Influence of $NaHCO_3$ Powder on Translucency of Microfilled Composite Resin Immersed in Different Mouthrinses

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ABSTRACT

The regular use of mouthrinses, particularly when combined with the use of air-powder polishing, could affect the appearance of tooth-colored restorations. The current study sought to evaluate the effect of $NaHCO_3$ powder on translucency of a microfilled composite resin immersed in different mouthrinses, at distinct evaluation periods. Eighty disk-shaped specimens of composite resin (Durafill VS, Heraeus Kulzer GmbH & Co. KG, Hanau, Germany) were prepared. The composite specimens were then randomly allocated into two groups according to the surface treatment: exposure to $NaHCO_3$ powder (10 seconds) or nonexposure, and they were randomly assigned into four subgroups, according to the mouthrinses employed ($N = 10$): Periogard (Colgate/Palmolive, São Bernardo do Campo, SP, Brazil), Cepacol (Aventis Pharma, São Paulo, SP, Brazil), Plax (Colgate/Palmolive), and distilled water (control group). The samples were immersed for 2 minutes daily, 5 days per week, over a 4-month test period. Translucency was measured with a transmission densitometer at seven evaluation periods. Statistical analyses (analysis of variance and Tukey's test) revealed that: distilled water presented higher translucency values (86.72%); Periogard demonstrated the lowest translucency values (72.70%); and Plax (74.05%) and Cepacol (73.32%) showed intermediate translucency values, which were statistically similar between them ($p > 0.01$). $NaHCO_3$ air-powder polishing increased the changes in translucency associated with the mouthrinses. Air-powder polishing alone had no effect on material translucency. Translucency percent was gradually decreased from 1 week of immersion up to 4 months. It may be concluded that the $NaHCO_3$ powder and the tested mouthrinses have affected the translucency of microfilled composite resin, according to the tested time.

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CLINICAL SIGNIFICANCE

During the last decade, the demand for composite resin restorations has grown considerably, however, controversy persists regarding the effect of surface roughness on color stability.

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INTRODUCTION

The outstanding development of adhesive dentistry coupled with strong esthetic demands from patients has resulted in an increasingly widespread use of resin composites in dental practice,[1] aiming to reproduce, as reliable as possible, the characteristics and appearance of lost dental tissue.[2] Despite the notable improvement in their composition and characteristics, the esthetics of resin composite restorations can be changed over time, because it is subject to a great number of adverse conditions that challenge its integrity and longevity.[1]

The contact of restorative materials with certain products, such as cigarettes, beverages, and mouthrinses, may negatively affect the esthetic and physical properties (microhardness,[1,3] surface roughness,[1] and translucency[2]) of the composites, thereby undermining the quality of restorations.[1,3–5] The extent of the damage on restorative materials and their longevity depend on the intrinsic features of composites, such as their chemical composition,[4,6] liquid absorption,[7] and consequent stain retention,[8] or even external features, such as the surface condition.[9]

Over the last few years, the regular use of mouthrinses has been quite widespread among dental patients. Even though these solutions may be effective for controlling and reducing plaque and gingivitis,[10] their influence in esthetic restorative materials are questionable, mainly because of the presence of colorants in their composition.[11] These dyes can be absorbed as a consequence of water or liquid absorption by the restorative materials, thus affecting the esthetic appearance of the restoration. Additionally, the mouthwashes may contain alcohol in raised percentages, and other ingredients such as detergents, emulsifiers, and organic acids.[12] These components can cause degradation and softening,[3,13] favoring the retention of dyes and internal discoloration of restorative materials. Both alcohol-containing and alcohol-free[4] mouthwashes can affect the microhardness of composite resins.[14] Because of these factors, staining of restorations may occur in a short period of time.[2]

Staining of a restorative material promotes color changes on its surface, and a restoration may become visually unacceptable.[15] Furthermore, dye retention may also affect the translucency rate because this characteristic is established by the optic density of restorative material. In other words, this property is attributed to the amount of light that passes through the material in such a way that greater optic density results in greater opacity of the material, thus decreasing the translucency. [2]

The retention of dyes can be influenced by other factors, such as the surface conditions of the restoration.[9] Many common procedures in dental practice, such as the use of air-powder polishing, promote alterations on the surface of dental materials contiguous with the tooth structure.[16–23] The $NaHCO_3$ powder is an instrument that has been widely employed because less time is required for adequate plaque and stain removal, especially when compared with prophylaxis paste.[21] Though efficient in stain and plaque removal, the air-powder polishing promotes a rough surface on restorative dental materials, such as glass ionomer cements and resin composites, favoring the retention of dyes[24] and decreasing their translucency.

The current study sought to evaluate the effect of the $NaHCO_3$ powder, used for prophylaxis, on the translucency of a microfilled composite resin immersed in different mouthrinses.

MATERIALS AND METHODS

Experimental Design

The factors examined comprised *surface treatment* at two levels: (1) specimens were air-polished with a bicarbonate-based dental powder and (2) specimens received no treatment (control); the *immersion solution* at four levels: distilled water (control), Plax, Cepacol, and Periogard; and *evaluation period* at seven levels. Brand names, basic compositions, and pH for the tested mouthrinses are indicated in Table 1.

Preparation of Specimens

Eighty disk-shaped specimens were prepared with a microfilled composite resin (Durafill VS, Heraeus Kulzer GmbH & Co. KG, Hanau, Germany), using a stainless steel mold (10 mm in diameter and 2 mm thick). The mold was placed onto a glass plate with the upper and lower surfaces covered with Mylar matrix strips.

The composite resin of A2 shade was placed into the mold in a single increment. To compact the material, a microscopic slide with a 1.650 g weight was placed over the resin/mold assembly. After 30 seconds, the weight was removed and the resin composite was light polymerized at output power of 450 mW/cm^2 using a curing unit (Jet Lite 4000, Los Angeles, CA, USA). The polymerized specimens were then removed and maintained for 24 hours in 100% relative humidity at 37°C.

TABLE 1. BRAND NAMES, BASIC COMPOSITIONS, pH, AND COLOR FOR THE TESTED MOUTHRINSES.

Materials	Composition	pH	Color	Alcohol percentage
Distilled water	—	7.0	—	—
Plax	Aqua, sorbitol, alcohol 8.7%, glycerin, sodium laurel sulfate, sodium methyl cocoyl taurate, PVM/MA (copolymer of methyl vinyl ether and maleic anhydride), aroma, disodium phosphate, sodium fluoride, sodium hydroxide, triclosan, sodium saccharin, CI 16035	7.0	Red	8.7
Cepacol	Cetylpyridinium chloride, mentol, alcohol 14.5%, glycerin, water, blue dye n°5, green dye, metil salicylate, mint oil, sodic saccharine, mentol crystallized	7.0	Green	14.5
Periogard	Chlorhexidine gluconate 0.12%, water, glycerin, alcohol 11.6%, polysorbide 20, aroma, sodium saccharin, colorant Blue #1	5.8	Blue	11.6

Surface Treatment

After 24 hours, the 80 disk-shaped specimens were assigned into two groups according to the surface treatment. In the experimental group, specimens were air-polished with a bicarbonate-based dental powder, adjusted to a 5-mm distance with inclination of 45°[22] for 10 seconds. In the control group, the specimens received no treatment. After surface treatment, the samples were soaked in distilled water at 37°C for 24 hours.

Immersion Protocols

The specimens of each group were randomly allocated into four subgroups ($N = 10$) according to the mouthrinses employed: Plax (Colgate/Palmolive, São Bernardo do Campo, SP, Brazil), Cepacol

(Aventis Pharma, São Paulo, SP, Brazil), Periogard (Colgate/Palmolive), and distilled water (control group). During 4 months, each sample was immersed in 20 mL of the respective solution for 1 minute under constant agitation in a magnetic agitator, 5 days per week, twice a day (with a 12-hour interval between exposures). After each immersion, specimens were washed and then stored in distilled water at 37°C.

Before the beginning the study, the pH of the tested mouthrinses was determined with a pH meter (digital pH meter model AS 720, electrode A 11489, Procyon, São Paulo, Brazil).

Translucency Measurements

The translucency values were obtained using the equipment JOUAN (Jouan, Paris, France—series 021 A/N° 10), a transmission densitometer, which measures the light radiation crossing the specimen. Light source with a tungsten filament (2,854K color temperature) excites the photoelectric cell, which in turn emits a signal to the galvanometer according to the degree of excitation from the light source, on a 0 to 100 scale, thereby indicating percentage of light that activated the photoelectric cell. This is the percent values of translucency. The measurements were performed at seven predetermined evaluation periods: T1—1 hour after sample preparation, T2—1 hour after surface treatment, T3—1 week after the first immersion in the solutions, and T4 to T7—1, 2, 3, and 4 months after the first immersion in the mouthrinses, respectively.

Statistical Analysis

After checking whether the assumptions of normality and homocedasticity had been met, translucency data were analyzed by analysis of variance and Tukey's test at 0.01 significance level.

RESULTS

An overview of the results reveals that, when the surface treatment was compared ($p < 0.01$), the experimental group (exposed to $NaHCO_3$ powder) showed lower translucency values (74.10%) than the untreated group (79.30%).

With regard to the solutions, the data revealed that Periogard was the solution that most altered the translucency of the tested composite resin (72.7%), being statistically different ($p < 0.01$) from distilled water (86.7%) and Plax (74.0%), and similar ($p > 0.01$) to Cepacol (73.3%). Cepacol (73.3%) demonstrated intermediate translucency values, which were statistically similar ($p > 0.01$) to that of Plax (74.05%).

Concerning the evaluation period, it was observed that, for the first and second measurements (T1 and T2), the translucency values were statistically similar and higher than the other periods. The translucency values decreased from T3 to T7 ($p < 0.01$). The interaction among solution, surface treatment, and evaluation period can be observed in Table 2.

Starting at T3 to T5, it was observed that specimens treated with $NaHCO_3$ powder and immersed in all mouthrinses, except the distilled water, showed translucency values lower than the untreated group ($p < 0.01$). Starting at T6, all specimens exposed to $NaHCO_3$, and immersed in Plax and Cepacol disclosed translucency values statistically similar among them and higher than those immersed in Periogard ($p > 0.01$). For the group nonexposed to $NaHCO_3$ powder, Cepacol showed the lowest translucency values, which were similar to Periogard and statistically different from Plax and distilled water ($p < 0.01$), which disclosed the highest translucency.

For T7 evaluation period, all specimens exposed to $NaHCO_3$ and immersed in Plax and Cepacol disclosed translucency values statistically similar among them and higher than those immersed in Periogard ($p > 0.01$). For the group not exposed to $NaHCO_3$ powder, Cepacol and Periogard showed the

TABLE 2. MEAN (STANDARD DEVIATION) OF TRANSLUCENCY VALUES OF MICROFILLED RESIN COMPOSITE IMMERSED IN MOUTHRINSES, EXPOSED OR NONEXPOSED TO THE $NaHCO_3$ POWDER.

	Exposed to $NaHCO_3$				Nonexposed to $NaHCO_3$			
	Plax	Periogard	Cepacol	Distilled water	Plax	Periogard	Cepacol	Distilled water
T1	88.1 (1.59)a	87.2 (1.03)a	87.6 (2.50)a	87.9 (1.37)a	87.8 (1.31)a	88.0 (1.24)a	88.0 (1.15)a	88.3 (0.94)a
T2	88.0 (1.05)a	87.0 (0.81)a	87.7 (1.33)a	88.0 (1.63)a	87.3 (1.15)a	87.5 (1.08)a	87.1 (0.73)a	87.9 (1.10)a
T3	71.8 (1.81)b	71.0 (1.88)b	74.6 (1.71)b	87.5 (1.84)a	82.8 (1.31)i	81.8 (1.03)i	81.6 (0 + 96)i	87.2 (1.22)a
T4	68.0 (1.15)c	66.8 (1.22)c	69.7 (1.94)c	87.3 (1.33)a	78.4 (0.69)k	76.4 (1.34)k	76.1 (0.99)k	86.6 (0.96)a
T5	64.3 (1.70)d	63.4 (1.64)d	65.6 (1.07)d	86.9 (1.44)a	75.0 (1.33)l	73.3 (1.49)l	71.3 (0.94)l	85.9 (0.99)a
T6	56.5 (1.64)e	54.0 (1.88)f	56.4 (2.27)e	85.6 (1.50)a	70.1 (0.73)m	68.0 (1.41)mn	66.4 (1.17)n	85.5 (1.08)a
T7	52.5 (2.54)g	50.5 (1.35)h	52.9 (1.79)g	84.9 (1.72)a	63.6 (1.77)o	62.9 (0.99)op	60.9 (1.19)p	85.1 (1.19)a

Means followed by different letters represent statistical differences.

lowest translucency values, revealing similarity between them. Plax and distilled water disclosed the highest translucency values at this time ($p < 0.01$).

DISCUSSION

This study was conducted to determine the effects of air-powder polishing and three commercial mouthrinses on the translucency of a microfilled composite resin. The esthetics and longevity of tooth-colored restoratives are highly dependent on their surface characteristics.[23] Dye retention may be a consequence of water or liquid absorption by restorative material[7] and the surface condition.[9]

This study demonstrated that use of air-powder polishing increased the changes in translucency associated with mouthrinses, decreasing the translucency values. Other studies have demonstrated the relationship between surface roughness and staining of restorative materials.[9,20] The probable explanation for our results may be ascribed to the rough surface of resin composite promoted by the use of air-powder polishing, which may have increased the retention of dyes. According to Catirse et al.,[24] as the staining increases, the material becomes cloudier, and consequently, lower translucency values may be observed. When black backings are used, an increase in opacity may result in an enhanced lightness, while a decrease in opacity may result in a lower lightness.[15] In a more opaque specimen, more light will be reflected back. But, in a less cloudy specimen, less light will penetrate the material, thus being highly absorbed by the black backing.[15]

With respect to mouthrinses tested, it was observed that Periogard showed the lowest translucency values, which were statistically similar to Cepacol. Cepacol demonstrated intermediate translucency values, which were statistically similar to Plax. Plax showed the highest translucency values among the experimental groups. It may be explained by the alcohol content and pH of tested mouthrinses. Cepacol and Periogard have an alcohol content of 14.5% and 11.6%, and pH 7.0 and pH 5.8, respectively, whereas Plax has a pH 7.0 and lower alcohol content (8.7%). It might be assumed that the pH of the solutions seems to affect degradation of composite materials, probably in terms of matrix decomposition and filler leakage.[25] The degradation process is associated with the swelling of the matrix during the sorption process.[3] If sorption is increased, the retention of dyes can be favored.

There is limited information as to whether the alcohol content of mouthrinses can negatively affect dental composites.[3] Studies report that ethanol may cause softening of esthetic restorative materials.[3,12,14] However, Gurgan et al.[14] found that both alcohol-containing and alcohol-free mouthrinses affect the hardness and translucency of resin composites.[2] The presence of alcohol in some chemical solutions may be considered as a triggering factor of restorative materials staining.[26,27]Alcohol probably acts as a facilitating agent for dye penetration into the resin.[2] Thus, future studies should compare chlorhexidine with and without alcohol.

Gurdal et al.[10] reported that mouthrinses with various pHs and alcohol contents have no effect on the microhardness and color stability of esthetic restorative materials. However, the treatment method used (immersion of all samples in the mouthrinses for 12 uninterrupted hours) was completely different from the protocol used in the current study. The exposure protocol employed in our study sought to simulate regular mouthrinse application by the patient. A fact that may be elucidated is that the immersion time proposed for chlorhexidine was intensified to standardize the protocol for all mouthrinses, thus caution in extrapolating the results to the in vivo situation is needed.

According to Göpferich,[28] the degradation process and liquid sorption are dependent on the hydrophilicity of the polymer matrix and location of hydrolysable groups on the matrix chains. In this study, the tested resin composite has little filler content, thus a high sorption rate was expected. Another aspect that must be considered is the fact that only one resin composite was evaluated, and, most likely, other materials would behave differently.

Concerning the evaluation periods, it was demonstrated that, for all tested groups, the translucency values were high and statistically similar for T1 and T2 periods. Starting at T3 to T7 period, translucency values were gradually decreasing. The first and second measurements were obtained after sample preparation and after exposition to air-powder polishing, respectively, and no immersion had been done. However, the period comprised from T3 to T7 corresponds to the immersion in mouthrinses, exactly when the translucency change started.

It is important to note that, in vivo, the pattern of the effect of mouthrinses on restorative materials is the result of a complex reaction among different chemicals, being dependent on many factors that could not be replicated in vitro.[10] Additionally, in vivo patients use toothpaste daily, which would affect surface stain and could improve the situation. So, it is not reasonable to indicate or to contraindicate the use of air-powder polishing or a mouthrinse based only on the translucency values obtained in the current study. However, the possibility of change in composite appearance associated with the use of mouthrinses, especially when combined with air-powder polishing, cannot be discounted.

Future research is needed to elucidate whether this is solely a surface phenomenon or throughout the body of the material.

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