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Comparative Color Stability Assessment of One- Shaded Structurally-Colored and Conventional Multi-Shaded Resin Composites

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Restorative Dentistry
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ABSTRACT

Purpose: To assess the color stability of one- shaded structurally- colored resin composite compared to conventional multi- shaded one. **Subjects and methods:** Thirty- two disc- like specimens from one- shaded structurally- colored resin composite (Omnichroma, Tokuyama Dental); Group I, or conventional resin composite (Filtek Z350, 3M ESPE); Group II were prepared, with equal allocation ratio (i.e.: n= 16). Samples were left in coffee then by using spectrophotometry, colors for all specimens were assessed in (CIE) Lab values; before (baseline) and 30 days later. Substitution in the (after - before) equation was performed to obtain the color change (ΔE); to detect color change for each specimen. Data was tabulated & statistically analyzed. **Results:** One- shaded structurally- colored resin composite (Omnichroma) showed statistically significant ($p \leq 0.05$) color stability in comparison to conventional resin composite (Filtek Z350). **Conclusion:** One- shaded structurally- colored resin composite (Omnichroma) proved better than conventional resin composite (Filtek Z350) regarding color stability. Esthetic color matching, therefore, could be easily obtained and maintained.

KEYWORDS

Color stability, Filtek Z350, Single- shaded resin composite.

INTRODUCTION

Teeth have long been a term of beauty. Modern dentistry therefore, places a special emphasis on esthetics nowadays[(1)]. The corner stone of restorative dentistry is to restore the tooth back to natural appearance after being lost by caries or trauma. Such procedure is not an easy

- Paper extracted from Master thesis titled "Digital Photography versus Spectrophotometry Assessment of Color Stability of Two Resin Composites".

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one, it necessitates precise restoration in terms of shape, contour, surface texture and shade[2]. Shade selection, although seems easy, is actually an important step, that can endanger the final esthetic result.

Several approaches were adopted for shade matching. Visual shade selection is an up-to-date approach that is usually employed clinically. In this approach, a commercially supplied dental shade guide is simply matching with the natural tooth structure in question[3]. The accuracy of such technique is affected by many factors as doctor's experience, color perception problems, eye fatigue, illumination source as well as background color saturation. Inversely, spectrophotometry is the most accurate tool for shade selection[4].

Omnichroma is a recent resin composite; supplied in only one shade with structurally- colored components. It is claimed by the manufacturer & proved in recent studies that it eliminates the need for shade selection phase by virtue of its high blending effect (BE) with surrounding tooth tissues[5]. This BE therefore could shorten chair time and approve patient satisfaction. Although attaining excellent esthetics is mandatory, its maintenance is the ultimate goal[6]. Resin composite surface staining, water absorption, surface roughness, smoking and diet can all lead to color instability[7]. Internally generated composite discoloration is also persistent and related to type, quantity, and quality of the filler as well as the photo initiator system's synergist[8].

This study, therefore, has evaluated color stability of Omnichroma, the one- shaded structurally-colored resin composite, and compared it to conventional (multi- shaded) resin composite (Filtek Z350); using spectrophotometer, as the standard color- assessing device.

SUBJECTS AND METHODS

The research was carried out in accordance with international guiding principles. This study was approved by Research Ethics Committee of Faculty of Dental Medicine for Girls Al-Azhar University (**P-OP-21-02**).

Materials used in this study: (Table 1).

Sample size calculation:

To assess the color stability of two different types resin composite. A power analysis was designed to have adequate power to apply a statistical test of the null hypothesis that there is no difference would be found between tested groups. By adopting an alpha (α) level of 0.05 (5%) and a beta (β) level of 0.20 (20%) i.e., power = 80% and an effect size of (1.02) calculated based on the results of Soliman et al. (2021)[9], the predicted sample size (n) was found to be a total of (32) specimens. Sample size calculation was performed using G*Power version 3.1.9.7.

Specimen preparation:

Thirty-two specimens from both types of resin composite were prepared and allocated for two equal groups (n= 16). (A_1): Light cured one- shaded structurally- colored resin composite, and (A_2): Light cured conventional resin composite (table 1).

Specimens were prepared by packing composite resin inside individual customized teflon molds of 10* 2 mm dimensions[10]. For each specimen the mold was slightly overfilled and was then covered on both sides with Mylar strips, the mold was then sandwiched between two glass plates before curing to flatten the surfaces and to extrude the excess composite to be removed[9]. The resin specimens were light-cured using LED device; 20 seconds for each side [11]. The specimens were finished and polished (soflex system, 3M ESPE) and then kept in a container of distilled water at ambient room temperature for 24 hours[11].

Table 1: Specification, composition and manufacturers of the materials used in this study:

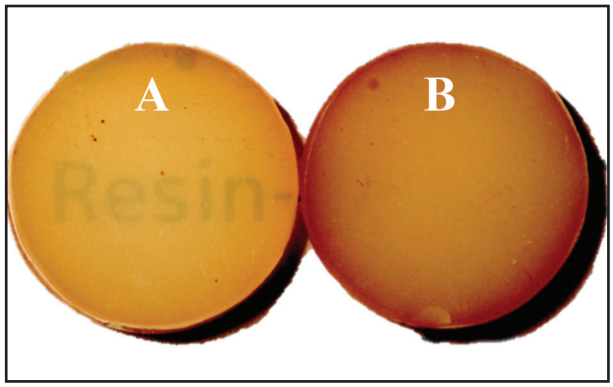
Material	Name	Type	Composition		Filler % By Weight	Batch Number	Manufacturer
			Resin Matrix	Filler Type			
Composite	Omnichroma	Supra nano Spherical fillers	UDMA, TEGDMAMequinol, Dibutyl hydroxyl toluene	Silica spherical zirconia filler (0.3 µm, particle size range: 0.2 to 0.6 µm)	79%	009 E39	Tokuyama Dental, Tokyo, Japan
	Filtek Z350	Nanofilled Enamel A1	Bis GMA, TEGDMA, UDMA, Bis- EMA	Silica nanofillers (5- 75nm), zirconia\ silica nanoclusters (0.6-1.4µm)	78.5%	2167	3M ESPE/ (St. Paul, MN – USA)
Polishing System	SofLex Finishing & Polishing sytem	Multistep polishing system in the form of series of disks	Paper covered with urethane provides the elasticity of the discs. The method consists of four distinct, individually color-coded aluminium oxide grits that range in size from coarse to superfine (superfine).	7982	3M\ESPE, ST Paul, MN, USA	Polishing System	SofLex Finishing & Polishing sytem
Storage Solution	Nescafé Classic	Coffee	100% Pure Coffee	6221007051114	Nestlé, Egypt	Storage Solution	Nescafé Classic

Baseline color assessment:

The baseline color assessment was performed using digital spectrophotometer Vita Easyshade Advance 4.0 (Vita Zahnfabrik, Bad Säckingen, Germany)[9]. The Vita Easyshade was turned on by pressing and holding any button on the handpiece for at least two seconds, calibration of the device was performed simply placing the tip on the calibration pad's center with a 90-degree angle[9]. After that, calibration of each specimen was done by positioning the device tip at 90 degrees with zero distance at the center of the specimen[11]. As the shade appeared on the device screen, the shade itself was selected to show the CIE L, a and b values. The values for each composite type, were then collected as baseline assessment.

Preparation of the staining medium and immersion of specimens: -

To prepare the coffee solution; as a staining medium, (3.6 g) of coffee (Nescafe Classic, Nestle, Switzerland) were added to 300 mL of distilled water that was at a boil and well stirred for 10 minutes. Then a filter paper was used in filtration process. The specimens were immersed in the coffee solution and placed in room temperature for thirty days. Every 48 hours the staining medium was changed and maintained in vials with tight cover to prevent evaporation, then after immersion period, specimens were washed gently for one minute to assure cleanness of specimens[9] (fig. 1, tab. 1).



Figure(1) Different translucency & color change of both resin composite types after 30 days in coffee solution.
A: Omnichroma resin composite specimen.
B: Filtek Z350 resin composite specimen.

Post- immersion assessment and color change calculation:

Spectrophotometric analysis was made for all specimens. Color values L, a and b of all samples were evaluated using the CIE L, a, and b color scale. Readings were all taken at the center of the specimens by one operator. The color change (ΔE) was calculated from the mean color change as Δ (L, a and b values) which are the differences in L, a and b values after and before staining medium immersion[12], for each specimen using the following formula: $\Delta E = \sqrt{[(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]}$. The color change was transferred to an excel sheet as a formula in the first data row **[** =SQRT((L2-L1) ^2+(a2-a1) ^2+(b2-b1) ^2)**]** as the excel cell expressed by a letter for the column and a number for the row.

After the equation has been written in the exact cells of first row of data, the cell was dragged from the lower right corner to automatically repeat the equation to the entire column for all specimens. Color change values for both composite types specimens were collected, tabulated & statistically analyzed.

Statistical analysis

Data was obtained from all groups, collected and statistically evaluated. Shapiro-Wilk's test was used to test for normality. Homogeneity of variances was tested using Levene's test. Data showed parametric distribution and variance homogeneity so they were presented as mean and standard deviation values and were analyzed using one-way ANOVA, followed by Tukey's post hoc test; for comparison between different groups. The significance level was set at $p \leq 0.05$ for all tests. Statistical analysis was performed with R statistical analysis software version 4.1.2 for Windows[13].

RESULTS

Conventional resin composite (Filtek Z350) group (A_2) (19.19±1.75) showed a significantly higher value of color change than one- shaded structurally-colored (Omnichroma) group (A_1) (10.24±0.27) ($p<0.001$) (tab.2).

Table (2)*Mean and standard deviation values for color change (ΔE) for both resin composite types.*

Devices	Color change (ΔE) (Mean±SD)		p-value
	Omnichroma (A_1)	Filtek Z350 (A_2)	
Spectrophotometer	10.24±0.27	19.19±1.75	<0.001*

*; *significant at ($p \leq 0.05$).*

Specimen records of Filtek Z350 composite resin group showed higher significant change in color (ΔE) with the coffee stain immersion compared to specimens of Omnichroma composite resin group within the same immersion period.

DISCUSSION

Color change of tooth colored restorative materials is an important factor that affects long term success of esthetic restorations. Patients main concern now is how long the restoration is going to last, and if their habits may affect the quality and

longevity of the restoration. Generally, many factors as the physicochemical properties of the composite resin material itself, the surface roughness as well as the nature of the staining agent, may cause changes in resin composite basic shades[14].

Omnichroma is a one shade resin composite that makes use of "smart chromatic technology" that can mimic natural tooth shades from A_1 to D_4[15]. Adding stains into the material itself is the way of producing conventional resin composites, on the other hand, Omnichroma appears to mimic the tooth by reflecting its own. Due to the advanced properties of Omnichroma in shade matching, Omnichroma was used in this study to assess its color stability; as it is considered one of the most important properties in esthetic restoration after its color matching. For comparison, Filtek Z350 was chosen as one of the most commonly used resin composites. Additionally, it is a nanofilled resin composite whose filler loading is 78.5% by weight; providing better physical properties and improved polish retention. Enamel A_1 shade was used; as its color after curing is really close to that of Omnichroma.

Composite disc- shaped specimens were used rather than composite- restored teeth, as targeting the exact color changes that would happen in resin composite, without any interfering reflections from cavity surroundings that could affect the results. Oxygen inhibition layer (OIL) is the viscid top layer, which appears after curing resin composite with no barrier with air[16] which affect directly the color stability. Which can be avoided by using mylar strip, which seems to be the most effective way, as it blocks any contact of restorative material with air[17]. Distilled water was used as a storage medium for 24 hours as it is not considered a colorant agent[17].

In the current study, staining medium was coffee, due to its regular consumption daily[13]. It was associated with the greatest color change for most composite resin materials and polishing methods as well[8]. To simulate the daily routine of a coffee consumption person to get an ideal result, so study time which was 30 days seems to resemble 30 months, as the average time and amount of drinking is about 15 minutes and 2-3 cups per day.

The resin component plays a crucial role in staining susceptibility. The percentage of water uptake in Bis- GMA based composite resin is doubled over TEGDMA based composite resin increased by 1%[17]. Specimen records of Filtek Z350 resin composite group showed higher significant change in color change (ΔE) with the coffee stain immersion compared to specimens of Omnichroma resin composite group[18].

Omnichroma is mainly composed of UDMA, which is hydrophobic in nature, this might have been the cause of the lower ΔE value as observed[18], contrary to Filtek Z350 showed higher stain; probably caused by the hydrophilicity of its matrix due to its content of TEGDMA. ΔE* values less than 1 were identified as unnoticeable by human visual system, and hence only instrumentally recognizable, ΔE* values between 1 and 3.3 were identified visually noticeable by expert observers but still clinically acceptable, while ΔE* values higher than the threshold value of ΔE* = 3.3 were identified noticeable by untrained observer, and hence clinically unacceptable[19].

Filler type, and size and what composite is composed of, affect directly along with the storage period to water sorption[20]. As proved before, that after dissolving coffee, tiny discoloring particles were being formed that can penetrate the composite matrix and cause a discoloration[21].

The current study results came in accordance with a previous study[22], that concluded that Omnichroma showed lower color change than the other in comparison and higher stability. This was additionally agreed by other studies that Filtek Z350 associated with a higher ΔE values in comparison of various resin composite materials[11,17,23]; after immersion in staining medium such as coffee solution. And also came in harmony with another

study[14], in which it was concluded that the two composite materials; Omnichroma and Filtek Z350XT showed unacceptable color change after artificial-aging in tea and red-wine.

On the other hand, results were different from a study[24], that showed that concluded that the Omnichroma displayed more degraded color stability comparable to regular resin composite in coffee, but more impaired than the standard composite in cola; as they utilized lower molar acrylic teeth; different from this study.

CONCLUSION

Under study limitations, one- shaded structurally-colored resin composite, (Omnichroma), appeared much better than multi- shades resin composite (Filtek Z350) with respect to color stability.

RECOMMENDATIONS

1. This study recommends the use of one- shaded structurally- colored resin composite whenever more color stability is required, and encourages more researches assessing it clinically.
2. Further researches for developing a more durable and color stable resin composite are still needed.
3. Further studies comparing Omnichroma with various resin composite types, in different staining media are required. Clinical assessment is highly recommended as well.

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Conflicts Of Interest

There are no conflicts of interest.

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