Original Article

Effect of a whitening mouthwash containing blue covarine on enhancing tooth and composite resin discolorations

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Abstract

Objective: This study examined the impact of a blue covarine whitening mouthwash on enhancing the color of stained composite resin specimens and teeth.

Methods: This in vitro study involved a total of 72 specimens including 36 human incisors and 36 disks prepared from a resin composite. The specimens in each group were randomly distributed to three subgroups (n=12) according to the applied mouthwash: Listerine, iWhite and a control group. Control specimens were maintained in distilled water throughout the study. The remaining specimens were immersed in a coffee solution for two weeks, then treated with either Listerine (containing hydrogen peroxide) or iWhite (containing blue covarine) mouthwashes. The immersion lasted for four minutes daily over 56 days. Color assessment was performed by a spectrophotometer at baseline (T1), post-staining (T2), and post-mouthwash immersion (T3) and color change (ΔE) between stages was calculated.

Results: Significant discoloration was observed after immersion in coffee solution in the experimental groups as compared to the control ($P<0.05$). The color change between baseline (T1) and after immersion in mouthwashes (T3) was not significantly different between the two experimental groups on tooth samples ($P=0.12$). However, ΔE (T_1-T_3) was significantly lower in iWhite ($\Delta E=2.27$) than the Listerine mouthwash ($\Delta E=4.99$) on composite specimens ($P<0.001$).

Conclusions: Both hydrogen peroxide- and blue covarine-containing mouthwashes showed comparable effects in restoring tooth discolorations, although the color changes were detectable after treatment ($\Delta E > 3.3$). The mouthwash containing blue covarine (iWhite) restored the original color of composite resin specimens more successfully than the mouthwash containing hydrogen peroxide (Listerine).

Keywords: Bleaching, Blue covarine, Color, Composite resin, Mouthwash, Tooth discoloration

Introduction

Within the past few years, there has been an increasing interest in cosmetic procedures in the field of restorative dentistry (1). Tooth discoloration can significantly impact smile esthetics and oral health-related quality of life (2). Consequently, there is an increased demand for teeth whitening procedures and tooth-colored restorations (3, 4).

Composite resins, favored for their esthetic appeal and compatibility with tooth structures, are commonly used for cosmetic restorative procedures. Composite resins exhibit pleasing esthetics immediately after treatment, but they are prone to discoloration under oral conditions, leading to esthetic mismatch and the need for costly and time-consuming replacements (4, 5). This discoloration results from external factors like tobacco, food colorants, beverages, poor oral hygiene, and internal factors related to the properties of enamel, dentin, and the resin itself (3-5).

Tooth bleaching is a cosmetic, safe and effective dental treatment. There is a variety of tooth-whitening products such as strips, pens, mouthwashes, and toothpastes, that are available over-the-counter (OTC) for unprofessional use (1, 6).

Mouthwashes have gained popularity not only for chemical plaque control but also for tooth-whitening purposes, due to their affordability, availability, and ease of use (7). Peroxide is a common whitening agent that is used in whitening products (8). Whitening toothpaste and mouthwashes sometimes contain blue covarine, which adheres to enamel, creating an optical illusion of whiter teeth (8). However, the effectiveness of these OTC

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Table 1. Composition of the materials used in this study

Material	Commercial name	Manufacturer	Compounds
Composite resin	Estelite Asteria	Tokuyama Dental Corporation, Tokyo, Japan	Matrix: Bisphenol A-glycidyl methacrylate (Bis-GMA), Bisphenol A-polyethoxy methacrylate (Bis-MPEPP), Triehtylene glycol dimethacrylate (TEGDMA), Urethane dimethacrylate (UDMA) Filler: 200 nm spherical silica-doped zirconia (SiO2-ZrO2)
Mouthwash	iWhite Instant	Sylphar, Belgium	Water (Aqua), Glycerin, Sodium hexametaphosphate, PEG40 hydrogenated castor oil, Phthalimido-peroxy caproic acid, Aroma, Diazolidinyl urea, Sodium benzoate, Potassium sorbate, Citric acid, Xanthan gum, Acesulfame, Potassium, Copper phthalocyanine, Sodium laureth sulfate, O-phenylphenol, Sodium fluoride (220 ppm F^-).
Mouthwash	Listerine® TOTAL CARE	Johnson & Johnson S.P.A, Pomezia, Italy	Water (Aqua), Sorbitol, Propylene glycol, Poloxamer 407, Sodium sulfate, Phosphoric acid, Eucalyptol, Methyl salicylate, Thymol, Sodium benzoate, Sodium saccharin, Menthol, Sucralose, Disodium phosphate, Hydrogen peroxide

products in bleaching teeth are often debated due to potential misuse and insufficient evidence about the multiple products available in the market.

The present study aimed to assess the effectiveness of a whitening mouthwash containing blue covarine in correcting the color of discolored resin composite and teeth specimens.

Material and Methods

The protocol of this *in vitro* study was approved by the ethics committee of Zanjan University of Medical Sciences (IR.ZUMS.REC.1400.010). This study involved 36 extracted human maxillary and mandibular incisors and 36 disc-shaped samples made of a composite resin (Estelite Asteria; Tokuyama Dental Corporation, Tokyo, Japan). Table 1 presents the characteristics of the materials utilized in the study.

The obtained teeth were intact and did not have any cracks, fractures, carious lesions, or structural defects. Teeth were disinfected in a 10% chloramine solution for one week. They were then scaled and cleaned using pumice and a rubber cap. To prepare the composite resin discs, a cylindrical mold measuring 8 mm in diameter and 2 mm in height was placed on a glass plate, and lined with polyester tape. The resin composite was then placed in the mold and covered with another polyester tape. The excess material was removed by applying a 3 kg weight. The specimens were polymerized with a light cure device (LED, Woodpecker, China) for 20 seconds at 850 mW/cm^2. Subsequently, the samples were washed, dried, and incubated in distilled water at 37°C for 24 hours to complete polymerization. Samples with a thickness variation of more than 0.05 mm were discarded. The composite specimens were polished using a multistep polishing system and a low-speed handpiece with moderate pressure, under frequent rinsing and drying.

The initial color of the samples (either teeth or composite specimens) was measured using a spectrophotometer (spectroshade, Hondy Dental type, Verona, Italy) (T_1). The samples were then randomly divided into three subgroups (n=12): 1. Listerine mouthwash containing hydrogen peroxide (Listerine® TOTAL CARE; Johnson & Johnson S.P.A, Pomezia, Italy), 2. iWhite mouthwash (containing blue covarine) (iWhite Instant; Sylphar, Deurle, Belgium), and, 3. Negative control group (distilled water).

The negative control group was immersed in distilled water throughout the experiment. The samples in groups 1 and 2 were placed in a coffee solution at 37°C for 14 days, prepared by boiling 3 grams of Turkish coffee powder in 250 ml water for 10 minutes. The solution was refreshed daily. After 14 days, samples were washed and color assessment was performed again (T_2).

Subsequently, the stained samples were immersed in either iWhite or Listerine mouthwashes for 4 minutes daily over 56 days. After each whitening treatment, the samples were washed and stored in distilled water at 37°C. The final color measurement was conducted after 56 days (T_3) (9-12).

For color assessment, the L*, a*, and b* values were recorded at T_1, T_2, and T_3 time points. Color alterations were calculated according to the following formula: $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

Table 2. Mean and standard deviations (SD) of color change (ΔE) values between treatment stages in the study groups

Sample type	Group	ΔE (T_1-T_2) Mean ± SD	ΔE (T_2-T_3) Mean ± SD	ΔE (T_1-T_3) Mean ± SD
Composite resin	iWhite mouthwash	7.68 ± 0.59[a]	5.66 ± 0.75	2.27 ± 0.58
	Listerine mouthwash	8.90 ± 1.22[a]	5.52 ± 1.01	4.99 ± 1.42
	Negative control	1.68 ± 0.25[b]	-	-
	P-value	<0.001	0.70	<0.001
Tooth	iWhite mouthwash	6.70 ± 3.04[a]	3.56 ± 1.53	4.77 ± 1.90
	Listerine mouthwash	5.94 ± 1.82[a]	5.18 ± 2.41	5.86 ± 1.34
	Negative control	1.27 ± 0.61[b]	-	-
	P-value	<0.001	0.06	0.12

T_1: Color at the baseline; T_2: Color after staining; T_3: Color after immersion in whitening mouthwash

Data normality was verified using the Kolmogorov-Smirnov test (P>0.05). One-way ANOVA, Tukey test, and independent samples t-test were used for statistical analysis. The analysis was performed by SPSS 16.0 software (SPSS, Chicago, IL, USA) and the significance level was set at P<0.05.

Results

Table 2 presents the color changes (ΔE) in the study groups between different time intervals.

Color changes in composite resin specimens

There was a significant difference in ΔE (T_1-T_2) among the study groups (P<0.001; Table 1). According to the Tukey test, the control group showed a significantly lower color change than both experimental groups (P<0.05). Immersion of composite specimens in iWhite and Listerine mouthwashes caused color changes of 5.66 ± 0.75 and 5.52 ± 1.01, respectively. According to the statistical analysis, this difference was not significant (P=0.70; Table 1).

Comparison of color changes between baseline (T1) and after immersion in mouthwashes (T3) revealed a significant difference between the experimental groups, with the iWhite showing a significantly lower ΔE (T_1-T_3) than the Listerine group on composite resin specimens (P<0.001; Table 1).

Color changes in teeth

There was a significant difference in ΔE (T_1-T_2) among the study groups (P<0.001; Table 1). According to the Tukey test, the control group indicated a significantly lower color change than the experimental group (P<0.05). Immersion of teeth in iWhite and Listerine mouthwashes caused color changes of 3.56 ± 1.53 and 5.18 ± 2.41, respectively. Although ΔE ($T_2 - T_3$) was greater in the Listerine than in the iWhite group, the difference was not statistically significant (P=0.06; Table 1).

Comparison of color changes between baseline (T1) and after immersion in mouthwashes (T3) revealed no significant difference in ΔE (T_1-T_3) among the experimental groups on tooth samples (P=0.12; Table 1).

Discussion

The present study evaluated the effect of whitening mouthwashes on the color of teeth and composite restorations. Color determination in dentistry is achieved either visually or with devices like spectrophotometers, which offer more precision by eliminating human error (13). In this study, color measurements were conducted using a spectrophotometer and the CIE L*ab** color system. It is worth mentioning that ΔE values below 1 are undetectable to the human eye, while values between 1 and 3.3 are noticeable to experts, and values above 3.3 are visible to laypeople (14).

The finishing and polishing of composite resin impact its optical properties, mechanical strength, and longevity (15). Untreated composite surfaces are more prone to color changes (16). Therefore, a multi-step polishing system was applied in this study for polishing the composite samples.

The findings of this study revealed that coffee staining significantly altered the color of both composite and tooth samples (ΔE>3.3). The outcomes of this study align with other research indicating significant color alterations in composite resin and the enamel due to coffee (17, 18). The coffee's concentration, temperature, duration of exposure, and the type of composite resin influence the degree of staining. The 14-day coffee immersion in our study simulated approximately 12 months of daily coffee consumption (19).

Estelite Asteria composite resin was utilized in this study, containing various components such as bisphenol A-polyethoxy methacrylate (Bis-MPEPP), triehtylene glycol dimethacrylate (TEGDMA), urethane dimethacrylate (UDMA), and Supra-nano fillers (200 nm spherical SiO2-ZrO2). According to previous studies, composite resins containing UDMA and nanofillers are

less prone to discoloration compared to micro-hybrid resin composites (20, 21).

In the present study, the difference in ΔE (T_2-T_3) between iWhite (containing blue covarine) and Listerine (containing hydrogen peroxide) was minor and statistically insignificant in composite resin groups. However, a comparison of ΔE values from the baseline (T_1) to after immersion in whitening mouthwashes (T_3) revealed significant differences between the experimental groups, with the iWhite group showing a less pronounced color difference ($\Delta E<3.3$) compared to Listerine. This indicates that iWhite is more effective in returning the color of stained composite resin to its baseline state.

In tooth samples, both types of mouthwash demonstrated comparable levels of color alterations between different treatment stages. The ΔE (T_1-T_3) in both groups was greater than the threshold limit of 3.3, implying that tooth discoloration would be detectable at the end of the treatment period even after using whitening mouthwashes. Although whitening mouthwashes were effective in color alteration of discolored teeth, they were not capable of restoring the original color of tooth samples.

Listerine contains hydrogen peroxide, which improves color by breaking down organic pigments (4). iWhite mouthwash, which is alcohol and hydrogen-peroxide-free, uses blue covarine for an optical whitening effect (9). Previous studies corroborate that blue covarine imparts a whiter appearance to teeth immediately after use (9). Sodium hexametaphosphate in iWhite is also recognized as an effective whitening agent (22), and phthalimido-peroxy caproic acid contributes to whitening through oxidation (23).

Our results are to some part consistent with studies performed by Yazdi et al. (4) and Oliveira et al. (24), who found that Listerine effectively whiten both composite resins and teeth. Harorlı and Barutcigil (9) and Crastechini et al. (25) examined the impact of various whitening types of mouthwash on the color alteration of composite resins. These studies revealed that mouthwashes, which contain ingredients like hydrogen peroxide, blue covarine, and sodium hexametaphosphate, demonstrated a reduction in the discoloration of composite samples (9, 25), similar to that found in this study.

In contrast to the findings of this study, Gürdal et al. (26) reported no significant difference in color stability between mouthrinses and distilled water. Alavi et al (27) found that significant color recovery was only achieved with the Zenon Smart White mouthrinse (containing pyrophosphate and triphosphate), as compared to Signal White Now (containing blue covarine) and Pasta del Capitano Whitening (containing Plasdone). Çam et al. (28) found that the whitening mouthrinses tested in their study did not significantly change the color of Bis-GMA-free composite resin during the immersion period. The discrepancy between the results of previous studies may be due to variations in sample types, staining solutions, active agents of mouthrinses, and mouthwash application methods.

It is important to note that *in vitro* studies cannot fully replicate oral conditions. Numerous factors such as dietary habits, pellicle formation, and saliva are challenging to simulate in laboratory settings. Future in vitro and in vivo research would provide a more comprehensive understanding of whitening products' mechanisms of action and effectiveness. Further studies could also focus on the preventive capacity of these mouth rinses against tooth staining.

Conclusion

The findings of this study demonstrate that both iWhite and Listerine mouthwashes had comparable effects in whitening tooth samples. However, iWhite was more effective than Listerine mouthwash in restoring the original color of composite resin specimens.

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