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Original Article

EFFECT OF STORING IN COFFEE IN SURFACE ROUGHNESS OF NANO HYBRID RESIN BASED COMPOSITE USING NOVEL MONOMER

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ABSTRACT:

Objective: This study evaluated the effect of 90 days of storing in Coffee on surface roughness of two Nano hybrids Resin Based Composite one Methacrylate composite and other with Novel Monomer.

Materials and Methods: 20 discs were fabricated using two Methacrylate resin matrix composite: Filtek Z350 XT (3M ESPE, St. Paul, MN, USA) and Venus Diamond (Heraeus Kulzer, Germany). All discs were immersed in coffee for 90 days. Surface roughness was measured using Atomic forced Microscope. Surface roughness baseline measurements were made at 1 week and repeated after 90 days of storage in coffee. Data were submitted to ANOVA ($p \leq 0.05$).

Results: There were no significant surface roughness (Ra, nm) was detected during the study ($p < 0.005$). Ra was shown higher for Filtek Z350 XT (9.9 ± 0.005) than that for Venus Diamond (7.352 ± 0.003) after immersing for 90 days in coffee.

Conclusions: Within the limitations of this study, Storing resin based composite for 90 days in aggressive beverage solution showed a significant effect on the surface morphology of the resin based composite. Using of novel monomer with Methacrylate had direct effect on surface roughness, which interferes with color stability and esthetic approach.

Key words: Resin Base Composite, TCD- Monomer, AFM, Surface roughness, Beverage solution

INTRODUCTION:

Colored tooth Resin-based restorations are widely used in dentistry because of the patients are seeking for esthetic appearance similar to tooth color and smooth surface.

To attend successful clinical performance, these materials are attended to have long-term durability, which is aggressively influenced by the oral cavity with aggressive colored beverages, [(1)] However, tooth colored restorations suffer discoloration with time, [(2)]. Scientist worked on development of resin materials to tolerate the aqueous media and chemical challenges that current in the oral environment, [(3), (4)]. It has been

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presented that water has the power to degrade composite matrix by hydrolyzing inorganic filler particles, [5] and de-bonding filler/matrix interfaces [6]. Surface roughness is the main contributor for extrinsic discoloration of resin composite restorations, which is higher, associated to the organic matrix, inorganic filler composition of the composite. Rough surface greater than 200 *n*m provides higher probabilities of biofilm accumulation, that lead to stain and discolor bulkily or marginally, [7].

Composite discoloration may occur by three ways, [8]:

A- Extrinsic discoloration due to accumulation of plaque or biofilm on the restoration surface

B- Intrinsic discoloration due to physic-chemical reactions inside the body of the restoration

C- Surface or subsurface changes with slight penetration and reaction of dye agents on the superficial layer of composite resin

The effect of different storage media on methacrylate-based composite resins has been investigated, but has not been thoroughly reviewed about Methacrylate with novel monomers, which are developed recently, [9]. Therefore, the hypothesis of this study was by using an aggressive colored beverage as coffee, which is used daily according to social habits. In addition using this beverage could be unfavorably affected on the properties of esthetic restorative materials.

MATERIAL AND METHODS:

a) Sample preparation and grouping:

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. After that storing these discs in coffee media for 90 days.

b) Methods

The surface roughness values (Ra) were recorded using a Atomic Force Microscope AFM (Agilent 5420, Santa Clara, CA, USA). Scanning and imaging were presented in the laboratory

atmosphere under controlled temperature and dry conditions. The primary reading have been reported as a contact mode, in which a sharp silicon nitride tip is scanned over the sample surface with a very light force of about 7 to 10 N. The specimens were fixed on a piezo-ceramic tube that afforded three-dimensional movement of each sample with sub nanometer accuracy. As the specimen was scanned at constant force, the three-dimensional motion of the piezo-ceramic tube was recorded as an image and matched to the surface morphology. AFM images were gathered at a very low scan rate of 1 Hz in order to obtain measurements of the surface roughness (Ra) and avoid damaging the tip.

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 (Ra) values of surface roughness of Group I (Venus Diamond), and Group II (Filtek Z350 XT) immediately and after 90 days, which are displayed in table 2. All results shows no significant increase in Ra of all groups, which indicates that storing specimens in aggressive beverage media for 90 days as coffee had limited effective to surface morphology ($p < 0.005$). Ra value of Filtek Z350XT (Ra= 9.9 ± 0.005) was higher than Ra value of Venus Diamond (Ra= 7.352 ± 0.003), while Ra values was so close in immediate measurement, Filtek Z350XT (Ra= 7.032 ± 0.009) and Venus Diamond (Ra= 7.018 ± 0.008), as shown in figure 1.

DISCUSSION:

In this study, the effect of coffee on the surface roughness of two nano-hybrid composites with novel monomer and Methacrylate was investigated. The hypothesis of this study was coffee has stronger effect on Methacrylate resin than using Novel monomer. Coffee was selected in the present study because it has been used daily as social aggressive beverage. Roughening can be a consequence of the chemical dissolution of resin-based materials by the exposure of the surfaces to chemicals from drinks, food, microorganisms and saliva, [10] [11].

It was shown that there was no significant change in surface roughness when immersed in coffee of both type of Methacrylate resin based composite. The highest was shown in Filtek Z350XT (Ra=9.9± 0.005), while the lowest was shown in Venus Diamond (Ra= 7.352± 0.015). Ra of Venus Diamond (7.352± 0.015) was presented no significant changes after storing for 90 days and Ra of Filtek Z350 XT (9.9± 0.005). There are not many studies that have evaluated the surface roughness when storing in

aggressive colored beverage solutions as coffee during different time interval. The increase might be recognized to the polymerization reaction is not complete and goes on even after the initial set of the material. In addition maximum polymerization proceeds during starting curing, its reaction continues at least for next one week. Subsequently the materials had not extended their maximum physical properties, they were vulnerable to the chemicals of the beverage solutions.

Coffee may have higher ionizable groups and water-soluble solution, which are stable at high temperature. The sorption of these water-soluble secondary metabolites on the surface may have caused more color change. Resins composite are made up of several inter polymeric chains that have gaps between them. These gaps are filled with absorbed water and remain there. The number and size of these inter polymeric gaps regulate the amount of water absorption Therefore, surface roughness detected here is due to the diffusion of water between inter polymeric gaps and cause deboning of resin matrix with filler that leads to chelating of filler out of matrix and leaving larger gaps, voids that increase surface roughness values. It has been displayed that resin materials using urethane dimethacrylate as novel monomer have more color stability than resin materials using bis-GMA as matrix, [12]. Glass filler particles present in the resin matrix do not absorb, but can adsorb water on the surface. So that the amounts of water that capable enters the resin matrix mainly the cause of deterioration of aesthetic and physical properties of resin for long duration. Extra water sorption and hydrolysis may decrease the life of resin composites, by which the resin matrix hydrolyzes the silane and forms micro-cracks that increase the voids and increase the topography peak of surface roughness.

CONCLUSION:

During 90 days of storage in one of the aggressive colored solution that is socially used obtainable non-significant increase in surface roughness (Ra) values in all resin-based composite. On the other hand, using novel monomer as TCD-Urethane in addition to BIS GMA resin matrix presented lower surface roughness than conventional resin.

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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

Table 2: illustrate the Ra values for specimens and there Mean±(SD) Ra (roughness) in nm

Filtek Z350XT 0	Filtek Z350XT 3	Venus Diamond 3	Venus Diamond 0
8.6	11.5	8.03	4.65
6.04	7.91	5.85	5.33
6.54	10.8	9.12	7.5
7.18	9.78	8.27	5.97
6.8	9.76	5.49	11.64
Mean 7.032 ± (0.003)	Mean 9.9 ± (0.005)	Mean 7.352 *± (0.015)	Mean 7.018 * ± (0.009)

FIGURES:

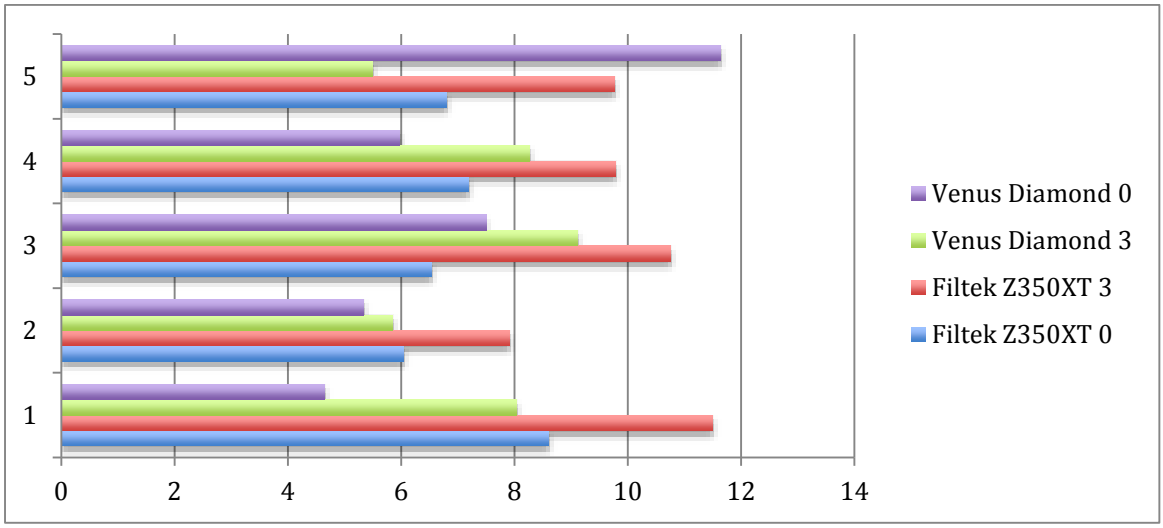

Figure 1:Bar chart illustrates the Ra of samples in different storage media according to time intervals.