An evaluation of the effect of different drinks on the color change of composan ceram composite resin (in vitro study)

Dr. Zahraa Nazar Al-Wahab, B.D.S., M.Sc.*

Abstract

The ability of tooth – colored restorative material to resist stain is important because discoloration of it may result in patient dissatisfaction and additional time and expense for replacement. However, the effect of different staining agents on the color difference of resin composite restorative materials has not been completely clarified.

The aim of this study was to evaluate the stainability of composan ceram resin composite upon exposure to different drinks.

Forty – two disk shaped specimens (10X2mm) were prepared from composan ceram using polytetraflouroethylen mold. The specimens were divided into six groups (n=7) and stored for 7 days at 37C̊ in different types of solutions (distilled water, coffee, coffee with sugar, coffee with sugar and artificial creamer, tea, tea with sugar). Color of all the specimens was measured before and after exposure with spectrophotometer using CIE L* a* b* relative and color changes (△E) were then calculated. The data were analyzed with one – way analysis of variance (ANOVA) and LSD test.

There was a highly significant difference when comparing the storage agents. Coffee solution produced the most severs stain and it stained composite more than tea. When tea and coffee groups with and without sugar were compared, both groups without sugar demonstrated a higher color difference than with sugar.

Coffee stained composite more than tea and the absence of sugar in coffee and tea increased color difference compared to coffee or tea with sugar.

Key words: (composan ceram, spectrophotometer, storage solutions).

Introduction

Advances in resin-bonding technology have resulted in resin-based composite, materials with lifelike characteristics, making these products the primary choice of dentists striving to meet patients' esthetic needs[1]. Due to the wide use of tooth-colored restorative materials, it is important to determine which one is susceptible to color change. To ensure excellent aesthetics, it is necessary for tooth-colored materials to maintain intrinsic color stability and a resistance to surface staining[2].

A restoration that undergoes significant discoloration may be a source of embarrassment for both the patient and the dentist. Indeed discoloration is considered a major esthetic failure in tooth – colored rest

* (Assistant lecturer, College of Healthy and Medical Technologies)

orations. However, dental resin based composites have been reported to change color because of intrinsic and extrinsic factors[3]. Intrinsic factors involve the discoloration of the resin material itself, such as the alteration of the resin matrix and the interface of matrix and fillers[4].These factors have a considerable influence on color stability which is usually attributable to chemical degeneration of the filler-resin bond and solubility of the resin matrix [5]. The cause for such chemical discoloration has been attributed to oxidation of the amine accelerator, exposure to various energy sources, while extrinsic factors include staining by adhesion or penetration of colorants, as a result of contamination from exogenous sources such as coffee, tea, other stain producing beverages and colored solutions [3]. Also external discoloration can be the result of dietary and smoking habits, bad oral hygiene and adsorption or absorption of water soluble stains throughout a resin matrix. The composition and size of the filler particles affect surface smoothness and susceptibility to extrinsic staining[5]. To study discoloration, the color change value must be evaluated which indicates the color stainability property of a material. It was stated that, the color change of a resin composite was influenced by many factors, such as shade of resin composite, curing condition, composite thickness, storage method of specimen during observation, length of observation period, color measurement method, and color measuring instrument[3].

Discoloration can be evaluated with various instruments. Since instrument measurements eliminate the subjective interpretation of visual color comparison[6], spectrophotometer and colorimeter, applied in both in vitro and in vivo environments, have made it possible to study the numerous parameters related to composite color stability[7]. Color change (ΔE) mathematically expresses the amount of difference between the L*a*b* coordinates of different specimens or the same specimen at different instances[8]. The Commission Internationale de l'Eclairage (CIE) L*a*b* color system, which is related to the color perception of the human eye for 3 coordinates, is an approximately uniform color space with coordinates for lightness, namely white-black (L*), red-green (a*), and yellow-blue (b*). A ΔE value of 3.7 or less is considered to be clinically acceptable[9].

The purpose of this study was to evaluate the stainability of composan ceram composite resin upon exposure to distilled water, coffee, coffee with sugar, coffee with sugar and artificial creamer, tea, and tea with sugar.

Materials and Methods

Six different solutions (distilled water, coffee, coffee with sugar, tea, tea with sugar, coffee with artificial creamer and sugar,) were evaluated and their effects on stainability of light curing glass ceramic microhybrid composite (Composan Ceram; Germany).

The restorative material and staining agents used in this study are shown in Table I.

Forty–two disk shaped specimens were prepared from the material using a polytetraflouroethylen mold. Each specimen had a diameter of 10 mm and a height of 2 mm[9]. Materials were dispended, manipulated, and polymerized according to the manufacturers' instructions into which the composite material was light polymerized for 40 seconds with a quartz tungsten halogen polymerizing light (Astralis 3;Ivoclar Vivadent, Schaan, Liechtenstien) with an output of 600 mW/ cm^2.

Group-W- specimens served as the control group, and specimens were stored in 37˚ C distilled water. Group -C- specimens were stored in 37˚C coffee (Nescafe Classic, Nestle, Switzerland); 5 g of the coffee was dissolved in 200 ml of boiling distilled water according to the manufacturer's suggested concentration. After 10 minutes of stirring, the solution was filtered through a filter paper. In the coffee with sugar groups (Group CS), specimens were stored in 37˚C coffee with sugar. In these groups, coffee was prepared as in Group C, and then 5 g of white sugar was added for every 200 ml. In the coffee with artificial creamer and sugar group (Group CSC), specimens were stored in 37˚C Nescafe and creamer (Nescafe; Nestle, Vevey, Switzerland). One packet of the prefabricated coffee mixture (coffee, artificial creamer, sugar; total 20 g) was dissolved in 200 ml of boiling distilled water according to the manufacturer's suggested concentration. Specimens in Group -T- were stored in 37˚C tea (Earl Gray; Lipton, Unilever Gulf, United Arab Emirates). The tea solution was prepared by immersing 1 prefabricated pack of tea into 200 ml of boiling distilled water for 10 minutes. In the tea with sugar groups (Group TS), specimens were stored in 37˚C tea with sugar. In this group, tea was prepared as in Group (T), and then 5 g of white sugar was added for every 200 ml. Before exposure to the staining agents, baseline color measurement of all specimens was recorded with the spectrophotometer. After 7 days storage in the solutions, the specimens were rinsed with distilled water for 5 minutes and blotted dry with tissue paper before color measurement. Color of the specimens was measured using:

$$\triangle E= [(L_1 - L_0)^2 + (a_1 - a_0)^2 + (b_1 - b_0)^2]^{½}$$

One – way analysis of variance (ANOVA) test was done to evaluate the effect of storage solutions on color change of composite resin to see if there is significance among groups then it followed by LSD test.

Results

Mean and standard deviation of color change values are presented in Table 2. Color change value for the C group was the highest, followed by CS group, T group, TS group, CSC group and the W group produced the lowest color change values.

One – way ANOVA test (in Table 3) revealed that, there was a highly significant difference when comparing between storage solutions and then LSD test was performed. From LSD test (in Table 4) it can be seen that there is a highly significant difference when comparing all the groups of storage solutions.

Discussion

The increasing demand for esthetic dentistry has been met with rapid development of new restorative materials. However failure or success of any esthetic restoration depends on the color matches and color properties[3]. Oral habits such as tobacco use and certain dietary patterns (for example, caffeine intake) may exacerbate the external discoloration of resin based composite material[1]. Color determination in dentistry can be divided into two categories: visual and instrumental. Instrumental colorimetry can potentially eliminate subjective errors in color assessment. Colorimetry and spectrophotometer are most exact than the naked eye in measuring slight differences in colored objects on flat surface[10]. The staining susceptibility of resin composites might be attributed to their degree of water sorption and hydrophilicity of the matrix resin. If the resin composite can absorb water, then it is also able to absorb other fluids, which results in its discoloration[11]. Water sorption occurs mainly as direct absorption in the resin matrix. The glass filler particles will not absorb water into the bulk of the material, but can adsorb water onto the surface[2].

In this study, six storage solutions were used for measuring color changes in composite resin. These solutions are distilled water, coffee, coffee with sugar, coffee with sugar and artificial creamer, tea, tea with sugar. Distilled water was used as a control and the other storage solutions were selected since they are widely used by the populations. Composite resin specimens were stored for seven days and at the end of storage period, color measurements were taken. The results of this study revealed that, distilled water showed no observed staining while coffee produced the most severe stain on composite resin. This finding agrees with Bagheri et al. in 2005, Omata et al. in 2006 and Villalta et al. in 2006 who found that, distilled water caused no perceptible color change on composite resin. This observation confirms the fact that water sorption by itself didn't alter the color of composite resin to a considerable extent[4].

In this study, when comparing between tea and coffee storage solutions, coffee stained composite resin more than tea and this is due to the fact that both coffee and tea storage solutions contain yellow colorants, which have different polarities. Higher polarity components (those in tea) are eluted first, and lower polarity components (that in coffee) are eluted later. Therefore, discoloration by tea was due to adsorption of polar colorants onto the surface of materials, which was removed by tooth brushing[2, 13], whereas discoloration by coffee was due both to adsorption and absorption of colorants[14, 2]. This absorption and penetration of colorants into the organic phase of the materials were probably due to compatibility of the polymer phase with the yellow colorants of coffee [2, 13] .This finding agree with Bagheri et al. in 2005 who determined the surface staining of resin based composites and glass ionomer cements after immersion in various stains and food stimulating solutions and this result agree with Guler et al in 2005 who evaluated the stainability of composite resin upon exposure to different staining agent. This finding disagrees with Ertas et al. in 2006 who evaluated the discoloration of different types of composite resin upon exposure to tea, cola, coffee, red wine and water. They claimed that there was no significant difference in color changes for composites stained in coffee or tea solutions. Also the finding of the present study disagree with Yazici et al in 2007, who claimed that the effect of coffee on color change of composite was similar to tea after storage in both solutions.

According to the results of present study, the presence of sugar in coffee and tea decreased the color difference, compared with coffee and tea without sugar. The reason for this may be due to the decrease of coffee concentration. This finding disagrees with Guler et al. in 2005 who evaluated the stainability of several types of composite resin upon exposure to different staining agents which are: water, coffee, coffee with sugar, tea, tea with sugar, coffee with artificial creamer and sugar, cola, red wine, or sour cherry juice. They claimed that, when tea and coffee groups with and without sugar were compared, both groups with sugar demonstrated a higher color difference than without sugar. They claimed that, the reason of this may be due to the sticky effect of sugar on the staining of coffee or tea.

In the present study, when comparing between groups of coffee solutions (coffee, coffee with sugar, coffee with sugar and artificial creamer), the coffee solution produced the most sever stain followed by coffee with sugar then coffee with sugar and artificial creamer. This agrees with Guler et al. in 2005 into which the presence of artificial creamer and sugar decreased coffee concentration.

Conclusions

The stainability of composan ceram composite resin was evaluated after seven days storage in different solutions. Within the limitation of this in vitro study, the following conclusions were drawn:

1- Color change values of tea with and without sugar, coffee with and without sugar, coffee with artificial creamer for composan ceram restorative material were greater than 3.7 and these values were considered visually perceptible.
2- The presence of sugar in coffee and tea decreased the color change, as compared with coffee and tea without sugar. These changes were found to be significantly different.

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Table 1: Materials used in the study

Product	Material Type	Manufacturer
Composan Ceram	Glass ceramic microhybrid composite (77%by volume inorganic filler. The monomer isBIS-GMA,UDMA, TEGDMA) Batch No. 2760	Promedica, Neumunster, Germany.
Nescafe Classic	Coffee	Nestle, Switzerland
Nescafe and creamer	Artificial Creamer	Nestle, Vevey, Switzerland
Lipton Earl Grey	Tea	Earl Gray; Lipton, Unilever Gulf, United Arab Emirates

Table 2: Mean and Standard Deviation SD of all groups

Group	EΔ
Group -W-	1.1 ± 0.2
Group -C-	8.8 ± 0.6
Group - CS -	7.2 ± 0.4
Group - CSC -	4.3 ± 0.2
Group -T-	6.1 ± 0.3
Group -TS-	4.9 ± 0.2

Table 3: One – Way ANOVA test among the data of the color change for each group

group	F-Value	P-Value	Significance
W	438.509	0.000	HS
C			
CS			
CSC			
T			
TS			

HS: highly significant at P<0.001

Table 4: LSD test comparing among groups

group	Difference between means	P-value	Sig.
W & C	-7.671	0.000	HS
W & CS	-6.100	0.000	HS
W & CSC	-2.200	0.000	HS
W & T	-5.014	0.000	HS
W & TS	-3.761	0.000	HS
C& CS	1.571	0.000	HS
C& CSC	4.471	0.000	HS
C& T	2.657	0.000	HS
C& TS	3.910	0.000	HS
CS& CSC	2.900	0.000	HS
CS& T	1.086	0.000	HS
CS& TS	2.339	0.000	HS
CSC & T	-1.814	0.000	HS
CSC & TS	-0.5614	0.00	S
T & TS	1.253	0.000	HS

HS: highly significant at P<0.001 S: highly significant at P <0.05