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The Effect of Every Day Drinks on Composite Restorations Aesthetics: In Vitro Study

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Abstract:
Aim:*The main objectives of this in vitro study is, within its limitations, is to evaluate whether every day drinks affect the aesthetics of the dental composite resin materials.*
Method: *Thirty microhybrid composite resin (Gradia Direct) discs were made (15 mm in diameter and 2mm thick) and randomly divided into five groups. The groups were immersed in colorants asred wine, coca-cola, filter coffee, aronia tea and distilled water as control group. Spectrophotometer X-RITE RM 200 was used to follow the changes in color with three measurements, first one at the beginning (baseline), second at the middle, third at the end of the research. Each group was immersed in its colorant twice a day for the duration of the study. The received data was analyzedaccording the CIE L*a*b* color system.*
Result:*Three out of four colorants have surpassed the clinically acceptable threshold of discoloration which is Δ2.7. Significant discoloration was observed with the warm drinks compared with the ones used on room temperature. The tea caused most significant discoloration (Δ22.17) followed by coffee (Δ16.73) and wine (Δ12.10). The drink that cased the least discoloration was the coca-cola (Δ1.24).*
Conclusion:*The color stability of the composite resin restorations is affected by the everyday drinks that are consumed, from some more than others.*
Key words: *discoloration; composite resin; spectrophotometer;*

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I. Introduction

The patients are mainly interested in the aesthetics and the cost of the dental fillings, rather than the physical and chemical composition of it. Luckily for us, as dentist, nowadays we can provide all in one. Today's dental materials have outstanding aesthetics, physical and chemical characteristics, and they are cheap in price.

Dental composite resin restorative materialswere introduced in the previous century, and quickly revolutionized the modern dentistry with their strength, placement procedure and aesthetics. Today, composite resin is the materials of choice by most dentist when it comes to fill a cavity with a permanent restoration. The composite resin has high acceptance in patients due to its exceptional color imitation as the rest of the natural tooth.Since their introducing, the materials have been continuously improved and upgraded, but preventing their discoloration is an important challenge that has yet to be developed.

Discoloration of the dental restorations is a major problem for the patients especially if it occurs in the frontal aesthetic zone. The change of color can be considered as one of the main reasons for replacing a restoration.

The discoloration of the aesthetic dental composite resin restorative materials is brought down on two main reasons, intrinsic and extrinsic. [1−22]The intrinsic discoloration comes from within the material, while the extrinsic is been caused by sources that come from the outside environment such as food, drinks, bad habits etc.

Proper placement, adequate finishing and polishing technics play a major role in the longevity of duration of the dental restoration. Failing to do so brings the possibility of adsorption plaque, thus compromising the outcome and the aesthetic value of the filling.

Modern time has given us spectrophotometric methods to be able to evaluate the color in shades, hue and chroma. The spectrophotometer is a high tech instruments that can determine the color by its smallest details in liquids and solid objects.

The aim of this *in vitro* study is to evaluate possible changes in color on dental direct composite resin restorative material immersed in various drinks, and to consider if polishing the final restoration contributes to maintaining the natural color of the filling.

The following hypotheses were tested:

i. the drinks tested do not affect the colour of the composite resin restorations
ii. the drinks temperature doesn't affect the aesthetics of the composite resin restorations

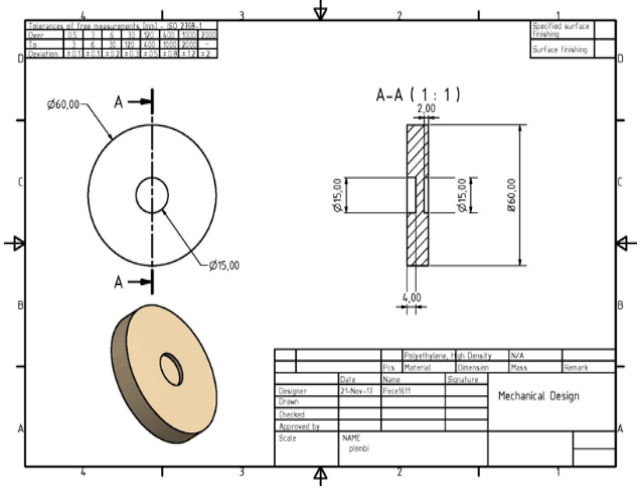
II. Material And Methods

For this research was used a microhybrid light-cured direct composite resin Gradia Direct (GC Dental Products Corporation Tokyo, Japan), shade A2 as most commonly used in the front region. All discs were made in the same way, in the same mold and cured with the same LED lamp. The changes of colour were followed with a spectrophotometer.

Mold preparation:

The mold was computerly designed as presented in figure 1, afterwards 3D printed with industrial plastic material.

Figure 1. Mold design



Specimen preparation:

The specimens were formed into discs with diameter of 15 mm, and thickness of 2 mm. To conduct this study a total of n=30 discs were made. The resin was taken out of the syringe with a suitable instrument and fitted into the mold and shaped. Afterwards the material was cured with a standard halogen lamp for the duration of 20 seconds, according the recommendations from the manufacturer. Half of the discs were immediately polished using standard polishing technique using a standard polishing rubbers and a low speed handpiece operating at 8000 rpm.At this stage the discs were divided into two main groups, polished and unpolished. After the making, all discs were immersed in distilled water for hydration. Hydration period was 24 hours.

Specimen grouping:

The samples were divided in 5 main groups consisting 6 randomly picked discs of which 3 are polished and 3 are not polished. All groups were immersed in the same staining solution during the research.
Each group consist two subgroups. The subgroups are divided in polished and unpolished discs.

Staining solution preparation:

Group I: Red wine (T'gaza jug, Tikves Winery). The wine comes inoriginal packing and was used at room temperature.
Group II: Coca-Cola (Skopskapivara, with a licence from The Coca Cola Company). The coca-cola is used at room temperature from the original packing.
Group III: Filter Coffee (Gold Selection, Tchibo). The coffee was prepared on a filter coffee machine and was used hot.
Group IV: Organic Aronia tea (Stefano Production). The tea was prepared by putting the aronia berries in a pot with 100 ml water, the pot was placed on a hotplate until the water boils. The tea was served hot.
Group V: Distilled water was used from its original packing on room temperature.
Artificial saliva was been prepared according the formula in the research conducted by *DO, Ozdaset all*[16]. The ingredientsof the artificial saliva used in this study is:4.2 mg/L NaF, 1280 mg/L NaCl,166.49 mg/L CaCl2, 125 mg/L MgCl, 2.6H2O, 44.74 mg/L KCl, 7.5 mg/L CH3COOK, 386 mg/L K3PO, 4.3H2O, 0.05 mg/L H3PO4 (85%) (pH 7).

Specimen staining:
As staining solutions were used:

- red wine,
- coca-cola,
- filter coffee,
- organic aronia tea, and
- distilled water

The red wine and coca-cola were used on room temperature, while the coffee and tea were prepared accordingly. The distilled water was been used as control group.

The research started right after the hydration period and lasted 14 days. During the research every group was been immersed in one staining solution. The groups were immersed in their solutions twice a day for the duration of 30 minutes. For the remaining period of the day the discs were stored in artificial saliva.

Spectrophotometric measurements:

A spectrophotometer X – RITE Model RM 200 was used in this research for the evaluation of possible changes in color.

Three measurements were taken during the research. The first measurement was taken right after the disc's hydration and prior the first immersion in colorants. This measurement is also a baseline for this study.Second measurement was taken midway at the seventh day. Third and last was taken after the fourteenth day, or at the end of this research.

Data analysis:
In this study we used the CIE L*a*b* (Commission internationale de l'éclairage) system for analysing colour data. 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 grayness starting from 0 – 100, black to white. The parameter a* represents the red – green axis, and the parameter b* represents the blue – yellow axis.
The differences in data (Δ - *delta*) was calculated with the arithmetic average for each group.
With this parameters was made a comparison of all groups with the control group in order to find out the possible changes. This was done so that we can find the baseline and final change of colour.

L*(final/baseline) = L*(sample) - L*(control)
a*(final/baseline) = a*(sample) - a*(control)
b*(final/baseline) = b*(sample) - b*(control)

Once we had the final and baseline L*a*b* coordinates the delta was calculated in all axes ΔL*, Δa* and Δb*.

ΔL* = L*(final) - L*(baseline)
Δa* = a*(final) - a*(baseline)
Δb* = b*(final) - b*(baseline)

The total discoloration of the discs was analysed with the following equation:

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

III. Results

The CIE L*a*b* coordinates of the samples are exhibited in Table 1. The results are shown in an arithmetic average of the discs. The table includes CIE L*a*b* coordinates for all four colorants including the control group. Results are shown for the three measurements taken during the 14-day study.

Table I. Arithmetic averagevalues received after each measurement

	Wine			Coca-cola			Coffee			Tea			Control		
	l	A	b	l	a	b	l	a	b	l	a	b	l	a	b
1 measurement	69.25	4.12	10.40	69.34	3.13	9.94	69.34	3.13	8.47	69.77	1.45	5.87	71.02	2.60	10.30
2 measurement	60.54	7.89	9.54	69.09	3.40	9.95	62.12	9.67	21.31	51.22	5.61	-1.03	81.82	3.40	7.30
3 measurement	60.40	7.99	10.16	70.73	2.83	8.69	59.44	6.99	17.12	51.15	4.45	-2.23	73.45	2.41	8.39

The total change of colour for the involving colorants in this research is shown in Figure 2 whereas all drinks have discoloured the sample discs. Thus, the null hypotheses was rejected. Clinically acceptable threshold for ΔE is 2.7. Apart of the coca-cola, all other colorants have ΔE higher than the clinically acceptable threshold. The highest ΔE was measured for the aronia tea (22,17), followed by coffee (16,73) and wine (12,1). The lowest was measured in coca-cola (1,24). Given this results the second hypotheses was rejected as both warm drinks have made a rather significant discoloration then the drinks used on room temperature.

Figure 2. Final ΔE results

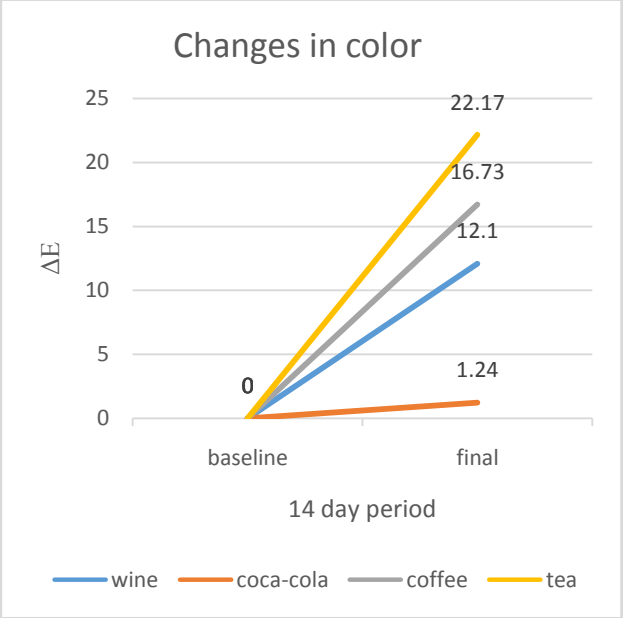


Figure 3 demonstrates the discoloration of the discs immersed in colorants. The discolouration is noticeable, especially for the tea, coffee and wine.

Figure 3. Discs after the test period, left to right: control, coca-cola, wine, coffee, tea.

IV. Discussion

The aetiology of the discolouration of composite restorations according to *Samraet all*[18] is multifactorial. Factors contributing the changes in restorations aesthetics are divided in two main groups: intrinsic and extrinsic.

As main intrinsic reason for discoloration, *Spina et all*[20] are considering the process of oxidation that includes changes in the chemical stability between the matrix and the fillers of the composite resin. On the other hand, *Park and all*[17], are pointing out the chemical instability of the composite resin that happens after uncomplete polymerization of the material during the fitting into the cavity which brings unwanted

discoloration, aging of the material due the chemical process among the non-polymerized monomers and the other substances.

Extrinsic factors develop as a result of absorption and adsorption coloring matters from exogenous origin. *Festuccia at all*[10] as main outside discoloration source is pointing all the daily products that we consume, closely related with the quality of oral hygiene and the use of tobacco. Extrinsic factors depend on many reasons like the colorant itself, time of exposure, type of composite resin, surface of the restoration, oral hygiene, taking chronic therapy, etc.

Surface texture of the dental materials plays a major role in accumulation of plaque which contributes to discoloration of the restorations and aesthetic view. *Ertas et all* [9] as most important factors in maintaining the natural color of the restoration is considering the smooth surface, the surface integrity and the finishing and polishing techniques.

Ergucuet all [8] , as main finishing goal are considering the need to get a final restoration with optimal contours, occlusion, strong positioning into the cavity and a smooth surface. Such proper finishing and polishing procedure can be executed by managing a subsequent use of finishing and polishing instruments, mainly from rough to the finest in order to make an optimal final aesthetic restoration. Nowadays we use diamond burs with fine granulation that are finishing and polishing the restoration at the same time.*Ergucuet all* [8] in their research are ascertain that the properly polished composite restorations is the key role in achieving an aesthetic and stable surface resistant to discoloration. They also describe that some finishing and polishing techniques are more effective than others in preserving the aesthetics in composite resin restorations.

Guler et all[11] are saying that adding a polishing paste while finishing and polishing has better results compared to standard finishing and polishing. Reason for that is the smoother restoration surface that we get after applying a polishing paste which gives us better texture and a surface less absorbent to plaque and pigments causing discoloration. On the other hand, *Barbosa et all* [6] , are ascertain that the same finishing and polishing techniques on different composite resins gives us different results prone to discoloration.

In their research, *Sarkiset all*[19] , are ascertain that at the beginning the polished surfaces of the composite resin restorations are less prone to discoloration than the non-polished, but at the end they all significantly change color.

According to *Tekce et all*[22], the degree of discoloration varies among patients and only if the changes in color come from exogenous source there is a possibility to remove them by polishing the restoration, while if the changes are intrinsic they are irreversible.

Numerous researches have been conducted lately evaluating the changes in color of the composite resin materials in simulated oral environment. [1−22] Number of materials have been immersed into various colorants, mainly in everyday drinks, food dyes, mouth rinse products etc. The changes in color are then statistically analyzed according some of the world color systems. Some of the studies have proven that certain drinks are prone to discoloring the composite restorations. Such drinks are coffee, wine, beer, tea, coca-cola, chocolate milk, mouth rinses etc. [1−22] Other researches are focused on the roughness of the surface of the restorations and the type of composite is been used.

V. Conclusion

Within the limitations of this in vitro research it was concluded that all colorants make changes in colour of the aesthetic restorations, some more than others. The clinically acceptable threshold was surpassed in three out of four colorants which gives as a lot to think about in the future when placing the fillings, but also when developing new materials. In the preserving of optimal aesthetics of the restorations the patients must be included with a constant and proper oral hygiene.

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