have been widely used by patients for prolonged period of time.[12] However, their action on esthetic materials is still controversial.[12,16] Thus, the aim of this study was to evaluate the influence of mouthwashes on the surface roughness of composite resin and dental ceramic after 7 and 30 days of use.

METHODOLOGY

Experimental design

Thirty specimens of both composite resin Filtek Z350 (3M ESPE, Sumaré, São Paulo, Brazil) and dental ceramic IPS e.max Ceram (Ivoclar, Barueri, São Paulo, Brazil) were prepared as described below. Each material was divided in three groups ($n = 10$), according to the following solutions: Distilled water (DW); chlorhexidine (CL) 0.12% (Periogard, São Paulo, Brazil), and cetylpyridinium chloride (CC) (Colgate Plax 2 in 1, São Paulo, Brazil). Product compositions are shown in Table 1.

Composite resin specimen preparation

Composite resin specimens were prepared according to the manufacturer's instructions. The material was incrementally inserted into a stainless steel matrix (6 mm × 2 mm). A polyester strip (KDent, St. Louis, USA) and glass slab placed on the material to protect its surface, and a static load of 500 g was on the top of the set to ensure homogeneous filling of the matrix. After removing the load, the specimens were light-polymerized (Ultralux, Dabi Atlante, Ribeirao Preto, São Paulo, Brazil) with light intensity of 750 mW/cm. The specimens were removed from the matrix and polished with Sof-Lex discs (3M ESPE, Sumaré, São Paulo, Brazil) according to the manufacturer's instructions. During the experimental phase, the specimens were kept in DW at 37 ± 1°C.

Table 1: Composition of products used in this study

Mouthwashes	Composition	Manufacturer
Composite resin	BIS - GMA, BIS - EMA, UDMA, TEGDMA Agglomerates (0,6-1,4 microns) of zirconia/silica particles (5-20 nm)	Filtek Z350, 3M ESPE, Sumaré, SP, Brazil
Dental ceramic	SiO_2, Al_2O_3, ZnO_2, Na_2O, K_2O, ZrO, CaO, P_2O_5, fluoride and pigments	IPS e.max ceram, Ivoclar, Barueri, SP, Brazil
Chlorhexidine 0,12%	Chlorhexidine gluconate 0,12%, water, glycerin, ethanol. pH 5-7	Periogard, Colgate, São Paulo, Brazil
Cetylpyridinium chloride	Sodium fluoride 0, 0 5%, cetylpyridinium chloride 0, 05%, pH 6-7	Colgate Plax 2 in 1, Colgate, São Paulo, Brazil

Dental ceramic specimen preparation

The ceramic specimens were prepared by mixing powder and liquid to obtain a mass that was inserted into a stainless steel matrix (6 mm × 2 mm). After this, each specimen was fired in a furnace for ceramic baking (Ceramco Phoenix Quick Cool; Dentsply Ceramco, Burlington, NJ, USA) at 403°C for 4 min, followed by a cycle of 1 h at 750°C, according to the manufacturer's instructions. The specimens were prepared and polished with abrasive sandpaper (Norton Abrasives, Saint-Gobain Abrasives, Guarulhos, São Paulo, Brazil) of decreasing abrasiveness (#100-, #320-, #600-, #800-, and #1000-, grit) under water irrigation. To standardize the polishing procedure, all steps were performed by the same operator.

Immersion in mouthwashes

Specimens were submitted to an immersion cycle in mouthwashes for 30 days. For each immersion, specimens were individually inserted in a bottle containing 15 mL of the respective mouthwash, for a cycle lasting 1 min, three times per day, and under constant agitation. The immersion cycles were carried out with an interval of 8 h, and solutions were replaced after each cycle. Between the cycles, the specimens were stored in DW at 37°C.

Surface roughness analysis

The surface roughness analysis was carried out in three time intervals: Before the first immersion cycle (T0), 7 (T1), and 30 days (T2) after the experimental procedures began. Three readouts were taken of each specimen with the aid of a Rugosimeter (SJ-201 P/M, Mitutoyo, Tokyo, Japan), and the mean value was used for statistical analysis.

Statistical analysis

Data were analyzed with the two-way ANOVA and Tukey tests ($P \leq 0.05$), by using GMC Software (Software Geraldo Maia Campos, Ribeirão Preto, São Paulo, Brazil).

RESULTS

Composite resin specimens

There was no statistically significant difference among the solutions (DW - 1.4 ± 0.13 μm; CL - 1.16 ± 0.13 μm; CC - 1.18 ± 0.13 μm). Surface roughness was statistically significantly lower after 30 days (T2-0.56 ± 0.60 μm) compared with the initial period (T0-1.63 ± 0.60 μm) and after 7 days (T1-1.57 ± 0.60 μm). The interaction between solutions and time is shown in Table 2.

Ceramic specimens

Immersion in CC resulted in a level of higher surface roughness (3.75 ± 0.60 μm) compared with DW (2.57 ± 0.60 μm) and CL (3.39 ± 0.60 μm). There was no statistically significant difference among the different periods (T0-3.05 ± 0.18 μm; T1-3.41 ± 0.18 μm; T2-3.26 ± 0.18 μm). The interaction between solutions and time is shown in Table 3.

DISCUSSION

Under specific conditions of this study, mouthwashes did no promote significant changes in surface roughness of composite resin in comparison with the control group (DW). Although the association of a mouthwash and an acidic solution may cause chemical dissolution of dental material,[16] the mouthwash product is not harmful when used alone. Furthermore, previous studies are still controversial with regard to the influence of mouthwashes on restorative materials. Sadaghiani *et al.* showed an increase in surface roughness after the use of mouthwash followed by brushing.[13] Nevertheless, Rocha *et al.* found no significant differences promoted by the same association.[9]

It is presumed that the components of mouthwashes will determine the degradation of restorative materials.[14,16] Studies have reported that mouthwashes with alcohol or low pH may cause a harmful effects on restorative materials,[15] due to the effect of polymeric matrix plasticization, which will result in a higher degree of ductility of the material.[17] Furthermore, Yeh *et al.* concluded that fluoride causes degradation of the composite resin matrix and fillers.[18] Nevertheless, in the present study, the mouthwashes containing fluoride did not promote any statistically significant change in the composite. Even if a depolymerization process had occurred, this was not able to promote a change in surface roughness of the composite resin. As the solutions did not contain alcohol, this may have contributed to the positive results.

Table 2: Mean values (standard deviation) of composite resin surface roughness (μm) to the interaction Solutions × Time

	T0	T1	T2
DW	1,81 (1.00)	1,76 (1.03)	0,66 (0.63)
CL	1,49 (0.81)	1,66 (0.96)	0,34 (0.26)
CC	1,59 (0.79)	1,29 (1.01)	0,68 (0.51)

Table 3: Mean values (standard deviation) of dental ceramic surface roughness (μm) to the interaction Solutions × Time

	T0	T1	T2
DW	2,38 (0.80)	2,97 (1.10)	2,37 (1.37)
CL	2,86 (0.88)	3,05 (0.90)	4,27 (1.50)
CC	3,92 (1.05)	4,20 (1.62)	3,14 (1.76)

The influence of restorative material composition on mechanical properties must be considered, since the chemical structure of polymers is essential to define whether the material will be harmed in an aqueous environment.[9] Although immersion media often affect material properties causing surface degradation,[19,20] the composite evaluated in the present study showed resistance to mouthwashes and did not undergo chemical and physical processes such as softening and plasticization.[9]

After 30 days, there was a decrease in surface roughness of the composite resin specimens. The composite probably absorbed the solutions that were disseminated through the matrix,[6] which resulted in swelling and consequent change in the resin matrix properties.[1] The late response may be due to the high percentage of urethane dimethacrylate in the composite, a hydrophilic component that hampers sorption.[21]

Since dental ceramic is the most inert of restorative materials,[12] an excellent clinical performance is expected.[11] Although an increase in surface roughness occurred with submersion in CC, this may be related to biodegradation of the vitreous ceramic, damaging only the polishing phase. The presence of glassy matrix may lead to dissolution of the glass network, considering that alkaline metal ions are less stable when in a glassy matrix phase than in a crystalline phase.[2] Furthermore, as a cationic surfactant, CC is able to reduce the surface tension and promote an increase in wetting.[14]

Studies have reported dental ceramic may be harmed by solutions present in an oral environment. Ccahuana *et al.* showed that dental ceramic suffered surface changes after exposure to acidulated phosphate fluoride.[8] Kukiattrakoon *et al.* found a decrease in microhardness when the ceramic was immersed in low pH solutions.[2] Furthermore, Esquivel-Upshaw *et al.* stated that the ceramic veneers were susceptible to degradation when in contact with low and high pH solutions, due to an ionic exchange mechanism.[22] However, Esquivel-Upshaw *et al.* showed that the degradation would be clinically significant only after a long period of use.[22]

In summary, although mouthwashes may have an effect on the surface roughness of restorative material, this did not seem to be relevant in a short period of time. Future researches must be conducted concerning the clinical environment and a longer period of use.

CONCLUSION

Within the limitations of this in-vitro study, it was concluded that mouthwashes did not promote a significant change in surface roughness of composite resin. Cetylpyridinium chloride promoted an increase in surface roughness of dental ceramic.

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Conflicts of interest

There are no conflicts of interest.

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