Original Article

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COLOR STABILITY OF NANO RESIN BASED COMPOSITE WITH NOVEL MONOMER AFTER THREE MONTHS STORING

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ABSTRACT:

Objectives: To investigate the effect of storing three months in organic media (coffee) on color stability of a nano resin based composite with novel monomer when compared with conventional one.

Methods: Initial color was recorded for specimens fabricated from nano resin based composite with novel monomer and conventional one. Specimens were stored at 37 C in coffee, for 3 months. Color changes were categorized using the CIE Lab color system. Data were submitted to analysis of variance for repeated measures, one-way ANOVA test (a = 0.05).

Results: The methacrylate-based resins based composites with novel monomers stored in coffee were significantly more stable by coffee than conventional methacrylate- based composites. They showed that ΔE of Venus Diamond (ΔE= 4.816 ± 0.568) was less than ΔE of Filtek Z350 XT (ΔE= 6.067 ± 0.725). There were no significant changes observed in ΔE both Venus Diamond composite and Filtek Z 350 XT. (P =0.05).

Conclusions: There were a slight effect of the immersion solution was noticed on color change in one of highest aggressive organic beverage materials. Color stability is material dependent.

Key words: Color changes, Beverages, Resin based composite, TCD- monomer.

INTRODUCTION:

Composite resins have been widely used as direct restoration in reconstruction anterior and posterior teeth, [1]. The great advances in material composition; physical and mechanical properties have made these materials a treatment of choice as direct composite veneers, [2]. Although ceramic veneers are highly esthetic and have advantage of color stability, limitations still exist in using ceramic veneers in all clinical situations, [3-5]. In spite of all these improvements there are compromising in longevity of resin composite [6-8]. Organic staining in the resin material surface or at matrix and filler interface [9], water and

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dye absorption by the material [10], surface roughness [11] is the main cause of color changes that cause improper aesthetic durability. In contrast, color change may be due to the chemical structure and size/type of composite filler particles [12].

Dental composites consist of a mixture of monomers and silane-treated filler particles such as quartz, zirconia, borosilicate and silica. While these materials undergo chemical degradation in the oral environment for long time interval [13]. The development of nano-hybrid resin composite attempted to revoke these deficits, promising both, excellent aesthetics and improved mechanical properties. Long-term vitro/vivo studies about durability of nano-hybrid resin composites to aesthetic and mechanical approach. All of these are forcing researchers to revoke the material's performance.

Part of improvements was occurred in filler systems, while more modern nano-hybrid resin composites presented by changing the monomer–matrix formulations. Besides traditional monomers like bis-GMA (bisphenol-A diglycidyl ether dimethacrylate), UDMA (urethane dimethacrylate) or TEGDMA (Triethylene- glycol dimethacrylate). This new generation of composite with new monomer is either by completely replacing monomers or by merging it with the traditional.

TCD-urethane monomers, TCD-urethane monomers are new methacrylic acid derivatives, containing urethane groups of tricyclodecanes (TCD), being prepared by reaction of hydroxyalkyl (meth) acrylic acid esters with diisocyanates and subsequent reaction with polyols, [14-16] [Venus Diamond and Venus Diamond Flow, Kulzer, Germany].

The null hypotheses was: there would be no significant difference in color changes of nano hybrid composite with novel monomer and traditional one after storing in coffee for three months.

MATERIAL AND METHODS:

Sample preparation: 20-discs (n=10) were prepared from two different composite resins of A2 shade, that marketed for esthetic restorations [group I: Venus Diamond (Heraeus Kulzer, Germany), and group II: Filtek Z 350 XT (3M ESPE, St. Paul, MN, USA)]. The compositions of the resin matrices and fillers of these composite resins are listed in Table 1. Composite resins were injected into Teflon moulds (8mm in diameter and 2mm in depth) and placed over Mylar strip on a glass plate. Finger pressure was applied to the glass plate to expel excess materials and create a smooth surface. The composite resins were then polymerized using a LED light-curing unit (Elipar S10, 3M ESPE, St. Paul, MN, USA) for 40 sec to allow thorough polymerization. The discs were removed from the moulds, stored in deionized water for 24 hours to complete polymerization, and then polished with Sof-Lex (3M ESPE, St. Paul, MN, USA) polishing discs in four sequences from coarse to superfine following the manufacturer's instruction.

Measuring color change: The color values were recorded using a digital spectrophotometer (Vita Easyshade, Compact, Vita, Zahnfabrik, Bad Sackingen, Germany). Positioning the specimens on a white background to prevent potential absorption effects performed color measurements. Three measurements were taken with the active point of the spectrophotometer in the center of each disc. The instrument automatically averaged the three readings and this average reading was subsequently used for data analysis. Initial color measurements were taken after polishing discs, which represent the (baseline) measurement, and then repeat rerecord after 3 months of immersion in coffee. Each specimen was dried using blotting paper before color measurement. The color difference (Δ E) was calculated for each sample using the following equation, [1,2].

$$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]\ 1/2$$

Before each series of measurements, the spectrophotometer was calibrated according to the manufacturer recommendations where ‘‘L’’ namely white-black, ‘‘a’’ red-green, ‘‘b’’ yellow-blue.

Statistical analysis: One-way analysis of variance (ANOVA) was used to evaluate the effects of material type and staining agent on color change, including the possibility of interaction between the two factors using a statistical software (SPSS for Windows, Version 20, SPSS Inc., Chicago, IL, USA). Using paired T-test for analysis for comparing samples in same subgroup. In the present study, $p \leq 0.05$ was considered as the level of significance.

RESULTS:

Mean, standard deviation and test of significance of mean values of color change between different groups for Group I (Venus Diamond), and Group II (Filtek Z350 XT) are shown in table 3. All results shows that the amount of ΔE in all groups was >3.3, which indicates that the storage of specimens in different color media during 3 months of immersion in coffee was effected to color stability. There were statistically significant differences in both groups in coffee storage ($p < 0.005$), but ΔE of Venus Diamond was less than ΔE of Filtek Z350 XT, (ΔE= 4.816 ± 0.568) and retrospectively, as shown in figure 1.

DISCUSSION:

Increasing aesthetic approach of patients has resulted in an increasingly widespread use of resin composites in dentistry. The mechanical, aesthetic properties are the clinical demand of composites, which depends on several factors, [17]. Dental composites are composed of three different phases [the organic matrix, the inorganic filler and coupling agent to bond the filler to the organic resin]. Discoloration of resin-based material may be caused either by intrinsic or extrinsic factors. The intrinsic factors include the discoloration of the resin material and the interface of the matrix and fillers. This intrinsic discoloration may be due to

insufficient polymerization or immersion in storage media for long periods.

Discoloration can be assessed visually and by using specified instruments as Spectrophotometer, Easyshade that can eliminate individual errors in color assessment. It has also been used in many previous studies to measure color change (ΔE) by comparing the values before and after storing in different storage media, [18]. Even the organic staining was influenced on color stability of several types of composite resin that have been investigated in the present study. Staining solution used in this study was coffee, which is most commonly used, everyday and have known as potential to stain tooth-colored restorations, [18-20].

The tested resin based composite in this study were showed that color changes of Venus Diamond composite (ΔE= 4.816 ± 0.568) were the least affected when immersed in coffee followed by Filtek Z350 XT (ΔE= 6.067 ± 0.725). Staining susceptibility of resin-based materials may be related to resin filler type, type of resin matrix or type of the staining agent, [21].The resin matrix can absorb water, or storing solutions, causing in its discoloration. Resin matrix is the weakest part that water sorption while the filler particles cannot absorb water into the bulk of the material, but can absorb it onto the surface. Therefore, the water sorption is dependent on the amount of resin matrix content of the composite. In addition, it dependents on the quality of bond between the resin matrix and the filler. Excessive water sorption can decline the longevity of resin composite by expanding and plasticizing the resin component, hydrolyzing the saline and micro-crack. These micro-cracks permit penetration that causes discoloration. Venus Diamond is a new nano-hybrid universal restorative system containing TCD-DI-HEA and UDMA, with 63.5-65.1% by volume of Barium Aluminum Fluoride glass fillers having size range of 5nm-20 µm. Filtek Z350 XT is a universal nano-hybrid restorative system containing BIS-GMA, UDMA, TEGDMA and bis-EMA with combination of non-aggregated 4-11zirconia filler, aggregated zirconia/silica cluster filler that are loading of 59.5% by volume and particle size range of 0.6-10 µm, as shown in table 1. It has been noted that a composite with large filler particles as in Venus Diamond are more prone to water aging discoloration than a composite with small filler particles as Filtek Z350 XT, which is in line with the hydrolytic degradation matrix filler interfaces. Thus, a composite with large filler particles has more color permeability than a composite with small filler particles, [22] .

Several studies have shown that the presence of TEG DMA in materials cause a high amount of hydrophilic capacity and more sensation of BIS-GMA to tonality and water absorption in comparison to UDMA. UDMA is more resistant to stain than BIS-GMA, [2]. Presence of TCD monomer may have strong affect of color stability in addition to use UDMA, because UDMA was used in both resin-based composite. This result may give strong forced toward improvement of resin

matrix and aesthetic approach with storing in coffee, which is beverage of daily used.

CONCLUSION:

All resin-based materials presented significant color change after immersion in coffee. Venus Diamond showed the less color change than Filtek Z 350 XT. Using of TCD monomer in resin matrix may allow to resist the penetration and discoloration of resin composite, In addition using high loaded filler composite that has high color stability than less loaded filler.

REFERENCES:

1. Hickel R,Heideman D, Staehle H, Minning P, Wilson N. Direct composite restorations: extended use in anterior and posterior situations. Clin Oral Investig. 2004; 8: p. 43-44.
2. Bagheri R, Burrow M, Tyas M. Influence of food-simulating solutions and surface finish on susceptibility to staining of aesthetic restorative materials. J Dent. 2005; 33: p. 389-398.
3. Sham A, Chu F, Chai J, Chow T. Color stability of provisional prosthodontic materials. J Prosthet Dent. 2004; 91(5): p. 447-452.
4. Archegas L, Freire A, Vierira S, Caldas D,Souza E. Colour stability and opacity of resin cements and flowable composites for ceramic veneer luting after accelerated ageing. J Dent. 2011; 39(11): p. 804-810.
5. Haselton D, Diaz-Anold A, Dawson D. Color stability of provisional crown and fixed partial denture resins. J Prosthet Dent. 2005; 93(1): p. 70-75.
6. Ruyter I, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. Dental Materials. 1987; 3: p. 246-251.
7. Mundim F, Pires-de-Souza Fde C, Garcia Lda F,Consani S. Colour stability, opacity and cross-link density of composites submitted to accelerated artificial aging. The European Journal of Prosthodontics and Restorative Dentistry. 2010; 18: p. 89-93.
8. Pires-de-Souza Fde C, Garcia L, Hamida H, Casimiro L. Color stability of composites subjected to acceleratedaging after curing using either a halogen or a light emitting diode source. Brazilian Dental Journal. 2007; 18: p. 119-123.
9. Catelan A, Briso A, Sundfeld R, dos Santos P. Effect of artificial aging on the roughness and microhardness of sealed composites. Journal of Esthetic and Restorative Dentistry. 2010; 22: p. 324-330.
10. Gregorius W, Kattadiyil M, Goodacre C, Rogencamp C, Powers J, Paranivia R. Effects of ageing and staining on color of acrylic resin denture teeth. Journal of Dentistry. 2012; 40: p. 47-54.
11. Gö nü lol N, Yilmaz F. The effects of finishing and polishing techniques on

surface roughness and color stability of nanocomposites. Journal of Dentistry. 2012; 40: p. 64-70.

12. Erdemir U, Yildiz E, Eren M. Effects of sports drinks on color stability of nanofilled and microhybrid composites after long-term immersion. Journal of Dentistry. 2012; 40: p. 55-63.
13. Knoblock L, Kerby R, McMillen K, Clelland N. Solubility and sorption of resin-based luting cements. Operative Dentistry. 2000; 25: p. 434-440.
14. Reiners J, Podszun W, Winkle J, inventor; (Meth)acrylic acid derivates of tricyclo(5.2.1.02.6)decanes containing urethane groups Europe.. 1990.
15. Ayad M. Susceptibility of restorative materials to staining by common beverages: an in vitro study. Eur J Esthet Dent. 2007; 2(2): p. 236-247.
16. William M. color measurement in dentistry. Journal of Dentistry. 2009; 37: p. 2-6.
17. Johnston W. Color measurement in dentistry. Journal of Dentistry. 2009; 37: p. 2-6.
18. Li Y, Swartz M, Philips R, Moore B, Roberts T. effect of filler content and size on properties of composites. Journal of Dental Research. 1985; 64: p. 1396-1401.
19. Abu-Bakr N, Han L, Okamoto A, Iwaku M. Color stability of compomer after immersion in various media. Journal of Esthetic Dentistry. 2000; 12: p. 258-263.
20. Gross M, Moser J. A colorimetric study of coffee and tea staining of four composite resins. Journal of Oral Rehabilitation. 1977; 4: p. 311-322.
21. Bagheri R, Burrow M, Tyas M. Influence of food- simulating solutions and surface finish on susceptibility to staining of aesthetic restorative materials. Journal of Dentistry. 2005; 33: p. 389-398.
22. Vogal R. Intrinsic and extrinsic discoloration of the dentition. Journal of Oral Medicine. 1975; 30(4): p. 99-104.

TABLES:

Table 1: illustrate the restorative materials that were used in this study.

Nano-Hybrid RBC	Manufacturer	Resin Matrix	Filler	Filler, wt/vol
Venus Diamond	Heraeus Kulzer	TCD-DI-HEA, UDMA	Filler particle size: 5 nm–20 µm Barium Aluminum Fluoride glass Highly discrete nanoparticles	81/64
Filtek Z 350 XT	3M ESPE	TEGDMA, UDMA, BIS-EMA	Combination of non-aggregated 20nm silica, non-aggregated 4-11nm zirconia, and aggregated zirconia/silica cluster filler	78.5/59.5

Table2: Color changes (DE) for composites with staining solutions after 3 months immersion in Coffee.

Filtek Z 350 XT	Venus diamond 1
7.27	5.75
6.9	4.56
6.33	4.02
5.44	4.57
5.09	5.15
6.4	4.75
5.7	5.16
6.33	4.52
6.07	4.15
5.14	5.53

Table 3: illustrate the mean and SD of Delta E of both groups after 3 months of storing in coffee

Resin composite Materials	Mean (Delta E)	SD
Filtek Z 350 XT	6.067	0.725
Venus Diamond	4.816	0.568

FIGURE:

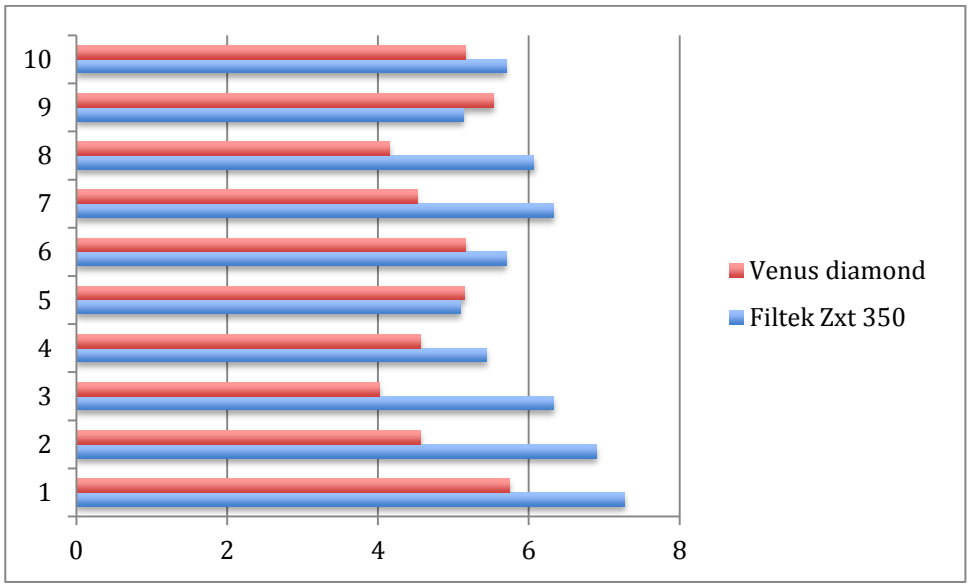

Figure 1: Illustrate the bar chart of Delta E of two resin composites in coffee after 3 months storing in coffee.