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Evaluating the Discoloration Effect of Tea on Kalore and Gradia Composites

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ABSTRCAT

Background and Aim: Discoloration of composite restorations over time is among common factors causing their replacement, which weakens the tooth structure and causes pulpal injury. Since tea is a common drink among Iranians, the current study aimed to evaluate the discoloration effect of tea on Kalore and Gradia composite resins.

Materials and Methods: This experimental study was performed on 20 disc-shaped specimens of two composites, Kalore and Gradia. Ten specimens of each composite type with subgroups of 5 were stored in tea and distilled water for 72 Hours. Color measurements were obtained using Spectrophotometer (Minolta, Japan) before and after immersion in solutions. Final spectrophotometry was done after polishing. The results were analyzed using Kruskal-Wallis test.

Results: The discoloration value of both composites increased significantly after being immersed in tea ($P<0.001$). Discoloration in Kalore was higher than Gradia ($P<0.014$); and amount of discoloration was clinically unacceptable for both composites. ($\Delta E > 3/3$) After final polishing of the samples kept in tea, amount of discoloration decreased for both composites ($P<0.001$) and ($P=0.002$) respectively; this reduction was more prominent in Kalore ($P=0.008$). Nonetheless, discoloration value was yet clinically unacceptable

Conclusion: Immersing the composites in tea caused clinically unacceptable amount of discoloration in both Gradia and Kalore and polishing had more corrective effect on Kalore.

Key words: Tooth Discoloration; Composite Resin;Polishing

INTRODUCTION

Discoloration of composite resins following consumption of beverages can lead to patient dissatisfaction and spending much time and money on their replacement. [1] Adaptation of the color between tooth and restoration over time is one of the most important factors in acceptability of restorations. The restorative material must be similar to the natural tooth in terms of color, translucency and surface. These materials must also remain color stable in the long term.[2] Discoloration is the main reason of replacing these composite resins which is related to several factors such as the individual's oral hygiene, nutrition, smoking habits, food pigments and UV radiation. [1-4]

Discoloration in resin based composites can be intrinsic or extrinsic; the latter one mostly occurs in cases that the restoration surface is rough and uneven [3, 5 ,6] while the former occurs

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following chemical changes in resin matrix of the composite. It also depends on the filler-matrix attachment surface, size and distribution of filler particles, the degree and depth of polymerization, oxidation of amine compounds and polymer matrix structure, as well as the hydrophilicity degree of the matrix. [3, 7 ,8]

Drinking beverages such as tea is one of the causes of discoloration in resin restorations that leads to their replacement. [9, 10] Early replacement of restorations weakens the tooth structure following the extra removal of tooth tissue and causes pulp injury. Hence, color stability of composite restorations saves a lot of time and cost and causes lower injuries to the tooth tissue. [11, 12]

Recently, novel resin-based composites have come into market that are based on DX 511 monomer (new monomer technology from Dupont). The manufacturers claim these composites to be less stainable, with lower polymerization shrinkage and consequently lower marginal gap and microleakage; as well as better polishability and higher beauty and luster.[13-15]

Various studies have been performed concerning the discoloration effects of tea on composites [13-21]; however, none have focused on the color stability of composites based on Dupont technology, so far. The lack of adequate information regarding this issue led to the current study which was conducted to evaluate the effects of tea on discoloration of Kalore and Gradia composites in vitro.

Materials and Methods:

This in-vitro study was carried out on 20 samples from the two composite types, Kalore and Gradia (10 from each type)[1, 13-21]. To prepare the composite samples, sufficient amount of composites were placed in stainless steel molds (9mm diameter ×1mm thickness). After folding the Mylar strip, the samples were pressed on both sides using glass slabs (1mm thick) so that air trapping and unevenness of surface would be prevented. [13-21] Then, Demetron II (Kerr, Italy) with light intensity of 600mw/cm2 was used to cure the samples on each of the upper and lower surfaces 4 times, each time for 20 seconds, using overlapping technique. The output light intensity of the device was checked by radiometer prior to curing each single sample. [14, 20]The upper surface of the specimens were polished using medium, fine and superfine Sof-lex polish discs (3M, USA); accompanied with water. Each polish disc was used for 10 seconds; samples were polished for 30 seconds, overall. The discs were replaced for each specimen [1, 15, 17 ,18]. The samples were stored in distilled water (37°C) for 24 hours in dark room for completion of polymerization. [13-16]

Initial color measurement was performed using spectrophotometer (Minolta, Konica CS2000, Japan) upon standard white background.[2] To prepare the tea solution, a teabag (Lipton, England) was dipped in 200ml distilled water (100°C) for 2 minutes and then removed [17, 19]; distilled water at 37°C was used as control (13, [15, 17,18] Samples were constituted of groups of 10 from Kalore and Gradia composites that were randomly divided into two subgroups of 5; one to be stored in tea and the other in distilled water. [1, 15 ,21]

Accordingly, the groups were as following:

Group 1: Control group 1: five Kalore samples to be immersed in distilled water; Case group 1: five Kalore samples to be immersed in tea.

Group 2: Control group 2: five Gradia samples to be immersed in distilled water; Case group 2: five Gradia samples to be immersed in tea.

The samples immersed in above mentioned solutions were kept in containers with tight lid to prevent evaporation, and were all incubated at 37°C for 72 hours. [1, 18-20] The solutions were renewed every day. After 72 hours the samples were taken out of solutions, rinsed with distilled water flow and were dried with tissue paper. Next, spectrophotometry was performed on all samples. [16-18]

Samples were polished with each medium, fine and superfine Sof-lex (3M, USA) discs for 10 seconds (30 seconds overall), accompanied with water; then the final color measurement was performed [15, 17 ,18]. Values of Δa, Δb and ΔL

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were calculated for each environment. The total color difference (ΔE) was calculated via the equation [21, 22]. Kruskal-Wallis test was used to compare the indices L (lightness), a (redness-greenness) and b (yellowness-blueness).

Results:

This experimental research studied the discoloration of 20 composite samples (10 Kalore and 10 Gradia) in tea and distilled water environments. The indices of a, b, and L were measured before and after immersion in tea and distilled water, and after polishing; in addition, the values of Δa, Δb, Δl and ΔE were calculated for different environments. Obtained results were analyzed through Kruskal-Wallis test.

The results obtained before polishing revealed ΔE of Gradia and Kalore to have no significant difference after being immersed in distilled water compared with the baseline (P=0.859). Value of ΔE in both Gradia and Kalore increased considerably after being immersed in tea (P<0.001); ΔE of Kalore was significantly higher than Gradia in this environment (P=0.014). Color change value for both composites stored in tea was clinically unacceptable (ΔE>3.3) (Table 1).

Table 1: ΔE value in study groups after being immersed in distilled water and tea

Composites	Distilled Water	Tea	P.value
Kalore	0.68±0.34	11.64±3.28	P<0.001
Gradia	0.73±0.48	7.52±1.56	P<0.001
P.value	0.859	0.014	

According to the results, the highest changes were observed in index L followed by index b. The value of L declined significantly in both composites after immersion in tea environment (P<0.001); it was considerably higher in Kalore than Gradia (P=0.001).

Value of b index in Kalore composite was significantly lower than the initial value in tea environment (P=0.004); while it showed no significant difference in Gradia composite (P>0.066). Value of index a significantly increased in both composites after being immersed in tea (P<0.001); the changes of index a in tea environment was not significant between Kalore and Gradia (P=0.456).

With respect to the results obtained after polishing, ΔE of Kalore and Gradia composites that were immersed in distilled water had no significant difference after polishing, compared with ΔE calculated before polishing (P=0.189). Compared with the ΔE obtained before polishing, ΔE of Gradia composites that were stored in tea declined significantly after polishing (P<0.001). In Kalore composites that were stored in tea, ΔE decreased considerably after polishing compared with the number obtained before polish (P=0.002) This number in Kalore composite was significantly higher than Gradia (P=0.008); in other words, polishing influenced Kalore more than Gradia. After polishing, ΔE of both composite types stored in tea was still clinically unacceptable (ΔE>3.3) (Table 2).

Table 2: ΔE value in study groups after polishing

Composites	Distilled Water (after polishing)	Tea (after polishing)	P.Value
Kalore	0.52±0.25	5.3±1.34	0.001
Gradia	0.42±0.38	4.95±1.83	0.001
p.value	0.189	0.008	

Discussion:

The results of this study showed that the value of ΔE increased significantly in both composites after being stored in tea; this increase was considerably higher in Kalore. Color change in the two composites was clinically unacceptable (ΔE>3.3). The value of ΔE in the two composites stored in tea decreased significantly after the final polish. The decrease was notably higher in Kalore; however, the value of color change was still clinically unacceptable (ΔE>3.3). The value of ΔE after polishing was found to have no significant difference between two composites. Several studies have been performed concerning the effects of colorant solutions on color stability of composites and various results have been reported. [13-21]

Based on the results of the current study, after being stored in tea environment, the color change of Kalore nanohybrid composite was significantly more than Gradia microhybrid composite. This was in line with the results of studies by Ertas, Nasim, Molhotra et al.; which had already reported the discoloration of nanocomposites to be more than microhybrid composites after being stored in colorant environments. [14, 15,19] It was consistent with the study by Park et al. that had affirmed the discoloration of nanocomposites to be clinically unacceptable in colorant environments. [16] Our study was also in line with several studies that have reported the changes of L parameter as the most effective factor in composites color change. [14, 15] In the study by Piqqo et al., the discoloration value of Kalore composite was higher than Gradia, but the difference was not statistically significant since it can be attributed to the preparation method or the storage time of samples. [13]

However, the results of the study by Topcu et al. revealed that the effects of colorant beverages on Filtek Z250 microhybrid composites were less than effects observed on Filtek Supreme nanocomposites[18]. This difference can be related to the colorant storage environment and storage duration compared with the current study or the type of studied composites.

Since Kalore composite is newly marketed and adequate research has not been carried out on it, its color stability was essential to be studied. In this study, all samples were prepared in identical conditions, with identical dimensions and by the same operator. To complete the polymerization, the samples were stored in distilled water at 37°C for 24 hours [16, 17]

Being a common beverage among Iranians, tea was chosen as the colorant storage environment [13, 15 , 19]; therefore, the results can be beneficial for Iranian society. According to the previously performed researches, if a person drinks 2/3 cup of coffee daily over 15 minutes on average, so every 24 hours of storage in coffee equals a month of consumption [1, 17 , 19]; and 72 hours equals 3 months. However, this time span differs among different individuals depending on the amount of tea consumed daily and the total drinking time. Thus, coffee was replaced with tea since it is a common beverage among Iranians.

Color measurement can differ from one person to another; it may even be different in the same individual at various times. Factors such as exposure conditions, translucency, opacity, light distribution, and the human eye can influence the color assessment. In order to eliminate the subjective errors in this study, color measurement was carried out using the spectrophotometer (Konica, Minolta CS2000, Japan) belonging to Institute for Colorants, Paint and Coating which is highly precise and is considered to be superior to other color measurement methods. [15, 17] In this study, CIE L a b system was adopted for assessing the color change which is the most common color descriptive system.

ΔE<1 is not perceptible by human eye, 1<ΔE>3.3 is recognizable by experts, and ΔE>3.3 is differentiated by normal people (13-17). To simulate the mouth environment, the temperature was set at 37°C. [14, 16 , 19] The samples were identically polished using medium, fine and superfine paper polish discs. Polishing prior to being stored in solutions was done to simulate the clinical conditions, and polishing after storage in solutions to eliminate the

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deposition of adsorbed pigments [13, 14, 16] Measurement of color before and after polishing would separate the superficial and deep colors. The results of our study revealed that after being stored in tea environment, color change of Kalore composite was more than Gradia. ΔE of both composites declined significantly following polishing; however, this decline was higher in Kalore, indicating Kalore composites to have undergone surface discoloration, and Gradia to have undergone depth discoloration. In other words, polishing affects Kalore more than Gradia.

Considering the fact that the smaller the particles of composite, the more susceptible to erosion it would be, polishing can be more effective on these composites; i.e. these composites are more polishable. [17] Kalore composites are constituted of Nano fillers which can justify this issue. Meanwhile, a part of this issue can also be depended on the properties of the new monomer, DX511, which requires more complementary researches.

Mundim et al. studied the discoloration effects of coffee on composites and reported final polishing to have considerably improved the composite color.[17] Every single component of the composite can contribute to the intrinsic or extrinsic discoloration. Stainability degree of the composite can be impacted by several factors including chemical changes of the resin matrix, physical and chemical properties of the resin matrix such as water absorption degree and its hydrophilic properties, quantity and quality of the filler-matrix interface, proportion of filler to matrix, amount and size and distribution of filler particles, polymerization of inorganic phase, silanization and amount of silane, as well as extrinsic factors like diet, oral hygiene, and UV radiation [13-19] Increasing the filler percentage in nanocomposites has been made possible through alignment of nanoparticles in the space between the polymer chains.

Regarding the manufacturer's claim about the better polishability and the smoother surface of nanocomposites, they were expected to become more resistant to staining; while the results of the current study and some others revealed the nanocomposites to be more stainable than microhybrid ones.[14, 15 ,19] This can be due to the very small size of the filler particles that increase the particles surface and consequently prevent the silanization process to be performed well; so no tight connection would be established between the filler particles and resin matrix. It is mostly observed in those types with cluster form fillers which would undergo plastiaizig in resin part and silane hydrolysis over time and through absorption of water. Consequently, microscopic cracks would be created and would lead to degradation of mechanical properties and decrease in restoration lifetime besides discoloration.

Heterogeneity of fillers and presence of nanoclusters can cause more porosity in some nanocomposites which would result in higher stainability and more color absorption [18] Among the weak points of composite is the filler-resin interface which is so sensitive to water absorption. Nanocomposites need more silane due to silanization of fillers, their small size of filler particles and the broader interface they have. Therefore, the technical sensitivity of this process is high. Having hydrophilic groups, silane and the initiator tend to absorb hydrophilic molecules.

If the composite could absorb water, so it would also absorb colorant beverages and undergo discoloration [22]; exactly the issue that the current study has demonstrated. The stainability was also related to the chemical erosion of the resin matrix that is followed by chemical destruction and hydrolytic decomposition of the filler particles. [13] One of the priorities of this study was selecting two composites from the same manufacturer that decreased the variables of the research. Meanwhile, no considerable difference was observed between Kalore and Gradia composites regarding their amount and the filler material.

The pigments are absorbed and precipitated in the inorganic phase of composite resins. [13,19]Having hydrophilic or hydrophobic monomers, the combination and the structure of

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matrix can influence the color stability. As an example, compared to methacrylate-based monomers, UDMA-based monomers are less prone to change color because of low viscosity, less water absorption, and better polymerization with visible light. [18]

In this study, the resin matrixes of the two composites were similar in having UDMA-based and dimetacrylate co-monomers; and this was among the strong points of our study. Only Kalore included some amount of the novel monomer, DX511. Thus, higher stainability of this composite can be related to this new monomer and its physical and chemical properties which are not completely known yet. Besides, the polymerization degree of this composite that can play an important role in discoloration is not yet known.

The surface or extrinsic color change is closely related to hygiene, nutrition and patient's habits [13]; since the current study was carried out in vitro, clinical generalizability of it depends on performing clinical studies. In addition, many studies are required to be conducted evaluating other physical and chemical properties of composites.

Conclusion:

Immersion in tea caused unacceptable discoloration in Kalore and Gradia composites and polishing had more corrective effect on discoloration of Kalore composite.

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