Color Stability of Composite Resin after Immersion in Local Kashmiri Staining Solutions and Beverages

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ABSTRACT

Introduction: Long term success of any composite resin restorative materials mainly depends on their color stability. The aim of the investigation was to examine the color stability of three resin-based composite materials with a high content of inorganic filling material (Spectrum, Filtrex Z350 and Tetric N Ceram).

Material and Methods: Changes in color of test samples were determined after complete immersion in test solutions used primarily in Kashmiri population viz. Kashmiri tea, Saffron Kehwa and a turmeric solution. Color differences were measured by using a spectrophotometer and CIE L*a*b* color scale and the total amount of color difference was represented as ΔE.

Results: For all composite resins, Turmeric solution caused the most severe cases of discoloration (ΔE > 8.25). Kashmiri tea and Saffron Kehwa caused invisible (ΔE <1) or visible (ΔE >1) discoloration. In some samples clinically unacceptable (ΔE > 3.3) discoloration was noted.

Conclusion: No significant difference was found among the composite resins or between color values of specimens immersed in Kashmiri tea or Saffron kehwa. Immersing specimens in turmeric solution caused greater color change in all types of composite resins tested. It is apparent from the results that it is essential to improve the color stability of the composite resin materials used in esthetic zone.

Keywords: Color; Composite Resin; Saffron Kehwa.

INTRODUCTION

Color stability of composite resin restoration is most important criterion for their selection.[1] The problem of composite resin color change is well acknowledged by dentists.[2]

Color change usually occurs due to three reasons: 1) extrinsic factors due to accumulation of plaque and stains; 2) deep adsorption of staining substances;3) intrinsic discolorations due to physicochemical reactions in the resin matrix or polymeric matrix structure.[3] Degree of color change due to external sources varies from patient to patient and is based on the oral hygiene status, nutritional habits, cigarette smoking and consumed beverages.[4]

Composite structure and the amount of inorganic fillers content as well as type of fillers have a direct impact on resin surface smoothness[5] and susceptibility to extrinsic staining.[6] Surface roughness of composite restoration affects its durability as well as color stability. Reduction of surface roughness of a restoration is essential to prevent external staining. Apart from material's composition, finishing and polishing techniques can also influence the surface texture and stainability of the restoration.[6] In the recent years, various types of composite resins in different shades have been introduced to the market that are selected based on their tooth color coordination. Several types of composites are available for esthetic restorations of both anterior and posterior teeth, however, each differ from other according to the type of resin matrix, size, type, and amount of filler content. The type of beverages consumed also influences the staining of composite resins.

Beverages taken by Kashmiri population reflect strong Central Asian influences. As the beverages taken by Kashmiri population are different from rest of the world, the purpose of this study was to determine the color stability of 3 commercially available composite resins in different beverages/staining solutions mainly used in Kashmir (Kashmiri tea, turmeric solution and Saffron kehwa). Several studies have been conducted to determine the effects of staining solutions on the surface characteristics of esthetic restorative materials however there is no study done with Kashmiri beverages.

MATRIAL AND METHODS

Three direct composite resins currently indicated for esthetic restorations were used in the present study. Information regarding composite type, composition, curing time and manufacturer is given in Table 1.

Ninety specimens of each composite material (A2 Shade) were fabricated using a plastic mold (10mm diameter and 3 mm thick). Each material was inserted into the mold in 1.0-mm-thick increments photo-activated with a LED light-curing unit (DentAmerica), for 20 seconds, according to the manufacturer's instructions(Table 1). The specimens were finished and polished with aluminum oxide; SofLex discs (3M ESPE, USA) in a sequence of decreasing abrasiveness with light intermittent pressure using low speed handpiece.

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The specimen surface were moistened at each disc change. Thirty samples of each group were randomly divided into 3 subgroups for the 3 understudy solutions (n=30). Solution were placed in the stainless steel container, marked and labelled (Table-2,3). Each composite disc was placed in the solution and completely submerged. Kashmiri tea was prepared by boiling 15g of Kashmiri tea in 500 ml for half an hour. After attaining dark brown color the solution was filtered and poured in container. Once cooled the samples were immersed in the solution. Saffron kehwa was prepared by boiling 2-3 stigmas of saffron flowers in 100ml of water. After boiling for 15 minutes, it was poured in container. Samples were completely immersed in solution. The solution was changed after every 5 days. Turmeric powder was purchased from market and 50g powder was mixed with 500ml water. The suspension was filtered and composite discs were immersed into liquid. Fresh suspension was made after every 5 days. All the containers were sealed in order to prevent evaporation of liquid and stored in incubator at 37°C.

Preparation of testing solutions:

S. No	Testing solution	Preparation
1	Turmeric suspension	50g/500ml in water and filtered.
2	Kashmiri Tea	15g/500ml boiling water for 30 min. and filtered.
3	Saffron Kehwa	2 stigmas/100ml water rubbed for 5min.

Labelling of samples: Labelling of samples is shown in Table III and IV

Testing of Samples

Experimental recordings were taken before immersion and after 1 month of exposure to staining solutions. Before any readings, the specimens were removed and rinsed in distilled water and excess water were removed with tissue paper and specimens allowed to dry. The effect of the solution on the composite resin was measured with the help of spectrophotometer (Perkin Elmer Lambda 35, USA). Baseline color was measured according to the CIE L*a*b* color scale (Commission Internationale de I'Eclairage) relative to the standard illuminant D65 over a white background on a reflection spectrophotometer. The CIE L*a*b* color system is a 3-dimensional color measurement: L* refers to the lightness coordinate and its value ranges from 0 for perfect black to 100 for perfect white. a* and b* are chromaticity coordinates on the green-red (-a*=green; +a*=red) and blue-yellow (-b*=blue; +b*=yellow) axes.[7-9]

Color difference (ΔE) after treatment with beverages was calculated between the color coordinates before (baseline) and after treatment as measured in the reflectance mode by applying the formula $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.[7] Central square area with measurements of 2x2mm were selected to determine color change by using a spectrophotometer. The average of the 3 readings was recorded and the mean of each material was calculated with the use of the CIE Lab uniform color scale.

RESULT

A total of 270 specimens were evaluated for color alteration (ΔE) as a dependent variable. Analysis of variance and post hoc Tukey tests were carried out to check the significance. The minimum value was ΔE 1.20 for Filtrex Z350 stored in saffron kehwa while the maximum value of ΔE 8.25 was obtained for Spectrum stored in turmeric solution. The means and standard deviations of color change (ΔE) are presented in table 4. Color change in composites immersed in turmeric solution are significantly higher ($p<0.05$) than that in composites immersed in other beverages.

Commercial name	Type	Major Resin Components	Curing Time	Manufacturer
Spectrum	Microhybrid composite	Bis-GMA[a], Bis-EMA[b], TEGDMA[c]	20 s	Dentsply/Caulk, Milford, DE, USA
Filtek-Z350	Nanohybrid composite	Bis-GMA, UDMA[d], Bis-EMA, TEGDMA	20 s	3M ESPE, St. Paul, MN, USA
Tetric N ceram	Nanohybrid composite	Bis-GMA, Bis-EMA	20 s	Ivoclar vivadent AG Liechtenstein
a= Bisphenol-A-glycidyl dimethacrylate; b= Ethoxylated bisphenol-A-dimethacrylate; c= triethylene glycol dimethacrylate; d= urethane dimethacrylate.				

Table-1: Type of composite resin used:

Composite resin	Beverage
(F): Filtrex Z 350	K: Kashmiri Tea
(S): Spectrum	X: Turmeric Suspension
(T): Tetric N Ceram	Z: Saffron Kehwa

Table-2: Labelling of Composite Resin and beverages used.

FK	SK	TK
FX	SX	TX
FZ	SZ	TZ

Table-3: Labelling of 9 samples

composite	Kashmiri Tea	Saffron Kehwa	Turmeric
Spectrum	2.98±0.64	2.18±0.87	6.75±1.50*
Filtrex Z350	2.55±0.88	1.85±0.66	5.94±1.56*
Tetric n Ceram	2.60±1.23	2.02±0.36	6.23±0.71*
*indicates statistically significant difference with p value < 0.05			

Table-4: Means (standard deviation) for color changes (ΔE) values of tested materials (ANOVA, Tukey HSD test; p<0.05).

DISCUSSION

Color stability is a fundamental factor for long term esthetic results of tooth-colored restorations. An acceptable restoration must not only provide an initial shade match, but also maintain an esthetic appearance over the years in the restored tooth. Therefore, stain ability of materials should also be considered in selection criteria for use in an esthetic zone.

The present study assessed the color stability of different types of composite resins when submitted to the action of staining solutions present in widely consumed beverages in Kashmiri population. Color change can be assessed visually[10] or by specific instruments. In present study, spectrophotometry and the CIE L*a*b* coordinate system were used as has been used in previous studies.[11,12] CIE Lab system is a uniform 3-dimensional system which is widely used in determining chromatic differences and is more advantageous than Munsell color system. The value of ΔE* represents relative color changes that an observer might report for the materials after immersion or between time periods and have advantages such as repeatability, sensitivity and objectivity. Thus ΔE* is more meaningful than the individual L*, a*, b* values.[13]

Several authors have reported that color change (ΔE) ranging from 1 to 3 are perceptible to the naked eye[14] and (ΔE) values greater than 3.3 are clinically unacceptable.[15] Ruyter et.al. (1987)[15] suggested that the ΔE value of 1 unit is "visually perceptible." A ΔE color alteration between 1 and 2 is clinically acceptable and above 3.3 is considered clinically unacceptable. Considering these concepts, the composite resins tested in the present study showed unacceptable color changes when stored in turmeric solution(Table 5). The different composite resins tested in this study did not show statistically significant change in color after immersion in saffron kehwa and Kashmiri tea, but significant color change was observed after immersion in turmeric. Stober et.al (2001)[16] also verified a strong staining effect of composites after storage in turmeric solution for 8 weeks. Major constituents of turmeric are curcuminoids, the yellow coloring pigments that are responsible for staining composite resins. Smaller molecular size of curcuminoids coupled with water absorbed characteristics of the resins create a stronger staining effect. Composite resins usually absorb water and in doing so also absorb other fluid pigments, which results in discoloration. Water acts as a vehicle for stain penetration into the resin matrix.[17] Water sorption occurs mainly as direct absorption in the resin matrix. The effect of turmeric solution in terms of color change was maximum because the colorant of turmeric is more polar. Whenever the colorant is more polar and is thereby more hydrophilic, it staining effect is more in composite resin restoration.

The amount of unreacted monomer is directly dependent on the degree of conversion. Degree of conversion of composite resins light-cured under identical conditions ranges according to concentration of some monomers as some monomers present lower degree of conversion than others in the following order: Bis-GMA < Bis- EMA < UDMA < TEGDMA.[18] However, in the present study, these differences were not evident, as no significant difference in color change was noted among the tested composites, and all composites presented color alteration only when immersed in turmeric solution. Manufacturers are decreasing the particle size of fillers in order to increase smoothness[19] and decreasing solubility[20] as well as improving upon color stability as a result of higher monomer conversion.

Namkeen tea showed maximum discoloration for composite resin next to turmeric solution. The discoloration in tea is mainly due to adsorption of polar colorants on the surface of resins. Tannic acid, which is present in tea is the main cause of staining. Further fine tea particles get deposited in the interfacial gaps. Presence of microcracks into the resin matrix as a result of swelling and plasticizing effects along with interfacial gaps created between filler and resin matrix allow stain penetration and discoloration of the restoration.[21] The gaps may have formed due to polymerization shrinkage of resins during curing. Namkeen tea contains baking powder that has abrasive properties attacking the resin and making it more susceptible to microcracks and staining.

Least discoloration was noted in Saffron Kehwa. This result is attributed to minute quantity of saffron added to the beverage and the removal of accumulated layers. As the Saffron Kehwa layer on specimens reached a certain thickness, they tend to break away from the surface of the samples and return to the solution. The staining became more intense with time i.e. ΔE value for color change increased with time but the rate doesn't remain the same for 1 month. Rate of staining decreased with time due to saturation of colorant in the composite resins.

4It has been reported that composite resins with a lower amount of inorganic fillers presented more color change because the greater resin matrix volume allows greater water absorption.[11,22] Vichi, et al (2004)[23] also observed a greater color stability for Z-100 (66% of inorganic particles in weight) when compared to Tetric-Ceram (60%) and Spectrum TPH (57%). Liporoni, et al.(2003)[24] suggested that the discoloration of resin veneers can be partially removed by in-office bleaching and repolishing procedures.

CONCLUSION

Methodological limitations for in vitro studies are inherent in the assessment of color stability. In-vitro studies try to simulate the effects of long-term exposure in an oral environmental in a short time period, aiming to predict the clinical performance of materials, however, in the oral environment, the saliva and other fluids may dilute the stains. Furthermore, the contact of dental structures and restorative materials with staining agents is intermittent and may be exacerbated by mechanical wear.

REFERENCES

1. Kolbeck C, Rosentritt M, Reinhold L, Handel G. Discoloration of facing and restorative composites by UV-Irradiation and staining food. J Dent Pat. 2006;22:63-68.
2. Crumpler DC, Heymann HO, Shugars DA, Bayne SC, Leinfelder KF. Five-year clinical investigation of one conventional composite and three microfilled resins in anterior teeth. Dent Mater. 1988;4:217-22.
3. Asmussen E, Hansen EK. Surface discoloration of restorative resins in relation to surface softening and oral hygiene. Scand J Dent Res. 1986;9:174-7.
4. Guler AU, Yilmaz F, Kulunk T, Guler E, Kurt S. Effects of different drinks on stainability of resin composite provisional restorative materials. J Prosthet Dent. 2005;94:118-24.
5. Tjan AHL, Chan CA. The polishability of posterior composites. J Prosthet Dent. 1989;61:138-46.
6. Shintani H, Satou J, Satou N, Hayashihara H, Inoue T. Effects of various methods on staining and accumulation of Streptococcus mutans HS-6 on composite resins. Dent Mater. 1985;1:225-7.
7. Villalta P, Lu H, Okte Z, Garcia-Godoy F, Powers JM. Effects of staining and bleach- ing on color change of dental composite resins. J Prosthet Dent 2006;95:137-42.
8. Schulze KA, Marshall SJ, Gansky SA, Mar- shall GW. Color stability and hardness in dental composites after accelerated aging. Dent Mater 2003;19:612-9.
9. Bagheri R, Burrow MF, Tyas M. Influence of food-simulating solutions and surface finish on susceptibility to staining of aesthetic re- storative materials. J Dent 2005;33:389-98.
10. Yap AU, Tan KB, Bhole S. Comparison of aesthetic properties of tooth-colored restorative materials. Oper Dent. 1997;22:167- 72.
11. Fontes ST, Fernández MR, Moura CM, Meireles SS. color stabilty of a nanofil composite: effect of different immersion media. J.Appl.Oral Sci. 2009;17:388-91.
12. Johnston WM, Kao EC. Assessment of appearance match by visual observation and clinical colorimetry. J Dent Res.1989;68:819-22.
13. Khokhar ZA, Razzoog ME, Yaman P. Color stability of restorative resins. Quintessence Int. 1991;22:733-7.
14. Noie F, O'Keefe KL, Powers JM. Color stability of resin cements after accelerated aging. Int J Prosthodont. 1995;8:51-5.
15. Ruyter IE, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. Dent Mater. 1987;3:246-51.
16. Stober T, Gilde H, Lenz P. Color stability of highly filled composite resin materials for facings. Dent Mater 2001;17:87-94.
17. Satou N, Khan AM, Matsumae I, Satou J, Shintani H. In vitro color change of composite-based resins. Dent Mater. 1989;5:384-7.
18. Sideridou I, Tserki V, Papanastasiou G. Effect of chemical structure on degree of conversion in light-cured dimethacrylate- based dental resins. Biomaterials. 2002;23:1819-29.
19. Reis AF, Giannini M, Lovadino JR, Santos Dias CT. The effect of six polishing systems on the surface roughness of two packable resin-based composites. Am J Dent. 2002;15:193-7.
20. Sideridou I, Tserki V, Papanastasiou G. Study of water sorption, solubility and modulus of elasticity of light-cured dimethacrylate- based dental resins. Biomaterials. 2003;24:655-65.
21. Bagheri R, Burrow MF, TYas M. Influence of food-stimulating solutions and surface finish on susceptibility to stainng of aesthetic restorative materials. J Dent. 2005;33:389-98.
22. Kalachandra S, Turner DT. Water sorption of polymethacrylate networks: bis-GMA/TEGDM copolymers. J Biomed Mater Res. 1987;21:329-38.
23. Vichi A, Ferrari M, Davidson CL. Color and opacity variations in three different resin-based composite products after water aging. Dent Mater. 2004;20:530-4.
24. Liporoni P, Paulillo LA, Cury JA, Santos Dias CT, Paradella TC. Surface finishing of resin-modified glass ionomer. Gen Dent. 2003;51:541-3.

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