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Surface textures effect on color stability of composite resin restorative materials after immersed in everyday drinks: in vitro study

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Abstract:
Aim:*The purpose of this study is to evaluate the role of the surface texture in the change of aesthetics on dental composite restorations when exposed to most common drinks.*
Materials and Methods:*To conduct this study were made 54 composite resin discs (15 x 2 mm), shade A2.The materials used were microhybrid, nanohybrid and nanocomposite resin. Eighteen samples of each composite type were made, half polished and half non-polished. Red wine, coffee and distilled water (control group) was used as immersion media twice a day forfourteen days. The changes in aesthetic were followed with a spectrophotometer X-RITE RM 200 with three separate measurements. First measurement (baseline) after hydration period and prior first immersion, second at the middle of the research and final measurement after the testing period of fourteen days. Statistical analyses were executed with One-way ANOVA, Kruskal-Walis ANOVA, Student – t test, Mann-Whitney test.*
Result:*Severe discoloration was noticed by both colorants after 7 and 14 days. For statistically significant were taken into account $p<0.05$ values. Calculated results present significantly increased ΔE values in non-polished restorative materials comparing with polished only in microhibrid and nano composite resin when immersed in red wine.*
Conclusion:*The color alterationby the immersion media used in this study surpassed the clinically acceptable threshold in all the tested materials. A significant difference was only noticed between the polished and non-polished samples of the microhybrid and the nano composite resin restorative materials immersed in red wine.*
Key words: *discoloration; composite resin; spectrophotometer; surface texture*

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I. Introduction

The aesthetics in dental restoration has a crucial role in the patients smile. The search for optimal restorative material has led to major improvements in aesthetic materials and the techniques for placing them. Recent development of materials has allowed the dentists to give the most at every restoration. Modern restorative materials have outstanding aesthetic characteristics therefore are widely accepted by patients.

The color stability of the dental aesthetic restorations is an issue that has yet to be surpassed by manufacturers and modern technology. Discoloration of a dental restoration can occur by many reasons, mainly divided in extrinsic and intrinsic. [1−12]Intrinsic discolorations occur due the reactions inside the material among the matrix and the filling particles. Extrinsic factors can be caused by everything that is inserted in the mouth and exposures the restorative material. Such contaminators can be all the food and drinks, bad habits and poor oral hygiene. The surface texture of dental restorative materials has a major role in the accumulation of plaque anddiscoloring the dental filling by adsorption and absorption of other pigments.Proper placement, finishing and polishing of the final restoration are important procedures that enhances both aesthetics and longevity of the dental filling. The primary goal of finishing and polishing the final restoration is to receive a surface that imitates the tooth in lost contours and occlusion, and obtaining the aesthetic by making a smooth surface discolorationresistant.

Recent studies [1−12]have shown that beverages like coffee, red wine and tea are major contributors on staining the teeth including the restorative materials. The degree of discoloration vary depending on the type of composite resin and its filler particle, finishing and polishing techniques used, duration of colorant exposure, etc.

The aim of this study was to evaluate if the surface texture contributes to the discoloration on the composite resin restorative materials when exposed on every day drinks.

II. Material and methods

Three composite resin dental restorative materials were used to conduct this study. The materials used were Nano (Artiste), Nano hybrid (Evetric) and micro hybrid (Gradia Direct) composite resin, shade A2. Eighteen composite resin discs (15 x 2 mm) were prepared of each composite. The discs were shaped and formed into a plastic mold and polymerised according the manufacturer's instructions. The discs were polymerized using a standard halogen lamp for 20 seconds. Nine discs of each manufacturer were polished using a standard polishing rubbers at 4000 rpm, while the other nine discs were left as they are. At this point, all discs were immersed in distilled water for hydration. The hydration period was 24 hours.

The discs were divided into groups where each group consisted six discs of the same manufacturer, three polished and three not-polished. This separation of discs gave us nine groups, three groups of each manufacturer immersing in three separate colorants. The immersing media used for this study was coffee, red wine and distilled water as control group. The discs were immersed in the same colorant, twice a day. Each immersing period was 30 minutes for fourteen days. For the rest of the duration of the day all specimens were stored in artificial saliva prepared according the formula in *Özdaşet all*[7] .A spectrophotometer model X-Rite RM 200 was used to follow the changes in colour. Three measurements were made, first after the hydration period and prior the first immersion and is used as baseline. Second measurement was taken at the middle of the study, third and last at the end or after the second immersion at the fourteenth day.

CIE L*a*b* (Commission internationale de l'éclairage) system for analysing colour data was used for this research.. This system was chosen because of its capabilities of digitally analysing the received data through the three axis L*, a* and b*. The L* axis represents the degree of greyness starting from 0 – 100, black to white. The parameter a* represents the red – green axis, and the parameter b* represents the blue – yellow axis. Colour alterations values (ΔE) between the baseline, middle and final measurement was calculated with the following formula:

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

A database was created in the statistical program SPSS for Windows 23.0 to analyse the results of this study. Shapiro-Wilk test was used for normal distribution of data. The data is shown in percentage and standard deviation. For the comparison of the analyzed parameters among the three composite resin materials were used non parametric and parametric tests for independent samples (One-way ANOVA, Kruskal-Walis ANOVA, Student – t test, Mann-Whitney test). For the comparison of parameters between time points in three composite resin materials were used non parametric and parametric tests for dependent samples (Student – t test and Wilcoxon mathed pairs test).

III. Results

The immersion media showed significant changes of aesthetics in all restorative materials. The clinically acceptable threshold (ΔE=3.3) was surpassed by both coffee and wine in all composite resin materials. Highest discoloration was seen in the non-polished nano composite resin Artiste by coffee(ΔE=26.53 ± 4.4).

The data of interest is shown on spreadsheet and graphic. For statistically significant were taken into account p<0.05 values.

Table 1, Figure 1 shows comparative average and standard deviation values for parameter ΔE for polished and non-polished composite resin samples when immersed in red wine.

Calculated results present significantly increased ΔE values in non-polished restorative materials Gradia and Artiste comparing with polished, while the difference among polished and non-polished Evetric samples was not statistically significant.

Table 1. Descriptive statistics for parameterΔEof polished and non-polished samples forGradia, Artiste andEvetric, before and after immersing in red wine

Descriptive Statistics (mean ± SD) for parameter(ΔE)						
time period	GRADIA		ARTISTE		EVETRIC	
	polished	non-polished	polished	non-polished	polished	non-polished
RED WINE						
7 day	8.23 ± 0,85	11.98 ± 0.8	9.58 ± 1.55	17.19 ± 0	9.05 ± 0.49	8.68 ± 0.64
p value	t=5.65 p=0.0048 sig		t=8.51 p=0.001 sig		t=0.79 p=0.47 ns	
14 day	8.23 ± 0,8	12.36 ± 1,2	14.22 ± 2.5	25.55 ± 5.5	15.53 ± 5.4	13.38 ± 4.9
p value	t=4.76 p=0.0089 sig		t=3.23 p=0.03 sig		t=0.51 p=0.63 ns	

p(t-test for independent samples)

Figure 1. Average values of polished and non-polished samples for parameter ΔE for Gradia, Artiste andEvetricafter immersing in red wine for the period of 14 days

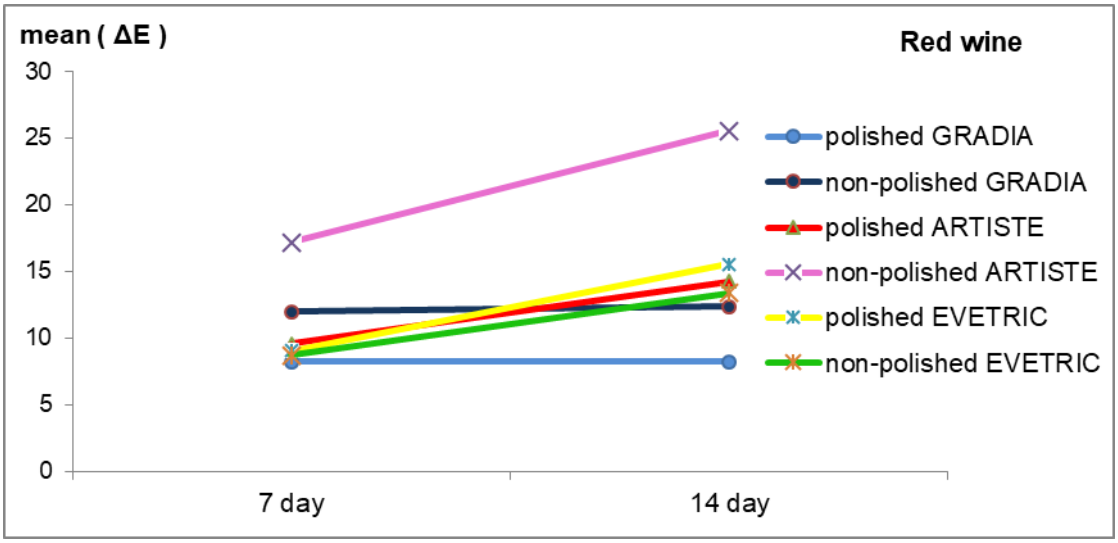


Table 2, Figure 2 shows comparative average and standard deviation values for parameter ΔE for polished and non-polished composite resin samples when immersed in coffee.

After the test period of 14 days, there was no significant difference in ΔE values between polished and non-polished samples.

Table 2. Descriptive statistics for parameterΔE of polished and non-polished samples forGradia, Artiste andEvetric, before and after immersing in coffee

Descriptive Statistics (mean ± SD) for parameter(ΔE)						
time period	GRADIA		ARTISTE		EVETRIC	
	polished	non-polished	polished	non-polished	polished	non-polished
COFFEE						
7 day	7.54 ± 1.5	16.38 ± 8.3	15.64 ± 2.1	22.42 ± 2.2	12.14 ± 5.6	17.41 ± 2.3
p value	t=1.82 p=0.14 ns		t=3.82 p=0.019 sig		t=1.51 p=0.21 ns	
14 day	15.81 ± 5.7	19.75 ± 6.1	21.28 ± 2.1	26.53 ± 4.4	17.39 ± 1.6	20.39 ± 3.8
p value	t=0.82 p=0.46 ns		t=1.85 p=0.14 ns		t=1.12 p=0.32 ns	

p(t-test for independent samples)

Figure 1. Average values of polished and non-polished samples for parameter ΔE for Gradia, Artiste andEvetricafter immersing in coffee for the period of 14 days

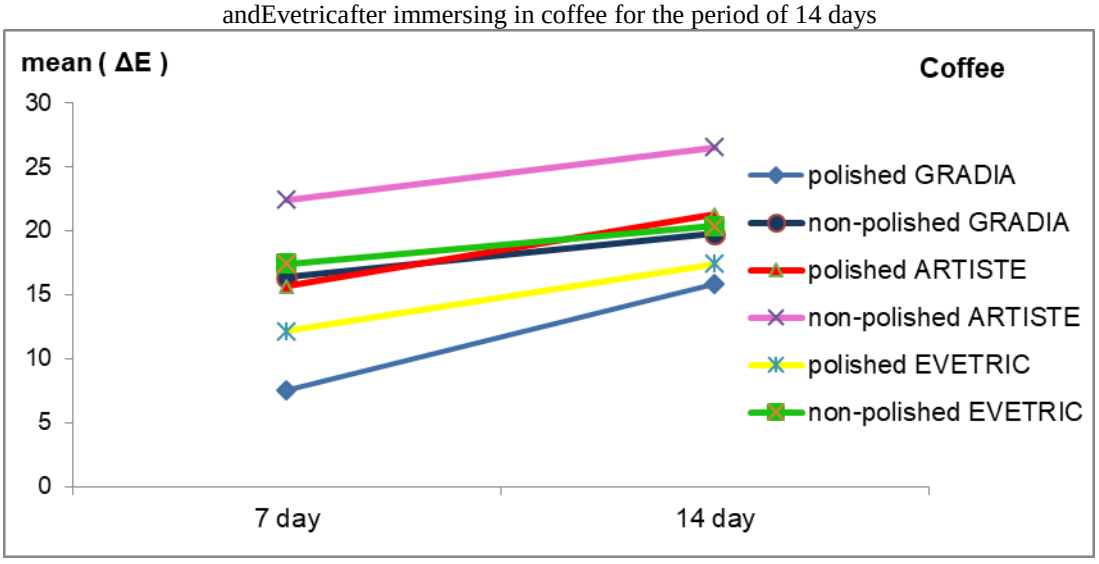


Table 3, Figure 3 shows comparative average and standard deviation values for parameter ΔE for polished and non-polished composite resin samples when immersed in distilled water.

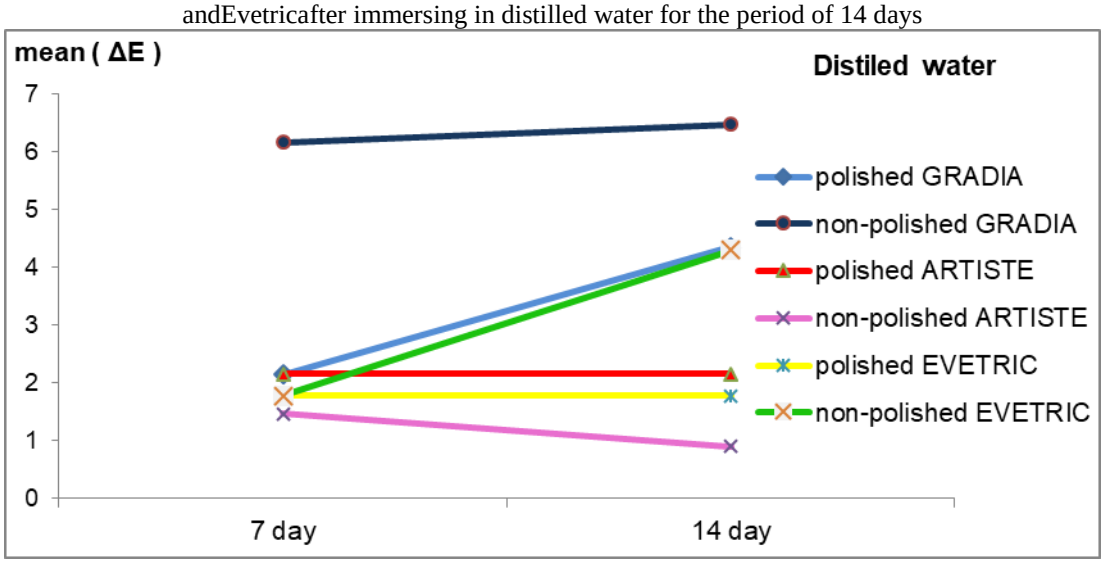
There was no significant difference in ΔE values between polished and non-polished samples among the three composite resin restorative materials.

Table 3. Descriptive statistics for parameterΔE of polished and non-polished samples forGradia, Artiste andEvetric, before and after immersing in distilled water

Descriptive Statistics (mean ± SD) for parameter(ΔE)						
time period	GRADIA		ARTISTE		EVETRIC	
	polished	non-polished	polished	non-polished	polished	non-polished
DISTILED WATER						
7 day	2.15 ± 3.72	6.17 ± 4.08	2.16 ± 3.75	1.47 ± 1.38	1.78 ± 3.09	1.78 ± 3.09
p value	t=1.26 p=0.27 ns		t=0.3 p=0.78 ns		t=0.0 p=1.0 ns	
14 day	4.36 ± 1.81	6.48 ± 5.62	2.16 ± 3.75	0.91 ± 1.58	1.78 ± 3.09	4.31 ± 3.89
p value	t=0.62 p=0.57 ns		t=0.53 p=0.62 ns		t=0.88 p=0.43 ns	

p(t-test for independent samples)

Figure 3. Average values of polished and non-polished samples for parameter ΔE for Gradia, Artiste andEvetricafter immersing in distilled water for the period of 14 days



IV. Discussion

Extrinsic discoloration of composite resin materials is mainly attributed to contamination by various drinks like coffee, tea, red wine, use of nicotine, poor oral hygiene and in some cases the finishing and polishing techniques of the final surface of the restoration.

In the present research, a significant difference in p values was found among the polished and non-polished microhybrid and nano composite resins when immersed in wine, while the nanohybrid composite resin immersed in wine didn't show a significant difference in p values. The p values between the polished and non-polished samples of all the composite resin materials immersed in coffee were not significant.

The immersion media tested in this research have shown significant discoloration on the samples and surpassing the clinically acceptable threshold, therefore is in correlation with previous studies.The colorants reacted differently among the type of composite resins used in this research, and within the groups considering polishing technique which was the case in recent similar published papers. [1−12]

In the present researchapart the microhybrid composite resin immersed in wine, all the composite types showed less discoloration in the middle rather then the final measurement which is in correlation with the study of *Elizabeth Sarkis.* [9] In both studies the discoloration after the tested period for both polished and non-polished samples of all types of composite resin was unacceptable.

Some authors consider that proper finishing and polishing the restoration may prevent adsorption and absorption of plaque and other pigments, thus maintaining the aesthetic and the longevity of the dental filling. [2−4]

In the study of *Yu at all*[12],is concluded that increased surface roughness leads to staining which is the case in the present study apart of the nanohybrid composite resin material immersed in wine where the polished samples were more discolored then the non-polished.

It has been proven that coffee and wine stains can be significantly reduced by simply re-polishing the surface.[11]

V. Conclusion

Within the limitations of this in vitro study, it was concluded that the immersion media made a significant changes in the primary aesthetic of all types of composite resin materials. Even though severe discoloration was noticed by both coffee and red wine, there was no significant difference between the polished and non-polished samples of nanohybrid composite resin immersed in wine and all composite resin types immersed in coffee. On the other hand, a significant difference was noticedbetween the polished and non-polished samples of the microhybrid and the nano composite resin restorative materials.

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