The Effect of Light and Dual Cure Resin Cement to The Color Change of Esthetic Restoration Porcelain Laminate Veneer

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Abstract

Esthetic Porcelain laminate veneer (PLV) restoration uses resin cements as the adhesive to bond to tooth. PLV's significant esthetic factor is color match of itself to existing dentition, where cement is one of influencing factors. Controversy of previous studies in literatures and clinical phenomenon found that PLV's color may change right after cementation using light and dual cure resin cement and after a long-term. Nevertheless, those were found using several cement colors on different thickness and colors of PLV.

To evaluate color change of same thickness and color of PLV, cemented with same color light and dual cure resin cement.

13 PLV IPS Emax 0.5mm cemented to models with translucent light and dual cured resin cements. Color change at 0 and 24 hours post cementation were evaluated using spectrophotometer.

ΔE PLV cemented with light and dual cure resin cements from 0 to 24 hours revealed color difference, however statistically insignificant (P>0.05). PLV with dual cure resin cement has the highest ΔE. There is insignificant difference between ΔE of light and dual cure after 24 hours (p>0.05).

Color changes of PLV cemented with light and dual cure resin cement are within clinically and esthetically acceptable.

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Introduction

Teeth are one of the critical components that affect one's appearance, and play an important role for social interaction. In previous studies about appearance satisfaction, many people unsatisfied with their teeth (37.3%), with discoloration as the highest contributor of complaints (89.3%), and followed by misaligned teeth (23.7%).[1]

Discolored or minor misaligned teeth can be restored using full veneer crown, however it is more invasive because it requires a lot of tooth reduction. PLV is an esthetic restoration alternative that is more conservative and less invasive, with just a minimum email preparation required. It is a thin layer of translucent porcelain that is used to enhance and modify the form and the color of teeth.[2] PLV has the characteristics of color stability, good mechanical strength, good compatibility with periodontal tissue, longevity, and good texture and translucency. The strain and stress transference.[3]

PLV can be made very thin, 0.3-0.7mm, with high translucency that mimic the tooth color.[4] Translucency is a substance property that permits the passage of light and disperses the light so that objects cannot be seen clearly through the material.[5] Cement plays a role as a medium between PLV and tooth. Therefore the color of PLV is influenced by the cement.

PLV uses resin cement for its cementation. There are 3 types of resin cement used for PLV restoration; i.e self cured, light cured, and dual cured resin cement. Cement color stability is very important for the long term success of the restoration.[3]

Based on clinical phenomena, it was found that color changes occurred in the PLV

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shortly after cementation, either by using cement resin type dual cure or light cure. This is quite a concern, especially in PLV restorations that are performed on only one or two teeth, as the changes are more clearly visible.

There was found a controversy in the literature on the effect of resin cement on color change in the PLV. Xing W et al showed that the effect of resin cements on the final color of PLV depended on cement shades and thickness of PLV. Turgut et al studied the color change in the PLV with two different thicknesses and porcelain colors, cemented with various colors and types of cement resin. It showed that the type and shade of resin cement, the thickness and shade of the PLV influenced the result of color of PLV. [6,7] But it has not been studied on color change which occurs in the PLV with the same thickness, color of the PLV and color of cement after it has been cemented with light and dual cement resin cement and after completed polymerization.. The aim of this study was to analyze the color changes in the restoration of PLV with the same thickness, which is cemented with light cure and dual cure resin cement.

Materials and methods

Preparation of tooth sample

The design of this study was laboratory experimental. Sample was made from a patient in Prosthodontic clinic, Faculty of Dentistry University of Indonesia, indicated for PLV restoration to correct slight discoloration and minor structure defect of the tooth. Impression was made 13 times using polyvinyl siloxane, then 13 working models were made using natural die material (Ivoclar Vivadent) to simulate the tooth. ND2 from natural die shade guide (Ivoclar vivadent) was chosen as it was the closest shade to patient's tooth color.

Preparation of veneers

Thirteen PLV were fabricated from IPS emax CAD ingots shade A2 (lithium disilicate, Ivoclar Vivadent) with high translucency and 0.5mm thickness. This shade was selected to match the adjacent teeth color of the patient. High translucency veneer was selected as any color change will clearly visible through a translucent veneer. Working models then scanned to a CAM machine to fabricate the PLV. All PLV were made by the same operator using Sirona inLab MC XL.

Resin cements

This study was using two different resin cement systems from one manufacture. One was Variolink II dual cure resin cement (Ivoclar Vivadent), base and catalyst, with transparent shade. The other was Variolink veneer light cure resin cement MV 0 shade (Ivoclar vivadent). All resin cements are low in viscosity that allow good flow and to form a thin cement layer between the PLV and the model.

Cementation of PLV with resin cements

Working models were divided into two groups, based on the type of resin cement used. Six PLV cemented with Variolink veneer light cure resin cement as group one, and the other six PLV cemented with Variolink II dual cure resin cement as group two. One PLV was cemented with DeOx (Ultradent) as control. Light cured resin cement was applied directly from a syringe. Dual cured resin cements were mixed on a mixing pad and applied to the surface of PLV using plastic instrument. Forefinger was placed on top of PLV until the PLV is fully seated at the model. Then the top surfaces of all specimens were light cured using LED curing unit (Valo, Ultradent) for 40s.

Color measurement

Color measurements were performed with spectrophotometer (Spectroshade micro). Spectrophotometer could detect any color change that sometimes was invisible to the eye. Color changes (ΔE) were calculated using Commission Internationale de l'Eclairage (International Commission on Illumination) L*a*b* standard to evaluate the degree of perceptible color change. This system represents a 3 dimensional color space consists of components of lightness (L), red-green (a), and yellow-blue(b).[9] Color values of all groups and control were measured according to the CIELab. Color values were measured two times, right after cementation (0 hour) and 24 hours after cementation. CIELab color difference (ΔE) between two different color readings was determined by using the equation:

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

Results

The distribution of each variable, average, standard deviation, minimum value, and maximum value are presented in table 1. Based on univariate analysis, it could be seen that the value of ΔE in the PLV that was cemented with both cements has increased from 0 hours to 24 hours post cementation. In addition, the ΔE values in the PLV group treated with dual cure had a larger average than the PLV group with light cure. The highest ΔE values were in the PLV group treated with dual cure resin cement 24 hours post cementation, whereas the lowest ΔE was in the PLV group treated with light cure resin cement 0 hours post cementation.

Type of cement	0 hours		24 hours	
	Mean ±SD	Min - Max	Mean ±SD	Min - Max
Light Cure	1.03 ± 0.13	0.83-1.20	1.1 ± 0.59	0.28-1.98
Dual Cure	1.10 ± 0.38	0.47-1.48	1.57 ± 0.55	0.67-2.29

Note: SD = Standard Deviation, Min = Minimal, Max = Maximal

Table 1. Color change distribution (ΔE) occurs in PLV 0 hours and 24 hours post cementation with light cure and dual cure resin cement.

Variable	p*
Light Cure 0 hours	0.41
Dual Cure 0 hours	0.46
Light Cure 24 hours	0.85
Dual Cure 24 hours	0.91

Shapiro-Wilk test; *p > 0.05 = normal distribution

Table 2. The normality test for the color change (ΔE) on cemented PLV with light cure and dual cure resin cement 0 hours and 24 hours post cementation.

	n	Mean±SD	Mean Difference ±SD	Mean Difference (CI95%)	p*
Light Cure 0 hours	6	1.03±0.14	0.72±0.66	0.62-0.76	0.80
Light Cure 24 hours	6	1.1±0.60			
Dual Cure 0 hours	6	1.10±0.38	0.47±0.61	0.17-1.12	0.11
Dual Cure 24 hours	6	1.57±0.55			

*Dependent t test (p <0.05)

Table 3. Analysis of color changes in PLV with light and dual cure resin cement after Polymerization.

The normality test for the color change that occurred in the PLV was done by Saphiro Wilk test because the sample size was <50 persons (Table 2). The test results showed that the color change distribution in PLV which was cemented with light cure and dual cure resin cement, either 0 hours or 24 hours post cementation, all was normal. This showed that a parametric test could be performed on the data obtained.

Bivariate analysis was performed by dependent t test to see the amount of color change that occurred in each PLV group after the complete polymerization of the used resin cement (table 3).

There were no significant differences in the PLV group treated with light and dual cure resin cement after complete polymerization.

Independent t-test was performed to analyze the PLV group shortly after cementation and after complete polymerization cement (Table 4). There was no significant difference in mean values of color change between PLV groups cemented with light cure and dual cure resin cement either after cementation (0hours) or after complete polymerization resin cement (24hours).

	n	Mean ±SD	Mean Difference±SD	Mean Difference (CI 95%)	p*
Light Cure 0 hours	6	1.033±0.13	0.66±0.16	0.30-0.43	0.695
Dual Cure 0 hours	6	1.10±0.38			
Light Cure 24 hours	6	1.10±0.59	0.47±0.33	0.26-1.20	0.186
Dual Cure 24 hours	6	1.57±0.55			

*Independent t test *(p<0.05)*

Table 4. Color changes analysis of PLV group cemented with light cure and dual cure resin cement.

Discussion

This study was conducted on 13 PLV samples which were made from the dental model of a patient with an indication of PLV restoration to improve tooth structure and position. The improved adhesive system as well as the development of technology in porcelain restorations today, makes the patient's demand for restoration of esthetic teeth with PLV.[8-10] PLV is an esthetic restoration which is used to change the shape, color, and tooth position in order to improve performance.[11] PLV is a minimally invasive restoration because it requires only minimal preparation on email. Lithium disilicate was chosen in this study because currently the most popular porcelain restorative materials used are lithium disilicate and zirconia, but lithium

disilicate has better mechanical strength and translusency.[12,13] Lithium disilicate has two methods in the manufacturing process, that is presssable and CAD/CAM.[14] In this research we selected CAD/CAM method to produce 13 PLV which is more efficient process and can be predicted to have the same thickness and shape.[15]

The aims of this study were to analyze the color change in PLV with lithium disilicate material which was cemented with light cure and dual cure resin cement. One of the failures of PLV restoration is the change of color.[16] Alhekeir et al in his study evaluated the clinical failure occurring in the PLV, 34.48% of the subjects showed a failure of restoration in which 60% of the failures were color change in PLV.[8] The color of PLV depend on a combination of color tooth structure that supports PLV, porcelain thickness, and resin cement. Turgut and Bagis in his research stated that the type and color of resin cement as well as the thickness and color of the porcelain affect the color of the PLV.[7,8]

Measurements of color were done with a tool that has been calibrated. Spectrophotometer was used. The use of spectrophotometers improves color selection accuracy by 33% compared to visual observation, and provides 93.3% success in color selection. This research use lithium disilicate type of high translucency with thickness of 0.5mm. PLV with a thickness of 0.5mm, according to Asmussen in his research stated in Archegas et al, could not cover the change of color of the cement used.[4] Translucent resin cement color was used to see the effect of two different resin cement types on the color of the PLV. The PLV sample was cemented on a working model made with a natural die. Natural die represents the color of the tooth surface of the patient, to simulate the same clinical condition as the patient's teeth. Then the PLV is divided into two groups where the first group will be cemented with light cure resin cement, the second group with dual cure resin cement, and one PLV glued with glycerin. Glycerin is a colorless viscous liquid that is used to prevent light scattering or refraction of light through the empty space between the PLV and the model of the teeth.[3,17]

This study found that PLV which were cemneted by light cure and dual cure resin cement showed color change from 0 to 24 hours after cementation, or after complete polymerization. Turgut et al stated that the final color change of PLV restorations after complete polymerization of resin cement could be seen from the change in L*, a*, b* coordinates.[7] Vichi et al stated that color differences (ΔE) is divided into 3 categories to distinguish the color changes. ΔE ≤ 1.0 is invisible and aesthetically acceptable. ΔE 1.0-3.3 otherwise there are color changes that do not look the difference clinically, but can be seen by experienced operators. ΔE ≥ 3.3 otherwise there are visible color changes and cannot be accepted clinically and aesthetically.[4,18]

The measurements with the spectrophotometer showed that the values of a* and b* of both groups increased from 0 to 24 hours, whereas the L* values varied without a specific pattern. The value of ΔE from 0 to 24 hours indicates a change of color but is not statistically significant ($p > 0.05$). Since the samples are not exposed to extrinsic factors, it can be argued that the color change that occurs is due to the intrinsic component.[19] Albuquerque et al, stated that variation of negative a* and b* towards positive indicates a change of color becomes more red and yellow.[20]

In addition, aliphatic the amine present in light cure resin cement serves as a co-initiator for camphorquinone. Camphorquinone has a yellowish pigmentation, but the material undergoes a photobleaching process when the polymerization process occurs.[19] Polymers of light polymerization appear yellowish during the first 24 hours post polymerization due to camphorquinone molecules that has not reacted to its original color, yellow. This explains the increase in the coordinates of b* from 0 to 24 hours post cementation in this study. However, insignificant statistically color changes in both groups can be attributed to the use of high-translucency PLV and 0.5mm thickness, making oxidized and unreacted components of the eluted polymerization system, resulting in reduced variation and color intensity.[19,20] this study used LED curing units with a wavelength of 470nm and performed as close as possible to the samples. Al-Kheraif's research on curing unit efficiency, the use of LED curing units with a distance of 5mm towards the specimens showed excellent polymerisation efficiency.[21]

The highest value of ΔE from 0 to 24 hours post cementation was in the PLV group which was cemented with dual cure resin cement. The

value of ΔE was 2.29. Some studies suggesting that cement resin dual cure tends to change value due to the degradation of the benzoamine which is found in the cement.[22] Oxidation of amine co-initiators reacting with benzoyl peroxide via the redox polymerization system is a major cause of color change in type dual-cure resin cement.[4,19] Aromatic amines in the redox system are susceptible to degradation and tend to cause discoloration resulting from unreacted benzoyl peroxide. The reaction occurs based on the physical contact of the two materials during the polymerization process, in which the mobility of the two molecules decreases as the polymerization process proceeds. Aliphatic amine in light polymerization system is chemically more stable, therefore cement resin of light cure type tends to cause a smaller color change than the dual cure type.[19]

In the measurement of color change after cementation (0h) and after complete polymerization (24h post cementation), showed that the difference between ΔE values of the PLV group treated with light cure resin cement (Variolink Veneer) and dual cure (Variolink II) did not significantly difference(p> 0.05). similar with Turgut et al, Archegas et al and Almeida et al showed higher ΔE values in dual cement type resin cement except for Variolink II cement, which showed similar results to ΔE on resin cement type light cure. Almeida et al states that this is because cement Variolink II has a proportion of photosensitizers more than chemical initiators on the system.[4,7,19]

Azer et al stated in Turgut et al, that the use of A1 and translusen color of dual cure resin cement (Varilonk II) does not cause significant color change in PLV with a thickness of 0.1 mm.[7] Montero in his research on 120 PLV Emax high translucency with a thickness of 0.5mm and 1mm, found a color change in PLV with a thickness of 0.5mm which was cemented with resin cement type light cure. The change was statistically significant on the use of light cure resin cement (Variolink Veneer) with -3 color, otherwise the use of cement with lighter color indicates a insignificant change in the color of the PLV.[23] The results of this study show that the use of resin cement with transparent colors of both types of cement does not cause statistically significant changes in the color of the PLV.

The weakness of this research is the use of two types of cement from the same manufacturing. Still needed further research with the use of several colors and cement from different manufactures to overcome these shortcomings. The use of one color PLV is also likely to cause a lack of variation from the results of this study. The operator must understand and consider the color and type of resin cement before using it in the cementation of the PLV.

Conclusions

The color change of PLV that was cemented with dual cure resin cement has a larger color change compared to light cure resin cement. There was a change of color but not meaningful on the PLV which was cemented both with light cure and dual cure resin cement. The use of light cure and dual cure resin cements in PLV restorations is clinically and esthetically acceptable.

Declaration of Interest

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