Original Article

Influence Of Exposure Time To Coffee On Color Stability Of Selected Composite Resin Veneers

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Abstract

Objectives: The aim of the study is to evaluate the effect of the time and instant coffee solution on the color stability of three types of composite resin based veneer systems.

Materials and Methods: 24 composite resin veneer samples were selected and divided into three groups: two groups of prefabricated veneers (Edelweiss, Ultradent Inc™ (EDL) and Componeer, Coltène/ Whaledent AG™ (CMP)) and one group of laboratory made (Nexco, Ivoclar Vivadent (NEX)) veneer system were tested (n=8). Specimens were prepared and stored in staining solution (instant coffee) and assessed color changes with Minolta spectrophotometer every three days for a period of 27 days, after which color differences (ΔE*) were calculated. Data collection and analysis was done using one-way ANOVA and Student's t-test (α=0.05).

Results: One-way ANOVA revealed a significant difference in color stability between the two veneer systems. NEX group veneer system exhibited the highest color stability (ΔE*= 0.73 ± 0.5) as compared to prefabricated veneer groups (EDL 10.07 ± 5.15, CMP 7.41 ± 4.64) with p value <0.05.

Conclusion: The color stability (ΔE*) of the laboratory made veneer system is significantly higher than the prefabricated veneer systems and more clinically accepted.

Keywords: Laboratory made veneer, prefabricated veneer, Color stability

Introduction

The cosmetic dentistry could be referring to any dental work that improves the appearance of a person's teeth, gums and/or occlusion. It primarily focuses on improvement dental aesthetics in color, position, shape, size, alignment and overall smile appearance (Schmidt and Tatum, 2006). The minimal intervention of cosmetic dentistry provides a paradigm shift in the quality of dental care. This shift combined with the increasing demand for aesthetic front teeth that has always motivated the dentist to try newly developed materials for more conservative treatment options (Toh et al., 1987). Among the restorations used to create aesthetic results are veneers, crowns and bridges. In minimal intervention of cosmetic dentistry, veneers are commonly used to ensure conservation of tooth structure and produced aesthetic outcomes of the anterior dentition (Christensen, 2003, 2004).

Dental veneer defined as a layer of tooth-colored restorative material, usually porcelain or composite resin, attached to the surface by direct fusion, cementation or mechanical retention (Mosby, 2011). Dental veneer was used for improving the color of discolored

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teeth and straightening slightly malpositioned teeth (Christensen, 2004). Dental veneer systems can be classified according to its material and the mode of clinical usage. The common types of veneer materials were porcelain and composite resin materials (Christensen, 2004). The mode of the clinical usage can be either direct; which is most of the time using composite resin materials, or indirect which the veneer had to be manufactured in the laboratory before its clinical usage (Affairs, 2003; Christensen, 2003, 2004). Composite resin veneer also could be classified as laboratory-made system or prefabricated system (Toh et al., 1987).

Most of the common prefabricated veneer systems were made from composite resin materials with specific polymerizing and finishing techniques (Coltene/Whaledent, 2013; Ultradent, 2012). The composite resin materials provide adequate aesthetic, high bond strength and superior mechanical properties (Rosenstiel et al., 1998). However, the shortcomings of these materials include wear, leakage and discoloration lead to impairment in the aesthetic value of the composite resin over time (Le Roux and Lachman, 2007). The discoloration of the composite resin could be due to internal and/or external factors (Rosenstiel et al., 1998). The external factors could be related to absorption and accumulation to stains (Vichi et al., 2004).

Color stability is the quality of being physically predictable, orderly, not readily moved (Mosby, 2011). Many studies have shown that composite resins are susceptible to color instability. Intrinsic and extrinsic factors were affect directly on the color stability of the composite resin veneer system. The intrinsic factors are: composition of the resin matrix, size and nature of the particles, filler loading, amount of photoinitiator or inhibitor, and the level of polymerization (Bayindir et al., 2012; Falkensammer et al., 2013; Jain et al., 2013). Meanwhile, exposure to food colorants, UV radiation, temperature changes, and water are the main extrinsic factors (Jain et al., 2013). These factors are essential in the hydrolysis and degradation of the composite resin that influenced the appearance of the materials (Asmussen, 1981; Jain et al., 2013; Vichi et al., 2004).

The instant coffee considered one of the highest consumption drinks globally. The international coffee organization stated that more than 1,896 million kg of coffee were used in Asia and Oceania in the last four years with 3.7% annual growth rate (Organization, 2016). Several studies related to color stability were confirmed the discoloration effect of the coffee on the composite resin restoration (Ertas et al., 2006; Jain et al., 2013; Turkun and Turkun, 2004). Based on that, the present study was used the instant coffee to be the staining solution beside the distilled water media.

Many studies evaluated color stability of adhesion materials related to different factors such as aging process, exposure time to staining solution, types of staining solutions and polymerization mode (dual, light or auto) (Falkensammer et al., 2013; Jain et al., 2013; Um and Ruyter, 1991; Vichi et al., 2004). However, most of the color stability studies were focused on the composite resin material in form of adhesive system or conventional restoration (Falkensammer et al., 2013; Jain et al., 2013; Kilinc et al., 2011; Miyagawa and Powers, 1983). There is lack of in vitro studies that evaluate the color stability for composite resin in form of veneer restoration whatever direct or indirect. The present study was aimed to evaluate the effect of the time and instant coffee on color stability of the prefabricated composite resin veneers and compare it with laboratory-made composite resin veneer. The null hypothesis of the present study was that there would be no significant difference between the color changes of the prefabricated veneer and laboratory-made veneer systems over time.

Methods and materials

Two prefabricated and one laboratory-made veneers were used in the present study as shown in Table 1. Eight veneers from each group (n=8) were cleaned by ultrasonic water bath (Renfert SYMBRO, Germany) with plaster solvent chemical solution (Gypsolve, England) to remove any accretion or industrial smear layer. Then, all samples were dried with non-oily dry air and stored in three different containers named (EDL, CMP and NEX). Then all

Veneer system	Compositions	Manufacturer
Edelweiss (EDL)	The veneer filler ratio is 82% by weight and 65% by volume. The variation of inorganic filler particle is between 0.02 – 0.03 µm.	Edelweiss Dentistry, Austria
Componeer (CMP)	Methacrylate, □silanized barium glass, hydrophobized amorphous silicic acid. Filler content by weight is 80% and by volume is 65%.	Coltène/Whaledent AG ™, Switzerland
Nexco (NEX)	Aromatic aliphatic UDMA & Aliphatic dimethacrylates, Highly dispersed silicon dioxide, Copolymer, Catalysts and stabilizers and Pigments.	Ivoclar Vivadent™, USA

Table 1: Veneer system materials

samples were immersed in distilled water for 24 hours under room temperature (27°C). By using Minolta spectrophotometer CM–(C 3500), the value of L*, a* and b* were measured based on CIE (Commission International de l'Eclairage) for each sample to be considered as baseline value (day 0). Then, they were transferred to three different containers consist of staining solution, instant coffee. One veneer from each group was stored in distilled water container. The value of L*, a* and b* were measured every three days interval for 27 days and this group was considered as a control group.

Staining solution preparation

The staining solution consisted of instant coffee which was prepared by adding approximately 48 mg of coffee to 250 ml of boiling water (Jain et al., 2013). The solution was divided into three different containers for three different veneer groups.

Color measurement

After calibration setup completed, three measurements of (L*, a* and b*) were done with the active point of the center of each specimen. The mean readings of each sample were recorded and were used for overall data analysis. The same procedures were repeated every 72 hours interval (three days) for 27 days. At each time of measurement, veneer sample was removed from the containers and washed with 10 stroke of soft toothbrush under running tap water. Then, it was dried with soft doubled paper wipes. The coordinate value of each sample was re-measured with the same sequence of calibration and measurement. All coordinates (L*, a* and b*) values were collected manually and recorded. The color difference (ΔE*) between the color coordinates was calculated by applying the specific mathematical equation: $\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$, in order to compare values before and after the storage treatment. ΔE* represent the color differences, ΔL* represent change in lightness, Δa* represent red-green coordinate and Δb* represent yellow-blue coordinate.

Data Collection and Statistical Analysis

All data were collected and recorded by manual and digital recording. The results were tabulate and subject to statistical analysis (IBM SPSS statistics v. 18 and W. Statistical Pro. by Evan Miller v. 1.8.8). Kolmogorov-Smirnov test was used to estimate the uniformity of the raw data distribution. For comparison between different variables, One-way ANOVA test and Student's t - test were used to compare between three different veneer groups.

Results

Table 2 shows the average mean values of (ΔE) for the three tested groups. The (ΔE) of EDL veneer group shows the highest mean values 10.07 ± 5.15 as compared to the other two veneer groups (CMP group mean values was from 7.41 ± 4.64 and NEX veneer group mean was 0.73 ± 0.5). While, (ΔE) of NEX ve-

Groups	Average (ΔE)	Minimum (ΔE)	Maximum (ΔE)
EDL	10.07 ± 5.15	9.83 ± 2.9	11.91 ± 3.1
CMP	7.41 ± 4.64	6.98 ± 2.5	9.19 ± 4.4
NEX	0.73 ± 0.5	0.68 ± 0.2	0.98 ± 0.3

Table 2: The (ΔE) mean and standard deviation values for the tested veneer groups.

neer group shows the lowest mean values. Figures 1 and 2 shows the liner correlation of the mean values of the color changes (ΔE) for all veneer groups through the experimental time intervals. In these two figures, the EDL veneer groups showed a significant change in the color ranged from 0 – 9.83 ± 2.9 in the first three days from storage in instant coffee solution. Then, in the next three days (day 6) showed slight color change (10.26 ± 2.9). After that, EDL veneer color change become more stable and ranged from 11.25 ± 3.3 to 11.91 ± 3.1 in the remaining 21 days of the experiments.

On the other hand, the CMP veneer group showed a significant change in the color ranged from 0 – 7.68 ± 3.2 in the first three days of experiments. After that, the CMP veneers become more color stable and ranged from 7.68 ± 3.2 to 9.19 ± 4.4 in the last 24 days of the experiments. Furthermore, the NEX veneers also showed significant color changes (p= 0.025) when compared with control group (distilled water) but showed lowest color changes when compared with EDL and CMP through experiment duration as shown in Figure 2a, 2b and 2c.

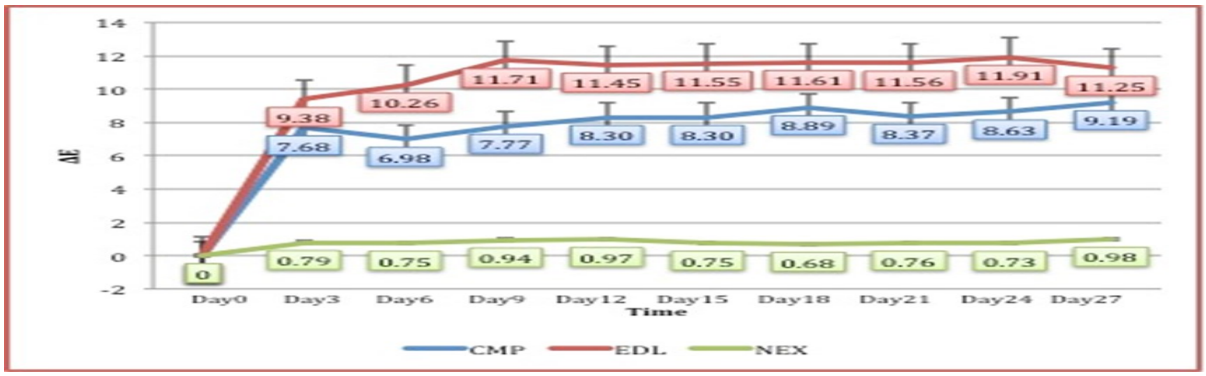

Figure 1: Liner correlation of the (ΔE) mean values of the veneer groups through time intervals.

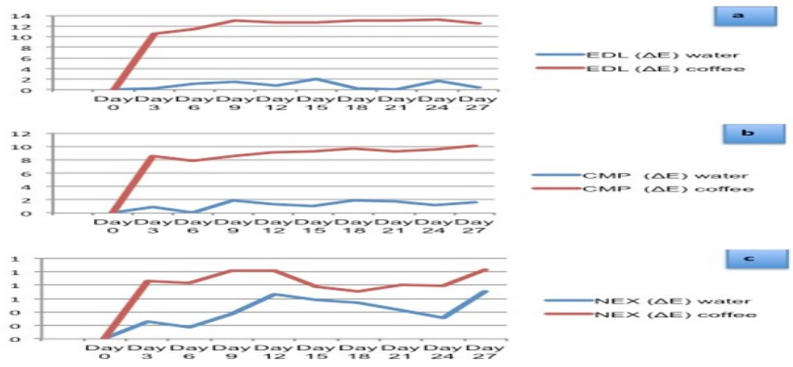

Figure 2: Liner correlation of the (ΔE) mean values of the veneer groups between instant coffee and distilled water media through time intervals.

Kolmogorov-Smirnov test was showed non-uniformly distributed values for surface roughness with 95% confidence intervals (α =0.05) as in Table 3. One-way ANOVA test was showed significant differences between average mean values of (ΔE) for the three veneer groups (P< 0.001) as in Table 4. While, Student's t-test reveled significant differences between mean values of (ΔE) within veneer groups as in Table 5.

Test Statistic D	Critical Value @5 % C	St. Error	Significant D>C	P-value
0.335	0.083	0.3	**Yes**	.000

Table 3: Kolmogorov-Smirnov test for the equality of distribution of the (ΔE) values. Color Stability (ΔE) departs from a uniform distribution (α =0.05).

Test Statistic F	Critical Value @5 % C	St. Error	Significant F>C	P-value
128.974	3.03	0.3	**Yes**	.000

Table 4: One-way ANOVA test for (ΔE) of the veneer groups. Average (ΔE) varies across values of Veneer (α =0.05).

		Test Statistic t	Critical Value @5 % C	St. Error	Significant t>C	P-value
CMP	EDL	3.634	1.973	0.4	**Yes**	.000
	NEX	13.562	1.973	0.3	**Yes**	.000
EDL	CMP	3.634	1.973	0.4	**Yes**	.000
	NEX	17.085	1.973	0.4	**Yes**	.000
NEX	CMP	13.562	1.973	0.3	**Yes**	.000
	EDL	17.085	1.973	0.4	**Yes**	.000

Table 5: Student's t- test for (ΔE) values within veneer groups.

Discussion

In principle, the composite resin veneers are widely used nowadays for different purpose regarding enhance the teeth shape, teeth alignment, cover discolored teeth and for smile design (Christensen, 2004; Dietschi and Devigus, 2011). However, one of the disadvantages is the color stability that it affects aesthetic and longevity of the restoration (Ertas et al., 2006; Jain et al., 2013). The null hypothesis of the present study was rejected: the results of one-way ANOVA test proved a significant difference between the amounts of color changes (ΔE) in the three veneer systems. Both of the prefabricated veneer systems showed significantly higher (ΔE) than laboratory-made veneer.

The EDL and CMP veneer groups showed significant increase in the ΔE in the first three days of immersing in the staining solution. As compared with the total amount of ΔE during the experiment, the first three days interval was the highest ΔE. After the first three days interval, both of EDL and CMP veneer groups showed relatively stable color changes until end of the tenth intervals. While, the NEX veneer group was showed significant and stable increase in the ΔE that ranged between 0.68 - 0.98 through the experimental duration. Jain et al. (2013) and Ertas et al. (2006) found that the composite resin material showed significant color changes when immersed in coffee solution. This is in

agreement with the findings of the present study.

The ΔE value has many clinical implementations, as any ΔE below 3.3 consider clinically accepted (Jain et al., 2013) while the ΔE value of more than 5.5 considered exceeded the critical threshold (Falkensammer et al., 2013). The present study findings of the ΔE showed noticeable color changes in the prefabricated veneer systems and exceeding the critical threshold while the ΔE of the laboratory-made veneer system was clinically accepted. These findings could be attributed to many factors related to the color stability of the composite resin such as the composition of the resin matrix and the curing mechanism of the material (Kim and Lee, 2008).

Several studies showed that curing under nitrogen pressure at specific temperature and time will improve the color stability of the composite resin (Jain et al., 2013; Kim and Lee, 2008). Furthermore, another studies were showed that insufficient matrix monomer conversion within the composite will induces absorption for the staining substances (Jain et al., 2013; Stober et al., 2001). The details that related to curing methods and the manufacturing technologies for the two prefabricated veneer systems of the present study were never published or mentioned in the official website of the manufacturer companies.

The findings of the present study showed high tendency for the prefabricated veneer shell to change its color when exposure to instant coffee in the first three days. However, the prefabricated veneer system consist bonding and luting agents beside the veneer shell. All veneer system components have different color stability towards the staining solutions (Archegas et al., 2011; Kilinc et al., 2011). Based on that, the present study findings should be combined with other in vitro and in vivo studies related to color stability on prefabricated veneer systems to be more clinically significant.

The ΔE was measured with a standard quantifying device (Color Spectrophotometer, Minolta, USA) rather than visual examination for accuracy, reproducible and statistically utilizable results. The veneer samples were stored in distilled water before the experimental steps because of the difficulty to adapt the oral environmental variations of the human subjects (Kilinc et al., 2011).

The spectrophotometer device can operate with two different measuring geometrics: specular component included (SCI) and specular component excluded (SCE). In the present study, the SCE was used in measurements record as it was proved that the color changes measured with SCE geometry were greater than those measured with SCI geometry (Jain et al., 2013; Lee and Powers, 2007). The veneer samples thicknesses in the present study were within 1.0 mm to match the spectrophotometer requirements and the ISO standards for the sample thickness (< or = 2.24 mm) for reliable results (Kilinc et al., 2011; Miyagawa and Powers, 1983). The immersion duration for the veneer samples in the staining solution was set at four weeks as study done by Jain et al. (2013) and Bayindir et al. (2012).

Most of the color stability studies used different staining solutions for the ΔE evaluations such as instant coffee, nails varnish and wine (Falkensammer et al., 2013). In the present study, the instant coffee was used to evaluate the ΔE as considered one of the most common daily drink and have the highest effect on the color stability of the composite resin (Domingos et al., 2011; Jain et al., 2013; Organization, 2016).

Conclusions

Within the limitation of the present study, the laboratory-made veneer showed clinically accepted color stability when immersed in instant coffee solution. Both of the prefabricated composite resin veneers were showed noticeable color changes when immersed in instant coffee solution which were exceeded the critical threshold and not accepted clinically. The highest level of color changes amount for the EDL and CMP were presented in the first three days of the total experimental duration. After that, both prefabricated veneer systems were showed the same color stability behavior.

Acknowledgment

The present study was supported by the research fund from Faculty of Dentistry of University Tecknologi MARA and all the experimental devices were used from the Research laboratory of the faculty; therefore, the authors are thankful for that.

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