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Impact of artificial saliva on the color stability of different nanocomposite restorative materials at different storage times (An in vitro study)

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Abstract
Objectives*: To evaluate Impact of artificial saliva on the color stability of different nanocomposite restorative materials at different storage times.* ***subjects and methods*** *A total number of 30 resin composite discs were prepared according to the manufacturer's instruction to assess color stability. The resin composite discs were divided into 3 main groups A (n = 10), composed of (A1) Filtek Z350XT (3MESPE), (A2) sphere TEC Dentsply Sirona, and (A3) Estelite sigma Quick. color stability was assessed.* ***Results****: at 3 and 12 months, spectrophotometer results exhibited that the "Z350XT" showed statistically significantly lower mean color change values (P<0.05) when compared with "Ceram X" and Estilite £ quick.* ***Conclusion****: the soaking time is of great importance, as it affects the composite color stability as well.*

Keywords*:* ***recurrent caries, color stability, class V cavity, resin composites, DIAGNOdent.***

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I. Introduction

Due to its durability, functionality, and aesthetic appeal, resin composites are the most popular choice among patients for dental restorations. In the oral environment, it's crucial that an aesthetic restorative material maintain its colour over an extended length of time. [1, 2]

For resin composites, aesthetics are constantly a top priority [3]. The optical qualities of the restorative material, such as light transmission through the material, light reflection on its surface, light diffusion, absorption, and scattering, may be connected to the aesthetic effectiveness of colour matching resins to repaired teeth. Additionally, the type and content of the organic matrix and inorganic filler may be connected to the optical qualities, which affect the capacity for colour matching [4].

Color stability is still a problem since changes can be seen both right away after polymerization and after some time has passed of storage [5]. Color compatibility, which refers to matching between the restorative material and the tooth structure, colour stability at various times, such as during and after manufacturing or placement, and colour interaction, which is related to layering and colour shifting where the surrounding hard tissue emits a similar colour to the composite materials, are the color-related characteristics of resin composite materials [6, 7] The chameleon effect, which combines the blending effect, colour induction, and colour assimilation effects of resin composite, allows resin-based restorative materials to achieve a shade that resembles the colour of the adjacent tooth structure [8- 10].

The patient might not be able to endure the obvious hue shift in the aesthetic zone. In order to determine the colour stability of resin composites under various circumstances, many investigations were carried out [11, 12]. The resin composites' alterations in hue are connected to both extrinsic factors related to the patient's lifestyle and intrinsic elements related to the resin itself [12-14]. Visually observing the colour shift is possible, as well as using instrumentation like a spectrophotometer or colorimeter [15]. As a result, the goal of this study is to assess how well class V cavities treated with various resin composites maintain their colour.

II. Subjects And Methods

Study design: This study was laboratory study.

A total number of 30 resin composite discs were prepared according to the manufacturer's instruction to assess color stability.

Sample grouping: The resin composite discs were divided into 3 main groups A (n = 10), composed of (A1) Filtek Z350XT (3MESPE), (A2) sphere TEC Dentsply Sirona, and (A3) Estelite sigma Quick.

Preparation of Specimens: A resin composite discs of the 3 main groups were prepared using a split Teflon mold with an internal diameter of 2 mm and 4 mm height. This Teflon mold was held by a metallic ring to keep the two split halves in place. A small groove was made inside the internal diameter of the mold at 2 mm height to enable the application of incremental composite into 2 layers of 2 mm each. The Teflon mold was placed on a clean and dry glass slab. Incremental fill resin composite was placed in two increments of 2 mm each, while the other two bulk fill resin composite were placed as a bulk of 4mm each. In both cases a transparent strip was placed over the surface of the resin composite disc and pressed hard with a glass slide to ensure proper adaptation and the absence of voids in resin composite disc. Then the glass slide was removed and the specimens were cured using a light emitting diode curing device placed at a zero distance from the top of the mold. All the specimens were finished from the sides to remove any rough or excess material using gray rubber points in order to attain a smooth surface similar to the clinical circumstances.

Storage of specimens: Resin Composite Discs were stored until the time of evaluation in artificial saliva that were changed daily.

Evaluation: -

Spectrophotometer, the specimens' colors were measured using a Reflective spectrophotometer (X-Rite, model RM200QC, Neu-Isenburg, Germany). The aperture size was set to 4 mm and the specimens were exactly aligned with the device. A white background was selected and measurements were made according to the CIE L*a*b* color space relative to the CIE standard illuminant D65. The color changes (ΔE) of the specimens were evaluated using the following formula: $\Delta E_{CIELAB} = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})$ ½. Where: L* = lightness (0-100), a* = (change the color of the axis red/green) and b* = (color variation axis yellow/blue)

Statistical analysis:

Data were collected , tabulated, and statistically analyzed using SPSS ® □ statistics Version 20. The Kolmogorov-Smirnov test was used to verify the normality of distribution. Numerical data were described as mean and standard deviation-test (ANOVA) was used for normally distributed quantitative variables, to compare between more than two groups. The qualitative data were. The level of significance was set at P<0.05.• All tests were two-tailed. The mean of a quantitative variable changes of two categorical variables were performed by a two-way ANOVA.

Figure (1): sphere TEC Dentsply sirona, Estelite sigma Quick *Supra-Nano Filled Universal Composite,* Resin composite Z350XT (3MESPE)

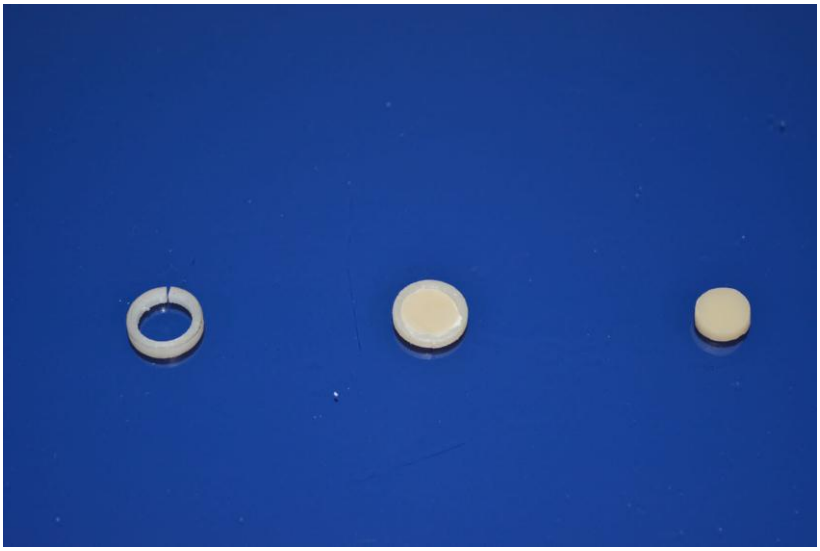

Figure (2): A resin composite discs

III. Results

Color change (In-vitro):

The spectrophotometer results in color stability concerning the type of the restorative material and the different follow-up periods. With regard to material, the overall statistical results of the spectrophotometer for the color change between the tested restorative materials were statistically significant at 3 months, 6 months, and 12 months of follow-up periods with a level of significance of (P=0.0007) as indicated by the Two-way ANOVA test. Also, the overall statistical results showed that the difference between the averages of some groups is big enough to be statistically significant, so, the null hypothesis (H_0) was rejected, in other words, there was an overall statistically significant (P<0.05) as indicated by the Two-way ANOVA test. With regard to time, the overall statistical results of the spectrophotometer for the color change of each restorative material were statistically significant (P<0.00001) as indicated by the One-way ANOVA test. Also, the overall statistical results showed that the difference between the averages of some groups is big enough to be statistically significant, so, the null hypothesis (H_0) was rejected, in other words, there was an overall statistically significant (P<0.05) as indicated by the Two-way ANOVA test. However, the interaction between the different tested materials and the different follow-up periods showed that the null hypothesis (H_0) cannot be rejected since the P-value > α (0.05), in other words, the difference between the averages of all groups is not big enough to be statistically significant as indicated by the Two-way ANOVA test (P=0.698).

Table -: The overall comparison of spectrophotometer color change results of each tested material at different follow-up periods:

Variable	Z350XT (mean± SD)	Ceram X (mean± SD)	Estilite £ quick (mean± SD)	Overall
3 months	4.64 ± 0.51^{Ba}	5.82 ± 0.60^{Ab}	6.09 ± 0.62^{Aa}	P=0.0007*
6 months	5.03 ± 1.15^{Ba}	6.29 ± 0.47^{ABab}	6.59 ± 0.53^{Aab}	
12 months	5.18 ± 0.63^{Ba}	7.06 ± 0.44^{Aa}	7.33 ± 0.65^{Aa}	
Overall	P<0.00001*			
Interaction between raw and column	P=0.698ns			

*; Significant at P<0.05 ; ns; non-significant at P>0.05

; Different uppercase letters mean statistically significant in the same raw.

; Different lowercase letters mean statistically significant in the same raw.

IV. Discussion

In the present study, at 3 and 12 months, spectrophotometer results exhibited that the "Z350XT" showed statistically significantly lower mean color change values (P<0.05) when compared with "Ceram X" and Estilite £ quick. In the present study, Nanofilled composites (Z350XT) had the least color change than the other two groups. Among the groups, the Easy shade results at 3 and 12 months exhibited that the Z350XT showed statistically significantly lower mean color change values (P<0.05) when compared with Ceram X and Estilite £ quick. In agreement with our results, Roja et al., [16] compared the effect of chlorhexidine mouth rinse on the color stability between three different types of composites. All the three types of composites displayed color changes after immersion in mouth rinse, but the color shift depended on the material used, and the nanofilled composites (Filtek Z350XT) had higher color stability. Khosravi et al., [17] evaluate the effects of chlorhexidine mouth rinses on color stability of nanofilled and micro-hybrid resin-based composites. All composite resins tested showed acceptable color change after immersion in different mouth rinses. Filtek Z350XT showed less color change than Filtek Z250. Nuaimi et ., [18] evaluated the color stability of different types of nano-hybrid resin based composite restorative materials upon exposure to aggressive staining solutions (coffee and tea) over time. There were statistically significant differences between Filtek 350 XT in tea and coffee storage. Staining solutions are significant factors that affect color stability of composite resins

In contrast, Silva et al., [19] evaluated the effect of food-simulating media associated with brushing and coffee staining on color stability of different composite resins. The composite resin Filtek Z350XT showed significantly higher staining than all other composite resin tested. Hanaa [20] Evaluated of esthetics of composite resins. Filtek Z350XT and Ceram X duo. No significant color difference was observed between groups. Both type of composite provides acceptable color match and esthetic restorations. Excessive water absorption plasticizes the resin ingredients by hydrolyzation and by micro crack formation. Consequently, the interface between the matrix and fillers allows discoloration. [21]

Nanofilled composites contain nanoparticles that can fill the gaps between large particles which result in lesser and smaller voids in resin composites. Due to small particle size of the filler, the surface area of the fillers has increased dramatically, and the interaction between the matrix and filler surface is also increased. Nanofilled composites also have higher resistance to water absorption and lesser filler matrix debonding. [22] This could partly explain higher color stability nanofilled composites than other two types of composites tested in this study.

Estelite® Σ Quick, Microhybrid composites contain filler particles with an average size of 0.01–0.04 μm which are larger than nanofillers (20 nm). Large filler particles are more susceptible to discoloration and water absorption than smaller filler particle. Water absorption may cause microcracks by expanding and laminating the resin component and hydrolyzing the silane and decrease the functional life of composite resins; thus, microcrack formation and interfacial gaps between the filler and matrix allow soluble coloring agents of mouth rinses to penetrate and cause discoloration [23]. This reason could be attributed to the lesser color stability of micro hybrid composites than nanofilled composites. These results were in accordance with those of Roja et al., *et al* [16].

according to the type of restorative materials, tested at different storage times (3, 6 and 12 months) because the composites remained in the oral cavity for a long time, with various staining substances, at different times and periods. This study was carried out to see whether or not the consumption of beverages at special periods, after placement of restoration, may cause changes in the composite color. [24, 25]. Time has been a dominating factor in a further color change in the coffee-soaked samples, as shown by different values of ΔE found over time. This finding is in confirmation with the findings of Gupta *et al* [24]. Rai et al., [26] evaluate the effect of a saliva substitute (SS) on the color stability of three different nanocomposite restorative materials. All the specimens when immersed in SS showed greater discoloration than compared to the specimens immersed in DW. Group I showed greater resistance to color change compared to other groups.

V. Conclusion

The soaking time is of great importance, as it affects the composite color stability as well.

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