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Effect of Mouth Rinses Used for Covid-19 Prevention on the Color Stability of Composite Resins

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Abstract

Background: The aim of this study was to investigate the effect of different mouth rinses on the color stability of microhybrid (Opallis (OP), FGM) and nanohybrid (Estelite Sigma Quick (ESQ), Tokuyama) composite resins, which are recommended to be used before dental procedures to prevent the spread of severe acute respiratory syndrome coronavirus 2.

Methods: Forty specimens of each composite resin, A2 shade, were prepared and immersed in mouth rinses containing 0.2% chlorhexidine (CHX), 1% povidone-iodine (PVP-I), and 1.5% hydrogen peroxide for 1 minute daily, followed by reincubation in artificial saliva for 28 days. Color measurements were recorded at baseline, 7, 14, and 28 days using a spectrophotometer, and color differences (ΔE_{00}) were calculated to assess color stability. A 2-way ANOVA and Duncan test were used for statistical analysis.

Results: The color stability of both composite resins was significantly affected by the mouth rinses. The microhybrid composite (OP) exhibited greater color changes compared to the nanohybrid composite (ESQ). After 14 and 28 days, the ΔE_{00} values of OP samples exposed to Andorex, Batiqon, and Dermosept exceeded the clinically unacceptable threshold ($\Delta E_{00} > 1.8$). In contrast, the nanohybrid composite resin showed lower color change, remaining below the clinical acceptability threshold throughout the study period.

Conclusion: Mouth rinses, particularly those containing CHX and PVP-I, caused significant and clinically unacceptable color changes in composite resin restorations over time. The study suggests that the prolonged use of these mouth rinses in patients with composite resin restorations should be carefully considered to avoid undesirable aesthetic outcomes.

Keywords: Chlorhexidine, color stability, composite resin, mouth rinses, povidone-iodine.

What is already known on this topic?

- *Antiseptic mouthrinses such as chlorhexidine and povidone-iodine are commonly recommended to reduce the oral viral load, especially during the COVID-19 pandemic.*
- *These mouthrinses are effective against enveloped viruses like SARS-CoV-2 but have been associated with side effects, including staining of dental materials.*
- *Previous studies have shown that prolonged or continuous exposure to certain mouthrinses can lead to discoloration of composite resin restorations.*

What this study adds on this topic?

- *This study simulates real-life clinical use by evaluating the effects of daily short-term exposure to mouthrinses, followed by incubation in artificial saliva.*
- *The findings reveal that even brief, daily use of some antiseptic mouthrinses can cause significant and clinically unacceptable discoloration, particularly in microhybrid composites.*

INTRODUCTION

Coronavirus 2019 disease (COVID-19) which affects humans is a severe acute respiratory syndrome caused by coronavirus 2 (SARS-CoV-2). The SARS-CoV-2 is transmitted from person to person via direct contact or through respiratory droplets emitted by an infected individual while coughing or sneezing.[1] Large droplets of saliva containing microorganisms can be expelled by coughing, sneezing, breathing, or talking. The oral cavity thus plays an important role in the pathogenicity and transmission of SARS-CoV-2.[2] Reducing the viral load in the oral cavity may contribute to a lower risk of transmission.[3,4] The use of mouth rinses for this purpose has been suggested.[5,6] However,

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these mouth rinses are not used in the treatment of COVID-19 disease and do not protect the individual against the virus.[6] The use of antiseptic mouth rinses can kill the virus in saliva. Therefore, the possibility of transmission of the virus through the mouth is reduced with the use of antiseptic mouth rinse.[4,7] Chlorhexidine (CHX),[7,8] cetylpyridinium chloride,[9] hydrogen peroxide (HP),[7,8,10] and povidone-iodine (PVP-I)[7] are mouth rinses that kill enveloped viruses such as coronavirus.

The use of composite resins in dentistry has been on the rise as a result of patients' higher expectations regarding the aesthetics of dental treatment. These materials can be utilized in both anterior and posterior regions thanks to technological advancements.[11] Microhybrid composite, thanks to its optical, physical, and mechanical properties, is frequently used in anterior teeth where aesthetics is important.[12] Nanohybrid composites, developed in recent years, are important for aesthetic restorations due to their very high polishability and translucency properties, attributable to their nanoparticle content. Although the mechanical properties of these composites are not as high as microhybrid composites, they give successful results in anterior region restorations where chewing force is weaker.[13]

Decision of composite resin color and color stability of aesthetic composite resin restorations are important features. After the completion of restoration, it is expected to maintain its optical properties for a long time.[14] Color stability of restorations may be affected when exposed to environmental factors such as different foods, beverages, and medicines in the mouth.[15] In the literature, it has been stated that mouth rinses and antiseptics used to control intraoral infection and provide antimicrobial activity may cause discoloration of composite resin restorations.[16] There have been a few studies in the literature examining the effect of different mouth rinses recommended for pre-procedure use in dentistry applications, especially during the COVID-19 pandemic, on the color stability of composite resins.[17-19] The aim of this study is to examine the effect of different mouth rinses recommended for use in dentistry before dental procedure on the color stability of microhybrid and nanohybrid composites. Therefore, this study evaluated the effect of 4 types of mouth rinses containing 0.2% CHX, 1% PVP-I, and 1% HP on the color change of composite resin materials over time. The null hypothesis of this study is that the tested mouth rinses will not influence the color stability of composite resins, and there will be no significant difference between the composite resins.

MATERIAL AND METHODS

Since this study was performed on composite resin materials, it does not require any ethics committee approval. The color stability of 2 dental resin composites, a microhybrid (Opallis, FGM, Joinville, Brazil) and a nanohybrid composite (Estelite Sigma Quick (ESQ), Tokuyama, Tokyo, Japan) was evaluated in this study. The composite resins and mouth rinses used in the study are listed in Table 1.

Forty disc-shaped specimens (A2 shade) were prepared for each composite resin using a polytetrafluoroethylene cylindrical mold (8 mm diameter, 2 mm depth). The composite resins were polymerized with a light-emitting diode unit (Valo Ultradent, South Jordan. UT. USA) at standard power. After polymerization, the surfaces of the samples were polished using polishing discs (Sof-Lex, 3M ESPE, St. Paul, MN, USA). The disc-shaped samples were kept in distilled water for 24 hours before the first measurements. The initial color values (L'C'h') of the samples were measured using a spectrophotometer. The samples prepared from each composite resin were randomly assigned to 4 subgroups (n=10): control, Andorex, Batiqon, and Dermosept. Following the initial color measurements, the samples were immersed in mouth rinses with varying compositions: Andorex (0.12% CHX gluconate, 0.15% benzydamine hydrochloride), Batiqon (1% PVP-I), and Dermosept (1.5% HP). To simulate daily mouth rinse use, samples were immersed in their respective mouth rinses for 1 minute each day. After rinsing, they were incubated in artificial saliva at 37°C for 28 days.[19] Control groups were kept in artificial saliva throughout the whole experiment. The mouth rinses and artificial saliva were changed every day. Color measurements of the samples were repeated on the 7th, 14th, and 28th days and recorded. The methodology of the study is schematically presented in Figure 1.

The L', C', and h' values measured on the white background were used to calculate the ΔE_{00}. According to Paravina

Table 1. The Resin Composites and Mouth Rinses Used in the Study

Material	Description	Manufacturer
Opallis (OP)	Microhybrid composite (Bis-GMA monomers, Bis-EMA, TEGDMA, UDMA, camphorquinone, co-initiator, silanized barium-aluminium silicate glass (particle size of 0.5 μm, 79.8 wt%/57 vol%), pigments and silica.)	FGM Dental Group, Joinville, Brazil.
Estelite Sigma Quick (ESQ)	Nanohybrid composite (Silica, zirconia, Bis-GMA, TEGDMA, 82 wt %/71 vol%)	Tokuyama Dental Co., Tokyo, Japan.
Andorex	0.15% Benzydamine HCL and 0.12% Chlorhexidine Gluconate, glycerol, ethanol, sorbitol, E102, polysorbate 20, patent blue V, mint flavor.	Delta Vital, Istanbul, Türkiye
Batiqon	1% povidone iodine, stabilizer (diluted with distilled water)	Aqua Medical, Istanbul, Türkiye
Dermosept	1.5% hydrogen peroxide, stabilizer, distilled water (diluted with distilled water)	Alg pharmaceutical industry, Istanbul, Türkiye

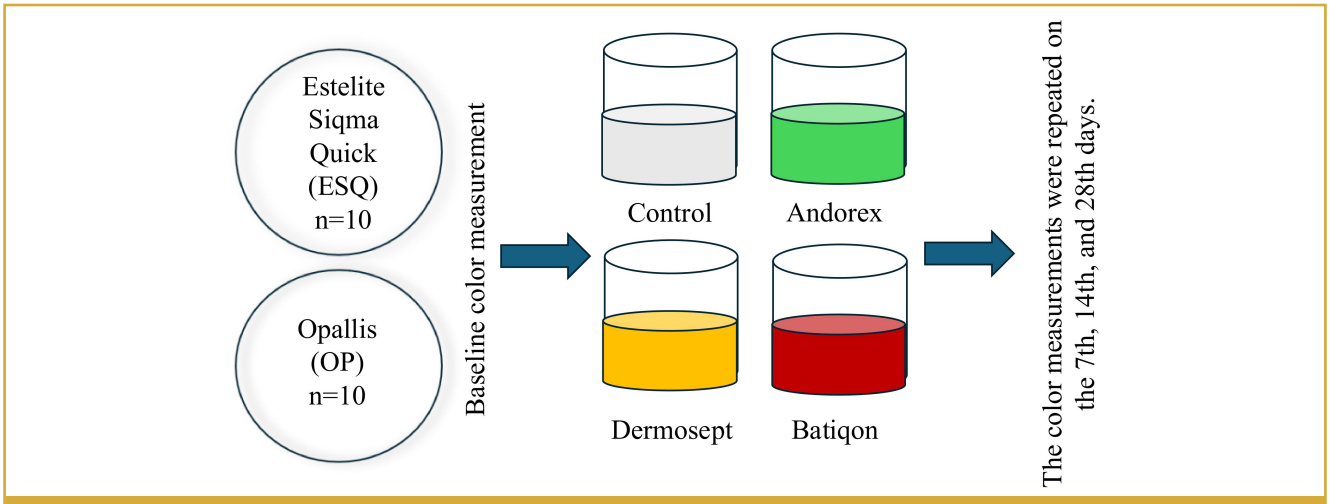

Figure 1. Schematic illustration of the study design and methodology.

et al,[20] a ΔE_{00} value greater than 1.8 at a 50%:50% CI has been stated as clinically unacceptable. Color differences in this study were calculated using baseline color parameters at each measurement time: baseline and on the 7th ($\Delta E1_{00}$), 14th ($\Delta E2_{00}$), and 28th ($\Delta E3_{00}$) days of the immersion period.

Statistical Analysis

SPSS IBM 26.0 statistical program (IBM SPSS Corp.; Armonk, NY, USA) was used for the evaluation of the color changes of composite resins. The normality of the data in the study was assessed using the Shapiro–Wilk test. Since the measurements were normally distributed, parametric tests were applied. The comparison of color changes between the "group and time" factors was conducted using a 2-way repeated measures ANOVA. Significant differences were identified using the Bonferroni post-hoc test. Between-group differences were analyzed with 1-way ANOVA followed by the Duncan test ($P < .05$).

RESULTS

Mean and standard deviations (SD) of color change (ΔE_{00}) values between treatment stages in the study groups are given in Table 2. According to this, the (group)*(time) interaction was found to be statistically significant ($P = .020$).

When the groups were compared based on the measurement time for nanohybrid composite resin (ESQ), a significant difference was observed between the 7th and 14th day mean ΔE values, with the exception of the artificial saliva (control) group. Additionally, a statistically significant difference was found between the 7th day mean ΔE value and the 28th day in these groups.

When comparing the groups according to the measurement time for microhybrid composite resin (OP), a statistically significant difference was found between the 7th and 14th days, as well as between the 7th and 28th days, in the mean ΔE values of the artificial saliva (control) and Batiqon groups. Furthermore, statistically significant differences were observed in all time intervals in other groups where OP composite resin was exposed to different mouth rinses.

The mean $\Delta E1_{00}$ values of OP composite resin samples stored in Andorex, Batiqon, and Dermosept solutions were statistically significant different from those of the other groups.

Table 2. Mean and Standard Deviations (SD) of Color Change (ΔE) Values Between Treatment Stages in the Study Groups

Composite Material	Mouth Rinses	$\Delta E1_{00}$-7th day Mean ± SD	$\Delta E2_{00}$-14th day Mean ± SD	$\Delta E3_{00}$-28th day Mean ± SD	*P
Estelite Siqma Quick (ESQ)	**Artificial saliva**	0.54 ± 0.37 ^{c}	0.57 ± 0.28 ^{c}	0.85 ± 0.41 ^{d}	*.072*
	Dermosept	0.71 ± 0.45 ^{B,c}	1.13 ± 0.43 ^{A,b}	1.49 ± 0.44 ^{A,c}	***.001***
	Andorex	0.60 ± 0.39 ^{B,c}	0.83 ± 0.45 ^{A,c}	1.07 ± 0.49 ^{A,c}	***.001***
	Batiqon	0.69 ± 0.51 ^{B,c}	0.90 ± 0.5 ^{A,b}	1.10 ± 0.48 ^{A,c}	***.001***
Opallis (OP)	**Artificial saliva**	0.69 ± 0.34 ^{B,c}	1.23 ± 0.39 ^{A,b}	1.33 ± 0.28 ^{A,c}	***.002***
	Dermosept	1.01 ± 0.8 ^{C,b}	1.45 ± 0.85 ^{B,b}	2.46 ± 1.13 ^{A,b}	***.001***
	Andorex	1.64 ± 1.3 ^{C,a}	2.57 ± 1.81 ^{B,a}	3.40 ± 1.71 ^{A,a}	***.001***
	Batiqon	1.67 ± 1.48 ^{B,a}	2.37 ± 1.78 ^{A,a}	2.74 ± 1.72 ^{A,b}	***.001***
***P*		***.025***	***.001***	***.001***	

*Different superscript capital letters in the same row indicate a statistically significant difference between the time intervals within each material and mouth rinse ($P < .05$).
**Different superscript lowercase letters in the same column also indicate a statistically significant difference within different mouth rinses for each material ($P < .05$).

Similarly, the mean $\Delta E2_{00}$ values of OP composite resin samples kept in Andorex and Batiqon solutions showed statistically significant differences when compared to the other groups. The mean ΔE_{003} values of OP composite resin samples stored in Andorex, Batiqon, and Dermosept solutions were also statistically significant different from those of the other groups. The lowest mean ΔE_{00} values at all time intervals were observed in the group where ESQ composite resin was kept in artificial saliva. The OP composite resin samples exposed to Andorex and Batiqon solutions showed mean ΔE values exceeding the clinically unacceptable threshold at the 14-day measurement. Furthermore, OP composite resin samples stored in Andorex, Batiqon, and Dermosept solutions exceeded the clinically unacceptable ΔE threshold at the 28-day measurement.

DISCUSSION

The detection of SARS-COV-2 in the saliva of patients with coronavirus reveals how important the oral region is in the diagnosis and transmission of infection. Especially in dentistry applications, it is possible to transmit the virus with droplets and aerosols.[4] The American Dental Association recommends gargling with antiseptics such as 1% HP or 0.2% PVP-I before dental treatment to prevent the risk of cross-infection. Povidone-iodine has higher virucidal activity than other commonly used antiseptic agents, including CHX and benzalkonium chloride.[21] In this study, the effect of long-term discoloration of mouth rinses recommended as a pre-procedure mouth rinse on dental restorative material in dentistry applications was evaluated. Mouth rinses with different contents made a statistically significant difference in the color change of composite resins. Therefore, the null hypothesis of the study was rejected.

In most studies evaluating the interaction of composite resins and mouth rinses, samples were kept in mouth rinses for an uninterrupted 12-hour period.[22,23] However, because it imitates the daily use of the patients and is more compatible with clinical data, the protocol of keeping the samples in the mouth rinse for intermittent periods was preferred in the study.[24] Also, considering that the short and long-term effects may differ, the samples were exposed to mouth rinse for 28 days.

In the CIELAB color system, color changes (ΔE) are calculated by a special formula using the differences in L*, a*, and b* values. This special formula was developed, and a new formula, CIEDE2000 (ΔE_{00}), was introduced in 2001.[25] CIEDE2000 formula was also used in the study as it was reported to be more sensitive than CIELAB in measuring color changes.[26]

The magnitude of the color difference that can be visually detected by the human eye is indicated as the perceptibility threshold (PT), and the color difference that creates acceptability between restorative materials is indicated as the acceptability threshold (AT).[27] The 50%:50% PT value in dental materials was specified as ΔE_{00}:0.8 and the 50%:50% AT value as ΔE_{00}:1.8. Dermosept Andorex and Batiqon caused a perceptible color change only in the OP composite resin after 7 days. At the end of 14 days, a perceptible color change was observed in all groups except the samples of the ESQ composite kept in artificial saliva. At the end of 28 days, it was observed that the color change in the samples in all groups was above the PT value, while the samples of the OP composite kept in Dermosept, Andorex, and Batiqon exceeded the AT value.

In previous studies, although different mouth rinses were evaluated, they stated that a statistically more significant color change occurred with long-term mouth rinse use.[24,28,29] Consistent with previous studies, color change increased with longer exposure time in all groups.

Color stability of composite resins can be affected by the resin matrix structure, amount and type of filler, degree of polymerization, and water absorption. As the filler amount of the composite resin increases, its resistance to coloration also increases.[30] The filling amount (82%) of the nanohybrid composite resin used in this study is higher than the microhybrid composite resin (79.8%). Also, in composite resins, smaller filler particle sizes are generally associated with improved color stability. Nanohybrid composites, which contain smaller filler particles compared to microhybrid composites, often exhibit better resistance to discoloration. This enhanced stability is attributed to the smoother surface finish achieved by the smaller particles, which are less prone to staining.[31] In this study, mean ΔE_{00} values of nanohybrid composite resins were found to be lower than microhybrid composites. This is in line with the results shown by other researchers, who showed that microhybrid composites show high discoloration when submerged in various agents.[15,32]

Mouth rinses can reduce plaque accumulation and have antibacterial and antiviral effects. However, many mouth rinses and antiseptics used can cause discoloration of restorations and teeth.[33] In a study evaluating the effect of mouth rinses containing PVP-I and CHX digluconate on the color change of composite resins, it was reported that samples kept in PVP-I showed high ΔE_{00} values. Similarly, in this study, samples kept in PVP-I at different time intervals in both composite groups showed high ΔE_{00} values. The results of the study showed that both composite resins presented greater color change after being submerged for 7 and 28 days in 0.12% CHX based mouth rinse. Color changes of the OP composite resin submerged in 0.12% CHX based mouth rinse on days 14 and 28 were considered clinically unacceptable. The use of 0.12% CHX-based mouth rinse for 3 weeks or longer may cause discoloration of the composite resins, and the resulting color may reach the clinically unacceptable limit. When prescribing this mouth rinse in patients with composite resin

restorations, the risks/benefits of mouth rinse use should be considered by the dentist.[34]

In daily life, the discoloration that may occur after the use of mouthwash and antiseptic solutions may decrease with the effect of saliva in the mouth, as well as the food and beverages consumed. The effect of using mouth rinse and antiseptic solutions in daily use should also be examined clinically, and their effect on the color stability of composite restorations should be considered.

Mouth rinses and antiseptics may contribute to increased discoloration of composite resin restorations over time. The extent of discoloration depends on various factors, including the structural properties of the composite resins, the composition of the mouth rinses and antiseptic solutions, and the duration of exposure. Therefore, it is recommended to limit the application time to minimize potential color changes.

Data Availability Statement: The data that support the findings of this study are available upon request from the corresponding author.

Ethics Committee Approval: N/A

Informed Consent: N/A

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