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ORIGINAL RESEARCH ARTICLE

The Effect of Whitening Mouthrinses on the Color Stability of a BIS-GMA Free Composite Resin: An Invitro Study

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Abstract

Purpose: Recently, many whitening mouthrinses have appeared on the market with different ingredients due to their ease in use and low costs. Whether these mouthrinses change the color of composite resins has been a matter of curiosity. In our study, it was aimed to investigate the effect of whitening mouthrinses with different chemical structures on the color stability of a resin composite that does not contain Bis-GMA.
Materials and Methods: Seventy specimens (8 mm x 2 mm) were prepared from a Bis-GMA free composite resin. These specimens randomly divided into seven groups, according to the mouthrinses (n=10): Listerine Advanced White, Colgate Optic White, Perfect White Black, Crest 3D White, Pasta Del Capitano, Oral B 3D White Luxe. The control group used in the study was distilled water. After the baseline color measurement values were recorded with a spectrophotometer (Vita Easy Shade V, Vita Zahnfabrik, Bad Sackingen, Germany), the samples were kept in mouthrinses for 24 hours. At the end of the keeping period, color measurements were repeated and changes in color values were calculated (ΔEab) using the CIE L*a*b* color system. Statistical analysis of the values obtained was made according to Kruskal Wallis test .
Results: Considering the median color change, samples demonstrated color changes within clinically acceptable limits in whitening mouthrinses after immersion (ΔEab = 1.005 - 2.062). There was no statistically significant difference among the whitening mouthrinses (p =0.183).
Conclusions: Whitening mouthrinses used in this study did not cause a significant color change during our holding time in Bis-GMA free composite resin.

Key words: color stability; mouthrinses; resin composite

Introduction

Composite resins; due to their advantages such as their ability to bind to enamel and dentin tissue and to create an esthetic restoration, they are generally used as restorative materials compatible with the tooth color. Color change that occurs in composite restorations causes color mismatch and endangers esthetics; this can lead to replacement of restorations that are time consuming and costly.[1] Discoloration that occurs in composite resins is affected by internal and external factors. Internal discolorations include changes that can occur in the structure of the resin, at the interface of the resin matrix and fillers.[2] External discolorations are caused by the adsorption or absorption of exogenous colorants such as coffee, tea, nicotine, drinks and mouthrinses.[3–5] There are many ways to remove the superficial stains that occur in composite resin restorations; such as repolishing, brushing, or using bleaching techniques.[6] Removal of discolorations with tooth brushing is a slower process. For this reason, it is preferable to use faster methods such as repolishing or bleaching techniques.[7] Among these bleaching techniques, mouthrinses are the most popular oral hygiene and teeth whitening measures due to their ease in use, low cost, and availability.[1,8] Manufacturers have claimed that whitening mouthrinses can prevent stains on teeth and prevent plaque formation. Generally, a low concentration of hydrogen peroxide (1.5%)

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is present in the formulation of whitening mouthrinses and sodium hexametaphosphate is also included to protect the tooth surface from new stains. Other ingredients of these mouthrinses are water, antimicrobial agents, salts, and also some of them contain alcohol and similar ingredients.[9] After using whitening mouthrinses the reduction in discoloration have been exhibited in several in vitro studies.[1,9–12] However, these studies investigated the mouthrinses on stained composite restorations and utmost of them tested hydrogen peroxide containing materials such as mouthrinses, office bleaching agents and home bleaching agents. On the other hand, the literature has revealed scarce information on the effect of these chemicals on unstained composite resins. Therefore, this in vitro study was aimed to investigate the effect of whitening mouthrinses with different chemical structures on the color stability of a resin composite that does not contain Bis-GMA. The null hypothesis was that the whitening mouthrinses will not be significantly change the color of the Bis-GMA free composite resin.

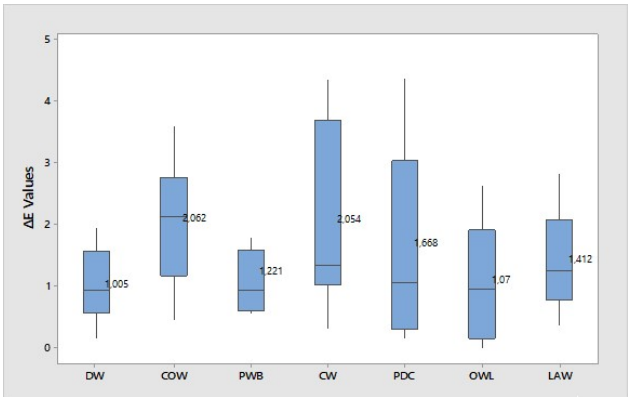

Figure 1. Color change distribution of resin composite after immersion period in control and test solutions (mean values corresponding to each group are presented in the figure).

Material and Methods

In our study, A3 shade resin composite (Gradia Direct Anterior, GC) without Bis-GMA was kept in six mouthrinses; Listerine Advanced White (LAW), Colgate Optic White (COW), Perfect White Black (PWB), Crest 3D White (CW), Pasta Del Capitano (PDC), Oral-B 3D White Luxe (OWL) with different content for 24 hours. The contents of the restorative material and whitening mouthrinses used are shown in Table 1. A custom-made polytetrafluoroethylene (PTFE) mold with a diameter of 8.0 mm and a thickness of 2 mm was used when preparing 70 disc-shaped samples. For polymerization of composite samples, an LED light device (Elipar Free Light, 3 M ESPE, AG, Germany, 1200mW/cm2) was applied perpendicular to the surface for 20 seconds both from the bottom and from the top according to the manufacturer's instructions. Disc-shaped samples were kept in distilled water for 24 hours before the initial measurements were made. Observing the color stability, samples were divided into seven subgroups (n = 10) as six different whitening mouthrinses and distilled water (DW). The samples were placed individually in sealed opaque bottles containing 20 mL of each mouthrinse. After being soaked in mouthrinses for 24 hours (which was equivalent to two years of 2 minutes daily use)[13], it was rinsed with distilled water and dried before measurements. L*, a*, b* color values of the samples were measured with a spectrophotometer (Vita Easy Shade V, Vita Zahnfabrik, Bad Sackingen, Germany) according to the CIELAB color scale. Measurements were repeated three times from the center of all samples by an operator before and after immersion in mouthrinses, and these three measurements were averaged. The color change δE was calculated for each sample individually using the formula: δEab*=[(δL*)2+(δa*)2+(δb*)2]1/2.

Statistical analysis

Statistical analysis was performed using Minitab18 Statistical Software. The normality test of the data was assessed by Ryan-Joiner test (similar to Shapiro-Wilk Test). Due to the non-normal distribution of data, the color differences (δE) between the groups were analyzed by Kruskal- Wallis test. The color change was summarized by the mean, standard deviation, standard error of the mean, range, and quartiles. Statistical significance was defined as a p-value less than 0.05. All the statistical analysis are performed with %95 significance level.

Results

The color difference (δE) of each sample was evaluated relative to the baseline (initial measurement). The median (1st quartile- 3rd quartile) and minimum, maximum δE values of the groups are presented in Table 2. The lowest δE values were observed in DW group, followed by OWL, PWB, LAW, PDC, CW and COW groups, respectively. Considering the median color change, clinically acceptable color changes (δE= 2.7) were recorded in all whitening mouthrinses.

As a result of the Kruskal-Wallis test, there was no statistically significant difference was observed between the whitening mouthrinses (p =0.183). In addition, when the Box Plot is examined, it is seen that the differences between the observations of the mouthrinses (mean δ E values) of DW and PWB groups are less than the other groups as shown in Figure 1. The results of CW and PDC groups are observed to be spread over a wider range. According to the post power analysis, the power is 0.78 and this shows that the sample size is sufficient.

Discussion

The effects of six different whitening mouthrinses on the color stability of a Bis-GMA free composite resin were evaluated in this study. According to the results of the present study, the null hypothesis was accepted because the daily use of whitening mouthrinses causes the color change of the composite resins, but this color change is not perceived clinically. According to the studies conducted, an δEab value greater than 2.7 at 50%:50% confidence interval has been stated as clinically unacceptable.[14,15] The composite resin tested in our study showed a clinically acceptable color change when kept in different whitening mouthrinses. We think that the reason for this is that the composite resin we use does not contain Bis-GMA. Because Bis-GMA based resins are less resistant to water absorption and dissolution than Bis-EMA and UDMA based resins.[16] Gürdal et al. showed that the effects of mouthrinses on color stability were not different from distilled water.[17] Lee et al. also found that mouthrinses affect color stability even though it is not visually perceived.[18] In our study, a composite resin without Bis-GMA showed adequate color stability and also showed clinically acceptable color change after holding time. Whitening mouthrinses containing various chemicals such as sodium citrate, sodium hexametaphosphate, peroxides, enzymes and pyrophosphates, work by bleaching or abrading the stain from the surface in the control of discoloration. The whitening efficacy of peroxide, a common whitening agent used in gel or liquid form, is well known in the literature.[19,20] This powerful oxidizing agent allows bleaching by breaking down long chain organic molecules into short chain compounds. However, adding peroxide to the ingredients of whitening mouthrinses is difficult due to safety restrictions, so hydrogen peroxide can be added at low concentrations of 1% to 2%.[8] In the formula of the mouthrinses we use in the study, bleaching is provided with hydro-

Material	Composition	Manufacturer
Listerine Advanced White	Water, Alcohol, Sorbitol, Tetra Potassium Pyrophosphate, Penta Sodium Triphosphate, Citric Acid, Poloxamer 407, Flavors, Sodium Saccharin, Sucralose, Sodium Fluoride, Sodium Benzoate, Tetra Sodium Pyrophosphate, Menthol, Eucalyptol, Thymol, Aroma, Propylene Glycol, Disodium Phosphate.	Johnson&Johnson, Skillman, NJ, USA.
Colgate Optic White	Aqua, Glycerin, Sorbitol, Propylene Glycol, PVM/MA Copolymer, Tetrapotassium Pyrophosphate, Polysorbate 20, Sodium Fluoride, Sodium Saccharine, CI 42051.	GABA International AG, Therwil, Switzerland.
Perfect White Black	Aqua, glycerin, PEG-40 Hydrogenated Castor Oil, Sodium Fluoride, Tetrapotassium Pyrophosphate, Tetrasodium Pyrophosphate, Charcoal Powder, Polyglyceryl-10 Stearate, Polyglicerin-10, Polyglyceryl-10 Myristate, Sodium Dehydroacetate, Menthol, Aroma, Sodium Citrate, Citric Acid, Sodium Lauryl Sulfate, Sodium Saccharine, Sodium Benzoate, CI 16255, CI 42051, CI 47005.	Beverly Hills Formula, Ireland.
Crest 3D White	Water, Glycerin, Hydrogen Peroxide, Propylene Glycol, Sodium Hexametaphosphate, Poloxamer 407, Sodium Citrate, Flavor, Sodium Saccharin, Citric Acid.	Procter&Gamble, Cincinnati, OH, ABD.
Pasta Del Capitano	Aqua, Glycerin, Alcohol, Potassium Citrate, Polisorbate 20, PVP, PEG-40, Sodium Benzoate, Aroma, Betaine, Lactic Acid, Sodium Lactate, Sodium Bicarbonate, Sodium Fluorit, Sodium Monoflorophasphate, Sodium Saccarin, Eugenol, Limonen CI 47005, CI 42051.	Farmaceutıcı Dott. Cıccarelli SPA, Milano, Italy.
Oral-B 3D White Luxe	Aqua, Glycerin, Alcohol, Aroma, Methylparaben, Poloxamer 407, Sodium Fluoride, Cetylpyridinium Chloride, Sodium Saccharin, Propylparaben, CI42051, CI47005	Procter & Gamble, GmbH, GrossGerau, Germany.
Gradia Direct Anterior A3	Resin (27%w): Urethane dimethacrylate (UDMA), dimethacrylates, trimethacrylates Fillers: Silica (38%w), Pre-polymerised resin fillers (35%w) Filler loading (Wt %) 73 Bis-GMA free	GC Dental Products Corp., Tokyo, Japan

Table 1. Properties of the materials used in the study.

Groups	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3
DW	1.005	0.178	0.563	0.140	0.560	0.935	1.557
COW	2.062	0.298	0.943	0.450	1.170	2.130	2.758
PWB	1.221	0.287	0.908	0.540	0.595	0.930	1.575
CW	2.054	0.457	1.444	0.300	1.008	1.330	3.688
PDC	1.668	0.512	1.620	0.140	0.295	1.055	3.027
OWL	1.070	0.293	0.927	0.000	0.140	0.950	1.910
LAW	1.412	0.258	0.816	0.360	0.788	1.250	2.085

Table 2. The distribution of color changes within mouthrinses.

Distilled water (DW), Colgate Optic White (COW), Perfect White Black (PWB), Crest 3D White (CW), Pasta Del Capitano (PDC), Oral-B 3D White Luxe (OWL), Listerine Advanced White (LAW).

gen peroxide in CW, microparticles in OWL, activated charcoal in PWB, tetrasodium pyrophosphate in LAW and optical properties in COW. Oral-B 3D White Luxe and Colgate Optic White with Patent Blue V (Color Index 42051) in its content show whitening properties. In an in vitro study on teeth, Lima et al [8] investigated the effect of mouthrinses containing hydrogen peroxide, and found that the tested mouthrinses had a whitening effect. The researchers soaked all teeth in an artificial saliva for 45 days by immersing the teeth into each mouthrinse for 1 min, twice a day. According to their results, both whitening mouthrinses were significantly changed the color of teeth, which was greater than the threshold level. [8] On the contrary, in a study investigating the effect of hydrogen peroxide containing mouthrinses on composite resin, a noticeable color change on the resins have not been revealed. [21] In line with these results, no statistical difference was observed between the CW group containing hydrogen peroxide and other whitening mouthrinses in our study. Polyvinylpyrrolidone (PVP) is a water soluble homopolymer and is available in a variety of molecular weights. PVP forms complexes with catechins by removing them from enamel, as is the case with many other compounds that cause discoloration. Although it is thought that this polymer binds and removes stains in various oral care applications and prevents the stain from reapplying (ISP Corporation 2011), the results obtained in the PDC group in this study are not statistically different from all mouthrinses. Since there is no study in the literature, investigating the effect of whitening mouthrinses which ingredients is hydrogen peroxide, active charcoal, microparticles, Patent Blue V and PVP on unstained composite resins, direct comparison of the results cannot be achieved. The Gradia Direct Anterior that we used in the study contains micro fillers. Micro-filled composite resins can be polished well and function well as the top layer in anterior restorations. The small filler size can contribute to reducing staining and improving the aesthetic appearance. [22] In addition to this information, Gradia Direct Anterior composite resin does not contain Bis-GMA. Polymer matrix of this composite resin is primarily based on UDMA, which has been described in literature as hydrophobic reported to exhibit a low δE. [23–25] Under normal polymerization conditions, the UDMA-based composite resin showed lower water absorption [26] and higher color stability [27] than those with other dimethacrylates in the resin matrix. Clinically, the effects of whitening mouthrinses on esthetic composite resin materials depend on many determinants that cannot be imitated in vitro, such as drinks, foods, pellicle and saliva. More in vivo and in vitro studies would be helpful to determine the whitening potential of various chemical mouthrinses.

Conclusion

The effects of whitening mouthrinses on the color stability of resin composite without Bis-GMA were not statistically different from the control group. The composite discs showed color change after keeping in the mouthrinses, but these differences were not clinically detectable.

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Author Contributions

M.C. and H.Y.G. participated in designing the study. M.C. and H.U. participated in writing the paper.

Conflict of Interest

Authors declare that they have no conflict of interest.

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References

1. Karadas M, Alkurt M, Duymus Z. Effects of hydrogen peroxide-based mouthwashes on color changes of stained direct composite resins. J Restor Dent. 2016;4:11. doi:10.4103/2321-4619.176018.
2. Um CM, Ruyter IE. Staining of resin-based veneering materials with coffee and tea. Quintessence Int. 1991;22(5):377–86.
3. Asmussen E, Hansen EK. Surface discoloration of restorative resins in relation to surface softening and oral hygiene. Scand J Dent Res. 1986;94(2):174–7. doi:10.1111/j.1600-0722.1986.tb01382.x.
4. Dietschi D, Campanile G, Holz J, Meyer JM. Comparison of the color stability of ten new-generation composites: an in vitro study. Dent Mater. 1994;10(6):353–62. doi:10.1016/0109-5641(94)90059-0.
5. Noie F, O'Keefe KL, Powers JM. Color stability of resin cements after accelerated aging. Int J Prosthodont. 1995;8(1):51–5.
6. Azarpazhooh A, Limeback H. The application of ozone in dentistry: a systematic review of literature. J Dent. 2008;36(2):104–16. doi:10.1016/j.jdent.2007.11.008.
7. Türkün LS, Türkün M. Effect of bleaching and repolishing procedures on coffee and tea stain removal from three anterior composite veneering materials. J Esthet Restor Dent. 2004;16(5):290–301; discussion 301–2. doi:10.1111/j.1708-8240.2004.tb00056.x.
8. Lima F, Rotta T, Penso S, Meireles S, Demarco F. In vitro evaluation of the whitening effect of mouth rinses containing hydrogen peroxide. Braz Oral Res. 2012;26:269–74. doi:10.1590/S1806-83242012000300014.
9. Harorlı OT, Barutcigil C. Color recovery effect of commercial mouth rinses on a discolored composite. J Esthet Restor Dent. 2014;26(4):256–63. doi:10.1111/jerd.12107.
10. Gul P, Harorli OT, Ocal IB, Ergin Z, Barutcigil C. Color recovery effect of different bleaching systems on a discolored composite resin. Niger J Clin Pract. 2017;20(10):1226–1232. doi:10.4103/*njcp.njcp*$_{3}$85$_{1}$6.
11. Shah K, Pachore P, Shah K, Chokshi S, Sanghvi Z, Patel N. Effects Of Hydrogen Peroxide-Based Mouthwashes On Colour Changes Of Stained Direct Composite Resins Restorations. Journal of Ahmedabad Dental College & Hospital. 2019;9:30–8.
12. Yazdi HK, Nasoohi N, Benvidi M. In Vitro Efficacy of Listerine Whitening Mouthwash for Color Recovery of Two Discolored Composite Resins. Front Dent. 2019;16(3):181–186. doi:10.18502/fid.v16i3.1589.
13. el Badrawy WA, McComb D, Wood RE. Effect of home-use fluoride gels on glass ionomer and composite restorations. Dent Mater. 1993;9(1):63–7. doi:10.1016/0109-5641(93)90108-3.
14. Paravina RD, Ghinea R, Herrera LJ, Bona AD, Igiel C, Linninger M, et al. Color difference thresholds in dentistry. J Esthet Restor Dent. 2015;27 Suppl 1:S1–9. doi:10.1111/jerd.12149.
15. Yilmaz MN, Gul P, Altinok Uygun L. Kompozit Rezinlerin Renkleşmeye Duyarliligi Uzerinde Cila Sistemlerinin Rolu. Turkiye Klinikleri J Dental Sci. 2020;26(1):86–93. doi:10.5336/dentalsci.2018-64331.
16. Alshali RZ, Salim NA, Satterthwaite JD, Silikas N. Post-irradiation hardness development, chemical softening, and thermal stability of bulk-fill and conventional resin-composites. J Dent. 2015;43(2):209–18. doi:10.1016/j.jdent.2014.12.004.
17. Gürdal P, Akdeniz BG, Hakan Sen B. The effects of mouthrinses on microhardness and colour stability of aesthetic restorative materials. J Oral Rehabil. 2002;29(9):895–901. doi:10.1046/j.1365-2842.2002.00924.x.
18. Lee YK, El Zawahry M, Noaman KM, Powers JM. Effect of mouthwash and accelerated aging on the color stability of esthetic restorative materials. Am J Dent. 2000;13(3):159–61.
19. Eimar H, Siciliano R, Abdallah MN, Nader SA, Amin WM, Martinez PP, et al. Hydrogen peroxide whitens teeth by oxidizing the organic structure. J Dent. 2012;40 Suppl 2:e25–33. doi:10.1016/j.jdent.2012.08.008.
20. Tredwin CJ, Naik S, Lewis NJ, Scully C. Hydrogen peroxide tooth-whitening (bleaching) products: review of adverse effects and safety issues. Br Dent J. 2006;200(7):371–6. doi:10.1038/sj.bdj.4813423.
21. Harorli OT, Barutcigil C. Farkli Beyazlatici Agiz Gargaralarına Maruz Birakilan Bir Nano-Hibrit Kompozitin Renk Degisikliginin Incelenmesi. Ann med health sci res. 2013;2(1):15–18.
22. Vichi A, Ferrari M, Davidson CL. Color and opacity variations in three different resin-based composite products after water aging. Dent Mater. 2004;20(6):530–4. doi:10.1016/j.dental.2002.11.001.
23. Barutcigil C, Yıldız M. Intrinsic and extrinsic discoloration of dimethacrylate and silorane based composites. J Dent. 2012;40 Suppl 1:e57–63. doi:10.1016/j.jdent.2011.12.017.
24. Mundim FM, Garcia Lda F, Pires-de Souza Fde C. Effect of staining solutions and repolishing on color stability of direct composites. J Appl Oral Sci. 2010;18(3):249–54. doi:10.1590/s1678-77572010000300009.
25. Nasim I, Neelakantan P, Sujeer R, Subbarao CV. Color stability of microfilled, microhybrid and nanocomposite resins–an in vitro study. J Dent. 2010;38 Suppl 2:e137–42. doi:10.1016/j.jdent.2010.05.020.
26. Ruyter IE, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. Dent Mater. 1987;3(5):246–51. doi:10.1016/s0109-5641(87)80081-7.
27. Khokhar ZA, Razzoog ME, Yaman P. Color stability of restorative resins. Quintessence Int. 1991;22(9):733–7.