Original Article

In-Vitro Effect of Alcohol and Non-Alcohol Mouthwash on Color Change of Two Types of Bleach Shade Composite

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ABSTRACT

Background and Aim: The purpose of this study was to examine the effect of alcohol and non-alcohol mouthwashes on the color change of two types of bleach shade composite.
Materials and Methods: Twenty-two samples of IPS empress direct composite (Ivoclar Vivadent, Schaan, Liechtenstein) and 22 samples of Vitalescence snow white composite (Ultradent Products, South Jordan, UT, USA) were prepared in 10 mm diameter and 2 mm thickness. The specimens were polished with Sof-Lex (3M ESPE, USA) abrasive papers in supra fine, fine, and medium sizes. The specimens were then stored for 24 hours in distilled water at 37°C, and an initial colorimetric assay was performed using SP64 spectrophotometer. Samples were randomly divided to be placed in 20 ml of alcohol and non-alcohol Listerine mouthwashes and were incubated at 37°C for 24 hours. The color of the specimens was again measured, and color change (ΔE) was calculated. Data were analyzed using two-way analysis of variance (ANOVA) at 95% confidence level.
Results: None of the mouthwashes caused clinically significant discoloration in the samples. The effect of both mouthwashes on composite discoloration was statistically significant (P=0.0001), and the interaction between the mouthwash and type of restorative material was significant (P=0.0001).
Conclusion: IAccording to the findings of this study, alcohol mouthwashes cause more discoloration in composite resins.

Keywords: Color, Resin Composite, Mouthwash

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Introduction:

Nowadays, dental composites are widely used in dentistry because of their esthetics. Patients' increasing demand for resin composites with so-called bleach shades has led to a variety of this type of composites.[(1)]

One of the features of cosmetic restorations is their long-lasting color durability. The success of cosmetic restorations is first due to the natural color similar to the teeth and then to their color stability.[(2)]

However, several resin composites, despite their small filler size, polishability, and acceptable visual properties, due to the nature of their resin matrix, absorb more water than ceramic materials and are subject to the influence of colorants.[3] The unpredictable discoloration is one of the common causes that lead to the replacement of resin composites.[4]

Generally, the color change of composites is divided into two types of internal and external color changes; internal color changes are caused by physical and chemical reactions in the inner layers of the restorative material, and external color changes are due to the consumption of colored food and drinks, smoking, and poor oral hygiene.[2]

To prevent and treat periodontal disease and for effective caries control and due to the difficulties in achieving an acceptable level of bacterial plaque control mechanically, the use of chemical agents as a supplement is recommended; the simplest of chemical agents are mouthwashes.[5]

It has been suggested that alcohol in mouthwash may soften the composite and cause discoloration of the material.[6] Previous studies on the color stability of composites have shown that beverages and mouthwashes have different levels of coloring on these restorative materials, and the coloring potential of these beverages and solutions varies according to their composition and properties.[7]

The purpose of this study was to investigate the effect of alcohol and non-alcohol mouthwashes on the color change of two types of bleach shade composites by an in-vitro method.

Materials and Methods

This experimental study was performed on an in-vitro model. Twenty-two composite samples from IPS empress direct composite (BLL; Ivoclar Vivadent, Schaan, Liechtenstein) and 22 samples of Vitalescence snow white composite (SW; Ultradent Products, South Jordan, UT, USA; Table 1) were prepared in plastic molds, 10 mm in diameter and 2 mm in thickness, such that a sufficient amount of composite was inserted into the mold and then compressed from both sides of the mold by 1-mm-thick glass slabs to prevent air retention.[8]

Then, each specimen was light-cured for 40 seconds on each side with an overlapping method using a light-emitting diode (LED) light-curing unit (sup2, 420 nm-480 nm, Woodpecker, China). The output intensity was checked before each curing time by a radiometer at an intensity of 850-1000 mW/cm2.

For standardization, all samples were polished with Sof-Lex abrasive papers (3M ESPE, USA) in supra fine, fine, and medium sizes with five motions for each side.[8]

Composite samples were divided into 4 groups (n=11) including:

- Two groups of 11 IPS empress direct bleach shade composite samples (BLL; Ivoclar Vivadent, Schaan, Liechtenstein).
- Two groups of 11 Vitalescence snow white composite (SW; Ultradent Products, South Jordan, UT, USA).

Table 1-Characteristics of composite filler particles

	BLL Composite IPS empress direct (Ivoclar Vivadent, Schaan, Liechtenstein)	SW Composite Vitalescence snow white (Ultradent Products, South Jordan, UT, USA)
Volume percentage of filler	77%	75%
Weight percentage of filler	57%	52%
Filler size	0.25 µm	0.7 µm
Composite monomer	Dimethacrylates	BIS-GMA

The samples were then stored for 24 hours in distilled water at 37°C to complete the polymerization, and a primary colorimetric assay of the samples was performed on a standard background using SP64 spectrophotometer (X-Rite Inc., Michigan, USA).[5]

Immersion of cured specimens in mouthwash solutions:

After completion of polymerization, each sample was randomly divided to be placed in 20 ml of alcohol-containing and alcohol-free Listerine mouthwashes (Johnson & Johnson Ltd., Maidenhead, UK). The compounds in both mouthwashes were identical and were only different in terms of alcohol (Table 2). The pH of the mouthwash solutions was measured by a pH-meter (MTT 65, Teb-Azma Co., Iran).

Table 2. Content and pH of the studied mouthwashes

Content \ Mouthwash	Listerine 1	Listerine 2
Menthol (%)	0.042	0.042
Thymol (%)	0.064	0.064
Methyl salicylate (%)	0.06	0.06
Eucalyptol (%)	0.092	0.092
Alcohol (%)	26.9	------
pH	3.4	3.7

The specimens were then packed in the mentioned solutions in capped containers to prevent evaporation, and the dishes were stored in an incubator set at 37°C for 24 hours, equivalent to daily use of mouthwash for one year.[8]

After 24 hours of immersion, the samples were rinsed with distilled water for 5 minutes and dried using a cloth before color measurement. [1]

The values of Δa, Δl, and Δb in each medium were calculated by subtracting the values of a, b, and l in that medium from the similar values in the initial measurement step. Also, ΔE00 in each medium was calculated using Δa, ΔL, and Δb of that medium according to the below formula: [5,9]

$$\Delta E_{00}' = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \frac{\Delta C'}{k_C S_C}\frac{\Delta H'}{k_H S_H}}$$

Two-way analysis of variance (ANOVA) was used to evaluate the effect of mouthwash and composite type on the amount of discoloration in the present study using SPSS software (version 22; SPSS for Windows, SPSS Inc., Chicago, IL, USA). Then, the mean values were compared using Tukey's honestly significant difference (HSD) test at 95% confidence level.[1,5]

Results:

According to the results of the two-way ANOVA test, the effect of composite type and mouthwash on the color change of the composites was statistically significant (P=0.0001 and 0.0001, respectively).

With the alcohol mouthwash, the discoloration difference between the two composites (BLL and SW) was statistically significant (P=0.0001) such that the mean discoloration in SW composite (ΔE=3.20±0.56) was more than that of BL composite (ΔE=0.27±0.08). Also, with the non-alcohol mouthwash, the discoloration difference between the two BLL and SW composites was statistically significant (P=0.0001) such that the mean color change in BLL composite (ΔE=1.65±0.43) was more than that of SW composite (ΔE=0.36±0.08; Tables 3 and 4; Figure 1).

Table 3. Mean and standard deviation (SD) of primary color components in the studied groups

Groups \ Parameters	L Mean±SD		a Mean±SD		b Mean±SD	
	Primary	Final	Primary	Final	Primary	Final
BLL composite in alcohol mouthwash	84.55±0.62	85.15±0.64	1.88±0.20	1.95±0.17	4.64±0.60	4.78±0.52
BLL composite in non-alcohol mouthwash	84.66±0.46	84.33±0.56	2.06±0.09	3.21±0.25	5.14±0.41	4.41±0.49
SW composite in alcohol mouthwash	80.24±0.32	80.27±0.41	0.16±0.14	2.34±0.44	7.26±0.32	6.03±0.30
SW composite in non-alcohol mouthwash	79.98±0.61	80.85±058	0.12±0.20	0.25±0.20	7.33±0.37	7.24±0.32

Table 4. Discoloration in the studied groups

Groups \ Color change	SD±Mean	P-value
BLL composite in alcohol mouthwash	0.27±0.08	P=0.0001
BLL composite in non-alcohol mouthwash	1.65±0.43	
SW composite in alcohol mouthwash	3.20±0.56	P=0.0001
SW composite in non-alcohol mouthwash	0.36±0.08	

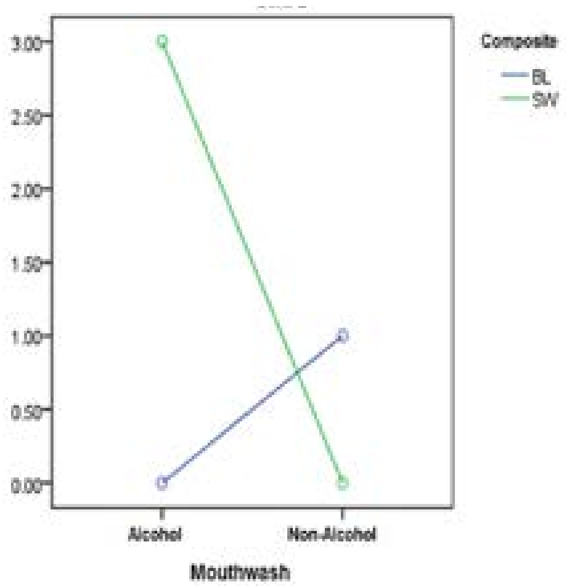

Figure 1. Average color change (ΔE) of composites with the alcohol-containing and non-alcohol mouthwashes

Discussion

This study aimed to examine the effect of alcohol and non-alcohol mouthwash (Listerine; Johnson & Johnson Ltd., Maidenhead, UK) on the color change of two composites (IPS empress direct bleach shade and Vitalescence snow white).

The amount of ΔE in both composites after placement in the mouthwash solution (equivalent to one year of daily use for 4 minutes) was statistically significantly different from the initial colorimetry; however, this discoloration was within the acceptable range. Regardless of the composite type, the amount of discoloration with the alcohol mouthwash was higher than that with the non-alcohol mouthwash. The highest discoloration with the alcohol mouthwash was in SW composite, and the highest discoloration with the non-alcohol mouthwash was detected in BLL composite.

The results showed that the discoloration of BLL and SW composites was clinically acceptable ($\Delta E < 3.3$). A study by ElEmbaby in 2014 showed that the discoloration of IPS Empress direct composite was the lowest and clinically acceptable in comparison with Z350 XT and Tetric EvoCeram composites in different mouthwashes;[5] this is in line with the results of our study. The difference in the color change of composites can be due to differences in the composition and the type of resins used in their structure.[10]

The chemical characteristics of the resin and the cross-linking degree can influence the water sorption of composites.[11,12] Water sorption can cause expansion and plasticization of the components, hydrolysis of silane-coupling agents, loss of bonds between the filler and resin matrix, and formation of micro-cracks, leading to internal color change in the composite.[5]

The presence of BIS-GMA and TEG-DMA monomers in the resin matrix can cause more water sorption and discoloration in composites with this type of resin matrix, which is clinically unacceptable. (11,13) According to Table 1, the presence of BIS-GMA in SW composite may justify further color change in this group.

Cavalcanti et al showed that the size and the density of inorganic fillers could contribute to the resistance of the composite to discoloration.[12] Chakravarthy and Clarence concluded that the smaller size and the higher density of fillers render a more polishable and smoother composite. The smoothness of the composite surface plays an important role in its resistance to surface discoloration.[14] In another study, Omrani et al reported excellent polishability and consequently less pigmentation in the nanofiller composite group compared to the microhybrid composites, which may be due to the small size of nanofillers.[15]

According to Table 1, the weight and volume percentage of the filler in BLL composite is slightly higher than that of SW composite and may be a reason for less discoloration. On the other hand, the small size of the filler in BLL composite increases the chance of abrasion and surface degradation, and this composite is susceptible to surface filler loss and further pigment accumulation, which may be the reason for the external color change. The large size of the composite fillers can influence their vulnerability when exposed to mouthwash solutions and may be a reason for the higher discoloration of SW composite.(5)

One of the factors affecting the internal color change of composites can be the type of photoinitiator. ElEmbaby reported that the photo-initiator type of IPS composite was the reason for less color change of this composite compared to the other groups. In IPS composite, the chemical initiator is Lucirin TPO, which absorbs light energy in the lower range of visible light and results in a decrease in the intensity of color yellow in the composite. In most composites, the photoinitiator is a yellow dye called camphorquinone. Light absorption by camphorquinone initiates composite polymerization. It also changes color with the absorption of light. If the polymerization is incomplete, yellow camphorquinone can cause composite discoloration.(5)

Another factor affecting the color change of composites is the pH of the medium or the environment in which the material is housed. Chakravarthy and Clarence reported that the pH of the environment can influence the surface properties of the composite and can lead to more discoloration.(14) Tantanuch et al showed that red wine results in more surface damage to resin composites compared to white wine due to higher alcoholic content and lower pH.(13) Alcohol-containing Listerine mouthwash has a lower pH because of its high benzoic acid and alcohol content. These contents greatly increase the degradation of the resin composite structure over time; this is a complex process that results in the disintegration of the polymeric composite matrix and causes major problems such as filler separation from the polymeric matrix, matrix collapse, release of residual monomers, wear of the composite surface, and discoloration.(15,16) Ceci and colleagues concluded that the solubility of composites in non-alcohol mouthwashes is lower compared to alcohol mouthwashes.(17) Laboratory studies have simulated the surface degradation of resin composites by keeping them in ethanol and have detected that the mechanical properties of the composites were jeopardized in alcohol-containing solutions.(17,18)

According to Table 2, the concentration of alcohol in the mouthwash in this study was 21.6% and pH=3.4, which is very high and may be a justification for further discoloration in this group.

The results of research by Pelino et al were inconsistent with our results.(19) They reported that prolonged placement of composite and enamel in alcohol-containing mouthwash solutions does not alter their morphology, ultrastructure, and biomechanical properties; this difference in the results may be due to the shorter duration of exposure of composite to mouthwash and different composite type in the cited study.(19)

In their study of alcohol-containing and alcohol-free mouthwashes, Werner and Seymour reported that these two types of mouthwashes did not differ in efficacy, and because of the nature of alcohol-based mouthwashes and the risk of cancer, they should be avoided; the risk cannot be estimated.(20)

It should be borne in mind that the oral environment is different from the laboratory environment. Factors such as dietary diversity, saliva, and the relationship between these factors can cause and intensify discoloration. From among these factors, saliva can reduce the discoloration by diluting and neutralizing the pH of mouthwash solutions, which lead to a decrease in the resin matrix softening and the formation of pellicle on the surface of composite restorations.(15) Considering these factors, further studies are needed to determine the effect of mouthwash solutions and toothpastes on the discoloration of composite restorations.

Conclusion:

According to the results of the present study as well as studies on composite discoloration and cancer risk with consumption of alcohol-containing mouthwashes, the use of non-alcohol mouthwashes is recommended.

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