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CONGRESS PROCEEDING

Effects of Different Beverages on Color Stability of Bulk-Fill Restorative Materials

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Abstract

Purpose: The aim of the study is to evaluate the color stability of a conventional composite resin and bulk-fill composite resins.
Material Methods: A total of 120 samples of 10 mm diameter and 2 mm thickness were prepared from three bulk-fill (Beautifil Bulk-Fill, Filtek One Bulk-Fill, Tetric N-Ceram Bulk-Fill) and one conventional composite (Z250) and light cured. Initial color measurements were made with a spectrophotometer. Samples for each composite were randomly divided into 3 groups (black, kombucha and matcha tea) (n = 10). The samples were kept in the solutions for 12 days, and the color measurement was repeated. The values of δL, δa, δb and $\delta E00$ were calculated. SEM images were taken from a randomly selected sample from each group. Two-way analysis of variance (ANOVA) with Bonferroni correction was used to evaluate the color parameters.
Results: Beautifil composite showed the greatest change in all values of E00, δL, δa, and δb., Filtek One and Tetric N-Ceram had the highest $\delta E00$ values values after Beautifil, respectively, and there was no difference between Z250 and Tetric N-Ceram. The lowest δL value belonged to Z250 composite, there was no difference between Tetric N-Ceram and Filtek One. Tetric N-Ceram had the highest δa value after Beautifil and, there was no difference between the Z250 and Filtek One. Filtek One had the highest δb value after Beautifil, there was no difference between the Tetric N-Ceram and Z250.
Conclusion: Beverages can negatively affect the surface properties of bulk-fill composite resins in terms of color stability.

Key words: bulk-fill; color stability; tea; spectrophotometer

Introduction

Resin-based composite materials (RBCs) are preferred for the direct restoration of posterior teeth because of their ability to adhere to the dental hard tissue, superior esthetics, and conservative tooth preparation, and their cost-effectiveness.[1] In dental treatments, the requirement for good esthetic and mechanical properties has led to the production of several new resin-based restorative materials. The disadvantages of the layering technique in the clinical application of conventional composites, which include a gap or contamination between the composite layers, the failure of interlayer bonding, and time-consuming clinical application, have led to the development of bulk-fill RBCs.[2] Bulk-fill RBC materials have become widely used for posterior teeth restoration due to their ability to fill a single increment up to 4–6 mm. In addition, the translucency of bulk-fill RBCs has been improved for deeper polymerization. Bulk-fill RBCs also contain a lower filler amount and an enlarged filler size, shrinkage stress relievers, polymer isolator modulators, and additional light-reactive photoinitiator systems.[1]

It has been claimed that bulk-fill RBCs have a higher polymerization depth and lower polymerization shrinkage than conventional RBCs. Bulk-fill composites are categorized into different types according to their viscosity, filler content, and indication, etc.[1,3] The long-term durability of RBC restoration depends on the restorative material (e.g., the monomer structure, filler size, type and loading, and monomer conversion rate) and the oral conditions.[4] Oral environment variables such as thermal changes, masticatory stresses, and chemicals from food and beverages, etc., have a significant impact on the restoration. Exposure to saliva, food components, and beverages in the oral environment can degrade the restoration and adversely affect esthetic and physical properties such as surface roughness, microhardness, color stability, and translucency.[5] Recently, people have become more interested in healthy food and healthy drinks. Kambocha tea is a popular fermented beverage that has been reported to have antioxidant and anti-inflammatory properties[6]. Matcha tea has also been proven to increase antioxidant properties and cognitive functions, and its consumption is rapidly increasing[7]. However, to our knowledge, no previous dentistry

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studies have investigated the effects of Kombucha and matcha tea on dental restorations. Although bulk-fill composite resin materials are widely used in dentistry practice, the literature contains limited studies evaluating the surface roughness of bulk-fill composite resins after beverage immersion.[1,3] Investigation of the physical and mechanical properties of composite resin materials depending on oral environment variables has substantial importance for clinicians in choosing the right restorative material.[1] Also, no previous study has evaluated the surface properties of giomer-based bulk-fill composite resins after beverage immersion. The aim of this study was to evaluate the effect of different teas on the surface roughness and surface morphology of conventional and three-fluoride-containing bulk-fill composite resins. The null hypothesis was that exposure to different teas does not affect the surface roughness of the tested composite resins.

Materials and Methods

A total of 120 samples, 10 mm in diameter and 2 mm thick, were prepared for three bulk-fill (Beautifil Bulk-Fill, Filtek One Bulk-Fill, and Tetric N-Ceram Bulk-Fill) and one conventional composite (Filtek Z250) using polytetrafluoroethylene molds. The detailed information about the materials was given at Table 1. The samples were polimerized for 20 sec with a light-curing device and left in an incubator in 37° distilled water for 24 hr to complete the polymerization. The upper surfaces of the samples were polished with polishing discs ranging from coarse to fine-grained. Initial color measurements were made with a spectrophotometer according to the CIELab. Four measurements were taken from each sample, and the average values were recorded. Samples of each composite were randomly divided into three groups (black tea, kombucha tea, and matcha tea) (n = 10). The samples were immersed in the tea solutions for 12 days[4], after which the color measurements were repeated. The values of δL, δa, δb, and $\delta E00$ were calculated. Scanning electron microscopy (SEM) images were taken of a randomly selected sample from each group. In the statistical analysis of the data, compliance with normal distribution was examined using the Shapiro–Wilk test. Two-way analysis of variance (ANOVA) with Bonferroni correction was used to evaluate the color parameters.

Results

The results were shown at Table 2 and 3. All differences were statistically highly significant. The Beautifil composite showed the greatest change in all values of E00 (8.93 ± 3.17), δL (-5.56 ± 1.58), δa (1.41 ± 0.98), and δb (12.07 ± 6.68) ($p < 0.01$). The matcha tea solution had a different effect on the different composites ($p < 0.01$) in all composites E00 (4.03 ± 5.10), δL (-1.21 ± 2.17), δa (0.05 ± 0.43), and δb (6.53 ± 8.71) values. When the $\delta E00$ values were compared, the greatest color change after the Beautifil composite was in the Filtek One composite (2.91 ± 0.99) and the Tetric N-Ceram composite (1.30 ± 0.74), and there was no difference between Filtek Z250 (0.82 ± 0.32) and Tetric N-Ceram (respectively, $p < 0.01$, $p < 0.01$, $p = 0.322$). The lowest δL value belonged to the Filtek Z250 composite (0.05 ± 0.74), and there was no difference between Tetric N-Ceram (-0.89 ± 0.86) and Filtek One (-1.00 ± 0.71) ($p < 0.01$, $p > 0.05$). When the δa values were compared, the highest value after Beautifil was in Tetric N-Ceram (0.62 ± 0.28). There was no difference between the Filtek Z250 (-0.17±0.22) and Filtek One (-0.05 ± 0.38) samples, which had a lower δa value than Beautifil and Tetric (respectively, $p < 0.01$, $p > 0.05$, $p < 0.01$). When the δb data were evaluated, it was found that there was no difference between the Tetric N-Ceram (0.78 ± 1.36) and Filtek Z250 (1.16 ± 0.77) with the lower δb value, Beautifil (12.07± 6.68) had the highest value and it was followed by Filtek One (5.53 ± 2.10) (respectively $p>0.05$, $p<0.01$, $p<0.01$,). SEM images were shown at Figure 1. Beautifil groups in all solutions had the most non-homogenous surface.

All experience indicates that distance education will be more than a necessity in the coming period. Especially, ensuring the continuity of service and education is very important in maxillofacial radiology, which is an indispensable branch for the scientific continuity of dentistry. Data obtained as a result of studies showed that distance education still has shortcomings in radiology practical training. Despite some drawbacks, the integration of online learning into radiology education should be utilized rapidly. It is inevitable to change hygiene habits after the pandemic and to make necessary changes in maxillofacial radiology education.

Discussion

Beautifil is a hybrid restorative material known as giomer. It has pre-reacted glass ionomer fillers within a resin matrix. Giomer composites release fluoride ions based on their water sorption characteristics. The pre-reacted zones of the giomer structure could cause osmotic pressure, which may increase the water sorption of the material. Water sorption enables water-soluble colorants to stain the composite material. In the present study, compared with other composite materials immersed in staining solutions, Beautifil had the highest color change values, which is similar to the findings of a previous study[2]. $\delta E00 > 1.8$ values were considered clinically unacceptable[8]. In the present study, Beautifil and Filtek One showed a clinically unacceptable color change. Bis-EMA is a highly hydrophobic resin monomer. It has been reported that better mechanical properties with lower water solubility in aqueous solutions might be obtained with Bis-EMA monomer[5]. When composite groups are examined in terms of color change, the conventional composite and the Tetric N-Ceram composite had the statistically lowest $\delta E00$ value. This may be related to the Bis-EMA content in their organic matrix. Because the resin matrix of a dental composite absorbs water, a lower filler ratio generall, leads to greater water sorption[2]. In the present study, Filtek One had the second highest $\delta E00$ value, after Beautifil, perhaps because Filtek One has a lower filler ratio than the conventional composite. In addition, Tetric N-Ceram and the conventional composite's hydrophobic bis-EMA content could be the reason of their color stability. Most resin-based materials contain camphorquinone (CQ) as a photoinitiator, which has been connected with discoloration. In Tetric N-Ceram, there are two additions to CQ: Ivocerin and Lucirin TPO. It has been reported that composite resins containing Lucirin TPO had a higher color resistance than composites with CQ[9]. The Bis-EMA and Lucirin TPO content could be the reason that Tetric N-Ceram had a lower $\delta E00$ value than Filtek One despite the similar filler ratio. Also, its glass filler particles may have enabled it to be more resistant to color change[10]. The highest δb (change of yellowness/blueness) values were observed for Beautifil, Filtek One, and the conventional composite while the lowest value was observed for Tetric N-Ceram. This may be related to the camphorquinone photoinitiator, which has shown a yellow color change over time.[9] There was a statistically significant difference between the means of the $\delta E00$ values of the different solutions ($p < 0.001$). Matcha had the highest staining capacity, which may be explained by the fact that its tannin content is higher than that of black tea[7]. This study did not investigate oral conditions since it was conducted entirely in vitro. Saliva has a pH neutralizing effect in the oral environment. Also, with oral hygiene routines, the extrinsic discoloration caused by beverages could be decreased or even inhibited. It would be appropriate to consider the effect of brushing in discoloration studies. Further in situ and in vivo studies are necessary to confirm the long-term effects of these teas on restorative materials. In future studies, these limitations should be considered.

Table 1. Details of the materials used in the study

Composite Resin Materials	Manufacturer	Type	Composition	Photoinitiator
Tetric N-Ceram Bulk Fill	Ivoclar Vivadent, Liechtenstein	Nano-hybrid	Monomers: Bis-GMA, UDMA, Bis-EMA Fillers: Barium aluminosilicate glass, prepolymer filler, ytterbium fluoride, spherical mixed oxide In total: 75-77 wt%, 53-55 vol% 0,4-0,7 μm	Camphorquinone Lucirin TPO Ivocerin
Filtek One Bulk Fill Posterior	3M Espe, St. Paul, MN, USA	Nano-hybrid	Monomers: AUDMA, AFM, DDMA, UMA Fillers: Ytterbium trifluoride (YbF3), zirconia filler, silica filler In total: 76 wt%, 58 vol% 0,004- 0,01 μm	Camphorquinone
Beautifil Bulk Fill	Shofu, Tokyo, Japan	Giomer	Monomers: Bis-GMA, UDMA, Bis-MPEPP, TEGDMA Filllers: S-PRG filler based on fluoroboroalumino silicate glass In total: 87 wt%, 74 vol%	Camphorquinone
Fitek Z250	3M Espe, St. Paul, MN, USA	Micro-hybrid	Monomers: Bis-GMA, UDMA, Bis-EMA, PEGDMA, TEGDMA Fillers: Modified zirconia/silica In total: 82 wt%, 68 vol% 0,01 μm to 3,5 μm with an average particle size of 0,6 μm	Camphorquinone

Table 2. Mean ± SD values of the $\delta E00$, δL, δa and δb of the composite resin groups.

	$\delta E00$	δL	δa	δb
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Beautifil	8.93 ± 3.17^{a}	-5.56 ± 1.58^{d}	1.41 ± 0.98^{g}	12.07 ± 6.68^{j}
Tetric	1.30 ± 0.74^{b}	-0.89 ± 0.86^{e}	0.62 ± 0.28^{h}	0.78 ± 1.36^{l}
Filtek One	2.91 ± 0.99^{c}	-1.00 ± 0.71^{e}	-0.05 ± 0.38^{i}	5.53 ± 2.10^{k}
Z250	0.82 ± 0.32^{b}	0.05 ± 0.74^{f}	-0.17 ± 0.22^{i}	1.16 ± 0.77^{l}

Two way ANOVA test *p<0.05
** Superscripts indicate statistical differences in the same column

Table 3. Mean ± SD values of the $\delta E00$, δL, δa and δb of the immersion solution groups.

	$\delta E00$	δL	δa	δb
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Tea	3.33 ± 3.12^{a}	-2.01 ± 1.85^{c}	0.46 ± 0.94^{e}	4.71 ± 2.94^{h}
Kombucha	3.11 ± 3.12^{a}	-2.32 ± 3.00^{c}	0.84 ± 0.86^{f}	3.41 ± 3.52^{i}
Matcha	4.03 ± 5.10^{b}	-1.21 ± 2.17^{d}	0.05 ± 0.43^{g}	6.53 ± 8.71^{j}

Two way ANOVA test *p<0.05
** Superscripts indicate statistical differences in the same column

Conclusion

Beverages can negatively affect the surface properties of bulk-fill composite resins in terms of color stability. Beautifil bulk-fill composite resin containing previously reacted glass ionomer particles was found to have lower color stability than other bulk-fill composites.

Acknowledgment

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Author Contributions

E.Ö. and A.K. have contributed to; conception and design of the study, data collection. A.K. analyzed the data. E.Ö. wrote the manuscript and revised the final version of the manuscript.

Conflict of Interest

Authors declare that they have no conflict of interest.

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