

# Investigation of the Effect of Different Content of Mouthwashes on Resin CAD / CAM Blocks

Bilge Ersöz \*, Serpil Karaoğlanoğlu  and Numan Aydın 

Department of Restorative Dentistry, University of Health Sciences Gulhane Faculty of Dentistry, Ankara, Turkey

\*Corresponding Author; bilgecaliskan9@gmail.com

## Abstract

**Purpose:** As a result of studies aimed at reducing the transmission of severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), mouthwash use has become more popular recently. The aim of this study is to examine the effect of mouthwashes with different ingredients on color changes.

**Methods:** Two different resin-based CAD/CAM materials (Vita Enamic and Brilliant Crios) were used in the study (n=32). Total of 64 samples were prepared by taking 2 × 7 × 12 mm sized sections from resin-based CAD/CAM blocks (n=32). After the samples were kept in artificial saliva at 37° C for 24 hours, a spectrophotometer was used to take initial color measurements (VITA Easy shade V, Germany). Then resin-based CAD/CAM samples were kept in 3 different mouthwashes containing Cetylpyridinium chloride (Oral-B), Povidone iodine (Batiqon) and Chlorhexidine (Kloroben) for 1 minute twice a day (n=8). Color measurement of the samples was repeated on the 7, 14 and 30 days. Values of color differences ( $E_{00}$ ) were assessed by one-way analysis of variance (ANOVA) and Tukey test ( $p < 0.05$ ).

**Results:** There was no statistically significant difference between the color changes at the end of 7, 14 and 30 days of Vita Enamic and Brilliant Crios CAD/CAM blocks kept in mouthwashes containing cetylpyridinium chloride, povidone iodine and chlorhexidine. ( $p > 0.05$ ). In the composite-reinforced CAD/CAM samples (Brilliant Crios), only Povidone-iodine-containing mouthwash produced color change above the noticeable threshold value ( $\delta E_{00} > 0.8$ ).

**Conclusion:** It has been determined that, mouthwashes with different contents did not cause a significant color change in resin-based CAD/CAM samples, which are frequently used during the pandemic period.

**Key words:** CAD / CAM material; COVID-19; Discoloration; Mouthwash

## Introduction

Today, different esthetic restorative materials are using by dentists to meet the expectations of patients who demand a whiter and more esthetic smile. Recently, new resin-based CAD/CAM materials have been produced, which combine the high durability and high color stability properties of ceramic materials, which are frequently used by manufacturers in esthetic applications, with the higher flexibility and lower abrasive properties of composite.<sup>1</sup>

In restorative dentistry, restoration materials are expected to retain their color and optical properties for a long time. The fact that restorations maintain their color stability against different physical and chemical effects that may cause coloration in the mouth affects their long-term success.<sup>2-4</sup>

Studies on the ways of transmission of the SARS-CoV-2 virus, which continues to spread rapidly and how it should be protected, continue today. Studies have reported that COVID-19 is transmit-

ted through the mucous membranes of the mouth, nose and eyes through surfaces contaminated with SARS-CoV-2.<sup>5</sup> A large number of live viruses were detected on the epithelial surface of the oral mucosa and the dorsum of the tongue of SARS-CoV-2 positive patients and saliva is an important for transmission tool for the COVID-19 outbreak.<sup>6</sup> The time a person coughs, sneezes, breathes or chatters, they emit large drops of saliva containing microorganisms. Therefore, it is believed that the oral cavity very important in the pathogenicity and spread of SARS-CoV-2.<sup>2</sup> According to recent studies, it is stated that the use of antiseptic mouthwashes in order to prevent COVID-19 transmission can reduce the oral viral load of COVID-19 and thus the risk of transmission can be prevented or greatly reduced.<sup>7</sup> Mouthwashes and antiseptic solutions also help to improve oral and dental health. It accelerates healing of tissue after the periodontal treatment and shortens the recovery time. Chlorhexidine gluconate, benzydamine hydrochloride, cetylpyridinium chloride and alcohol-containing mouthwashes

and antiseptics are among the most frequently using for this purpose.<sup>2</sup> However, in addition to these advantages, mouthwash and antiseptics can cause external discoloration of dental tissues and dental restorations.<sup>3</sup> Mouthwashes available in the market and that are easily accessible are povidone-iodine, chlorhexidine, hydrogen peroxide, cyclodextrin, citrox, cetylpyridinium chloride and essential oils. Since SARS-CoV-2 is an enveloped virus, some act by targeting the reactive outer lipid membrane, while others act on the capsid by denaturing proteins.<sup>2</sup> Mouthwashes with 3 different ingredients were used in the study: Mouthwashes with povidone iodine (PVP-I): When degraded, it contains iodine and a water-soluble polyvinylpyrrolidone polymer that has antibacterial properties. It also denatures proteins and oxidizes nucleic acids with iodine release. By disrupting numerous metabolic pathways and destroying the cell membrane, PVP-I has antiviral effects against both enveloped and non-enveloped viruses, and this impact is stronger than the other antiseptics like CHX.<sup>2</sup> Mouthwashes with chlorhexidine (CHX): It's a cationic bisbiguanide that's frequently utilized in medicine as a broad-spectrum antiseptic. CHX has antiviral properties, although it is only known to work against lipid-enveloped viruses, not non-enveloped viruses. According to studies, it minimizes the probability of SARS-CoV-2 spreading via aerosols.<sup>2</sup> Mouthwashes with cetylpyridinium chloride (CPC): It's a nonoxidant or corrosive quaternary ammonium compound that's highly cationic at neutral pH and can be dissolved in water or aqueous solutions. It has a wide range of antimicrobials that have a quick bactericidal effect on gram-positive bacteria. CPC also has antiviral properties, which makes it useful in the treatment of viral diseases, particularly respiratory tract infections. CPC acts by destroying the virus capsid. Although it is often found in mouthwashes, it is recommended to be used to fight SARS-CoV-2.<sup>2</sup> The goal of our research is to see how increasing usage of mouthwashes and antiseptics affects the color stability of resin-based CAD/CAM blocks during the COVID-19 pandemic induced by SARS-CoV-2. The null hypothesis of the study is that mouthwashes will not have any effect on the color change of resin-based CAD/CAM blocks.

## Methods

Two different resin-based CAD/CAM blocks (Vita Enamic, Brilliant Crios) were selected for the study Table 1. Samples of 2 x 7 x 12 mm were prepared from resin-based CAD/CAM blocks with a precision cutting device (Micracut 201; Bursa, Turkey). A total of 64 samples, 32 of each, were prepared from Vita Enamic and Brilliant Crios CAD/CAM samples. The samples were polished with a spiral shaped polishing kit (Clearfil Twist Dia; Kuraray, Japan) and polishing paste (Dia Polisher, GC, Tokyo, Japan). During the polishing step, the spirals were used under water cooling at 10000 rpm for 20 seconds. Samples were kept in artificial saliva at 37 °C for 24 hours after the polishing.

The initial color values ( $L^*$ ,  $a^*$ ,  $b^*$ ) of the samples were recorded with the spectrophotometer device VITA Easy shade V (VITA Zahnfabrik, Bad Säckingen, Germany). Color measurements were made by placing the probe tip of the spectrophotometer perpendicular to the sample surface. In the color measurement process, 3 measurements were made from each sample, from the center point of the samples.

The samples were kept in mouthwashes of different contents (Oral-B, Procter&Gamble, cetylpyridinium chloride; Batiqon, Povidex Aqua, 0.2% polyvinylpyrrolidone iodine; Kloroben, Drogosan; 0.12% chlorhexidine gluconate, 0.15% benzydamine hydrochloride) after the initial color measurements were completed. To simulate the daily mouthwash use of individuals, the samples were kept in mouthwashes for 1 minute. After the samples were kept in mouthwash for 1 minute, they were re-incubated in artificial saliva at 37 °C. Control groups were kept only in artificial saliva for 30 days. The mouthwashes and artificial saliva in which

the samples were kept were changed regularly every day. Color measurements of the samples, whose color measurements were recorded at the beginning, were recorded by repeating on the 7th, 14th and 30th days.

The CIEDE2000 formula ( $E_{00}$ ) was used to calculate the color changes of resin-based CAD/CAM blocks over the  $L^*$ ,  $a^*$  and  $b^*$  parameters. SPSS 22.0 statistical program (SPSS Inc., Chicago, IL, USA) was used for the statistical evaluation of the color changes of CAD/CAM blocks. Color change values were evaluated by two-way analysis of variance (ANOVA) and Tukey test ( $p < 0.05$ ).

## Results

When the study results were examined, no statistically significant difference was observed in the color changes of Vita Enamic and Brilliant Crios resin-based CAD/CAM samples, which were kept in mouthwashes containing cetylpyridinium chloride, povidone iodine and chlorhexidine, on the 7th, 14th and 30th days. The sample groups kept in mouthwashes showed similar color change with the artificial saliva, which was the control group, at all the time periods Table 2.

Although there was no significant difference in the coloration of the samples, the coloration of all samples was at the maximum level on the 30th day. When the coloration of the samples at the end of the 30th day is evaluated in terms of acceptable threshold value; mouthwashes caused discoloration of resin-based CAD/CAM blocks below the PT value ( $E_{00} : 0.8$ ). Only povidone iodine-containing mouthwash showed color change above the PT value ( $E_{00} : 0.8$ ) in the Brilliant Crios composite reinforced block.

## Discussion

Mouthwashes with different contents did not make a statistically significant difference in the color change of the resin-based CAD/CAM blocks. Therefore, the null hypothesis of the study was accepted.

New generation resin-based CAD/CAM blocks are widely preferred by clinicians benefit from the ease of preparation, polishing, and reparability. Despite the effective finishing and polishing processes in resin-containing restorative materials, the color changes that occur over time cause patient dissatisfaction, and this is considered as the esthetic inadequacy of the materials.

In recent years, spectrophotometer device is has been widely used to measure tooth colors.<sup>5</sup> CIELAB calculates color differences in materials with the  $\Delta E_{ab}$  formula using  $L^*$ ,  $a^*$ ,  $b^*$  values. In 2001, a new formula CIEDE2000 ( $E_{00}$ ) was developed by the CIE.<sup>8</sup> In this study, the color change caused by mouthwashes in CAD/CAM blocks was measured with a spectrophotometer device. Color changes were also calculated with the CIEDE2000 formula. The color changes on the CAD/CAM materials of mouthwashes, which have an increased frequency of use in the pandemic and can stain teeth and restorations in long-term use, were investigated.<sup>9</sup>

According to studies, periodontal diseases begin as a result of plaque accumulating for 10-21 days.<sup>10</sup> As a result of 4 weeks of plaque accumulation, white spot lesions may start.<sup>11</sup> In order to avoid the side effects of mouthwashes, its use is limited to an average of 5 weeks.<sup>12</sup> Therefore, the samples in this study were kept in mouthwashes for 4 weeks. It is also recommended to use mouthwashes for 1 minute twice a day in accordance with the manufacturer's instructions. Considering this situation, daily use was simulated by keeping our samples in a mouthwash twice a day for 1 minute every day. The solutions were replaced with new ones after each use, ensuring that the effectiveness of the solutions continued for 4 weeks. Generally, mouthwash and antiseptic solutions contain antimicrobial agents, herbal extracts that provide a refreshing taste and smell, and solvents such as alcohol, sorbitol or water. These

**Table 1.** Resin-based CAD/CAM blocks used in the study

Materials, Manufacturer	Type of material	Composition by weight		Lot Number
		Filler	Polymer	
Vita Enamic, VITA Zahnfabrik, Germany	Hybrid ceramic block	86% feldspatic ceramic	Methacrylate Polymer, UDMA, TEGDMA	81060
Brilliant Crios, Coltene/Whaledent, Switzerland	Composite resin block	70% of glass, amorphous silica	Cross-linked methacrylates Bis-GMA, Bis-EMA, TEGDMA	I89523

**Table 2.** Color change created by mouthwashes on resin-based CAD/CAM blocks

CAD/CAM Material	Mouthwash	7th day	14th day	30th day
Vita Enamic	Oral-B	0.6±0.1	0.6±0.1	0.7±0.1
	Batiqon	0.6±0.1	0.6±0.1	0.8±0.1
	Kloroben	0.6±0.1	0.6±0.1	0.7±0.1
	Artificial saliva	0.5±0.1	0.6±0.1	0.6±0.1
Brilliant Crios	Oral-B	0.6±0.1	0.7±0.1	0.8±0.1
	Batiqon	0.7±0.1	0.8±0.1	0.9±0.2
	Kloroben	0.6±0.1	0.7±0.1	0.8±0.1
	Artificial saliva	0.6±0.1	0.7±0.1	0.8±0.1
P		0.246	0.387	0.214

active ingredients and flavoring agents often contain coloring pigments.<sup>13</sup> In mouthwash and antiseptic solutions, pigment density, fluidity property of the solution, adhesion to the surface of composite resin materials and wettability are important factors affecting coloration.<sup>14</sup>

In the current study, although the povidone iodine-containing antiseptic solution caused more color changes on CAD/CAM blocks than cetylpyridinium chloride and chlorhexidine-containing mouthwashes, this difference was not statistically significant. In addition, while the Povidone-iodine-containing mouthwash showed a color change above the detectable threshold value PT ( $E_{00} : 0.8$ ) in the composite reinforced block, it created a color change below the detectability threshold value in the hybrid ceramic block. Hybrid ceramic CAD/CAM blocks are thought to exhibit less discoloration due to the high filler ratio and polymer infiltrated mesh structure.

This study has some limitations. After daily use of mouthwash and antiseptic solution, the washing effect of saliva, the effect of oral fluids, the effect of food and different beverages may change the color change caused by these solutions, but these factors could not be simulated in vitro in this study. More research is needed to investigate the effect of mouthwashes on the coloration of CAD/CAM materials.

## Conclusion

At the day 30, mouthwashes produced similar color differences on resin-based CAD/CAM blocks with artificial saliva. The color alterations did not differ in a statistically meaningful in the color differences within the CAD/CAM blocks.

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## Author Contributions

B.E. and N.A. participated in designing the study. S.K. and N.A. participated in generating the data for the study. N.A. and B.E. participated in gathering the data for the study. N.A. participated in the analysis of the data. B.E. and N.A. wrote the majority of the original draft of the paper. S.K. and N.A. participated in writing the paper. All authors approved the final version of this paper.

Authors declare that they have no conflict of interest.

## Authors' ORCID(s)

E.T. [0000-0003-0769-0457](https://orcid.org/0000-0003-0769-0457)

O.G. [0000-0001-8628-4507](https://orcid.org/0000-0001-8628-4507)

D.Y. [0000-0003-0601-8028](https://orcid.org/0000-0003-0601-8028)

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