Influence of Pre-Curing Different Adhesives on the Color Stability of Cemented Thin Ceramic Veneers

[1]Graduate Program in Dentistry, UP - Universidade Positivo, Curitiba, PR Brazil

Correspondence: Carla Castiglia Gonzaga, Rua Prof. Pedro Viriato Parigot de Souza, 5300, 81280-330 Curitiba, PR, Brasil. Tel: +55-41-3317-3180. e-mail: carlacgonzaga2@gmail.com

Orides Ferrari de Oliveira Jr[1], Patrícia Valéria Manozzo Kunz[1], Flares Baratto Filho[1], Gisele Maria Correr[1], Leonardo Fernandes da Cunha[1], Carla Castiglia Gonzaga[1]

The objective was to evaluate the color stability of thin ceramic veneers as a function of the curing mode (with and without pre-cure) of different adhesive systems applied to the internal surface of ceramics. Five adhesive systems (Scotchbond Multi-Purpose, Single Bond Universal, Gluma 2 Bond, Ambar, and Ambar APS) and photo-cured resin cement (Allcem Veneer) were used for cementing 0.6 mm-thick feldspathic veneers (Mark II) on composite resin substrates (Charisma Diamond). The groups, according to adhesive system, were divided into two subgroups (n=10): i) adhesive and resin cement were polymerized separately (pre-cure of the adhesive), ii) adhesive and resin cement were polymerized simultaneously. The CIELab color parameters were determined with a spectrophotometer at 24h (baseline), 7 days, 30 days and 12 months. Data were analyzed by two-way ANOVA and Tukey's test (α=0.05). The results indicated statistically significant differences for adhesive systems and time. The mode of curing of the adhesive system was not statistically significant: pre-cured adhesives (2.6$\pm$1.3) and not pre-cured adhesives (2.8$\pm$1.4). For the adhesives, ΔE values varied in the following order: Ambar-APS (1.6$\pm$0.5) < Scotchbond Multi-Purpose (2.6$\pm$1.2) = Gluma 2 Bond (2.7$\pm$1.2) = Ambar (2.9$\pm$1.2) < Single Bond Universal (3.5$\pm$1.5). For time, ΔE values were: 7 days (1.7$\pm$0.7), 30 days (3.5$\pm$1.2) and 12 months (2.9$\pm$1.3). It can be concluded that the different adhesive systems used for cementing thin ceramic veneers influenced the final color of the indirect restorations. The adhesives curing mode did not present a significant effect in the color stability of thin ceramic veneers.

Introduction

All-ceramic restorations with a high degree of translucency allow the passage of light (1); therefore, the color characteristics of the dental substrate on which they are cemented as well as the materials used for cementation greatly influence the overall color (2). Several studies report that color changes in the resin cement used for cementation may become visible, affecting the final aesthetic appearance of the restoration, which in turn leads to treatment failure (2-4). However, for cementing ceramic laminates to the dental substrate with conventional resin cements, two layers of adhesive system are used: one between the ceramic and the cement, and another between the cement and the dental structure. Yet, little is known about the influence of the adhesive system and its pre-cure on the color stability of thin ceramic laminates.

It has been reported that different adhesive systems used in composite resin direct restorations influenced the final color of the restoration (5). It is not yet known whether the adhesive layer used on the internal surface of indirect ceramic restorations causes a similar effect; especially in thin ceramic laminate veneers, which may also interfere

with the color stability and final aesthetic result of these restorations in the short and long term.

The cementation of ceramic laminates can be achieved using photo-activated resin cements, or either flowable or pre-heated composite resins, which require the application of an adhesive system for bonding to the dental substrate. In general, these adhesives are applied as a surface treatment on the inner surface of ceramic restorations, after conditioning with hydrofluoric acid and silanization. Simplified conventional adhesives have, in general, a relatively high amount of solvent in their composition. Consequently, nano-infiltration from the environment into the hybrid layer of these adhesives may possibly occur (6). In contrast, an adhesive system containing a hydrophobic layer, such as the three-step etch-and-rinse and two-step self-etching adhesives, tend to present lower hydrolytic degradation and increased longevity at adhesion interfaces when compared to simplified adhesives (7). Universal adhesives have proven to be more stable in regard to hydrolytic degradation due to changes in their chemical composition (8). It must be highlighted that the greater the hydrophilic characteristics and solvent content

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in an adhesive system or composite are, the higher the degradation rate and, possibly, color change are expected to be (9).

Among adhesive system components, the photoinitiator may play a particularly important role regarding the coloring and color stability of adhesive systems and composites. Camphorquinone is the main photoinitiator (a photosensitive molecule that absorbs light and leads to the formation of reactive species) used in most resin-based materials. However, despite promoting the polymerization of monomers and assuring good mechanical properties, camphorquinone has the significant disadvantages of having an intense yellow color and the need for a co-initiator component, which oxidizes over time (10). Depending on the quantity and concentration of camphorquinone in the material, it may develop an undesirable yellowish color, even influencing the color stability in the long term (11). This yellowish color in adhesive systems, for example, may affect the final aesthetic result in the cementation of thin ceramic laminates. For this reason, in order to minimize aesthetic problems due to discoloration, camphorquinone has been partially or completely replaced by other photosensitive molecules in some adhesive systems and composites.

More recently, virtually colorless adhesive systems have been introduced with the purpose of causing less interference with the final aesthetic result of thin ceramic restorations. Since each adhesive system may present a coloration resulting from its monomeric composition and type and amount of photoinitiator, it becomes important to know how adhesive use in the internal treatment of thin ceramic restorations can influence the final color stability of the restoration, after definitive cementation.

Regarding the photo-activation time, there is still no consensus in the literature as to whether the adhesive system layer in the ceramic laminate inner surface must be pre-cured or photo-activated simultaneously to the resin cement (12,13). On one hand, pre-curing the adhesives can increase the degree of conversion, but can interfere with the fit of the veneer, depending on the thickness of the applied adhesive layer. On the other hand, simultaneous photo-activation with the resin cement may reduce the clinical time and does not interfere with the adaptation of the restoration. However, there is no information regarding the influence of the photo-activation time of the adhesive on the color stability of thin ceramic laminates. Thus, the objective of this study was to evaluate the 12 month-color stability of thin ceramic laminate veneers as a function of the curing mode (with and without pre-cure) of different adhesive systems applied to the internal surface of the ceramics. The null hypotheses were: i) the application of different adhesive systems on the inner surface of the ceramics would not influence the final color after cementation; ii) pre-curing of the adhesive layer applied to the internal surface of the ceramic would not influence the final color of thin laminate veneers after cementation.

Material and Methods

One hundred and twenty disks of composite resin (Charisma Diamond, Kulzer, Hanau, Germany, shade B1) were made with 5 mm diameter and 1 mm thick, using a polytetrafluoroethylene matrix, interposed between two glass slides and two polyester strips (TDV, Pomerode, SC, Brazil). The composite resin was placed in a single increment and light activated with a LED photo-curing unit (Radii-cal, SDI, Bayswater, Australia) with 1200 mW/cm² irradiance for 20 s. The irradiance of the photo-curing unit was checked before use and the battery was charged completely. These composite resin disks served as the substrate for the cementation of the ceramic laminate veneers.

Blocks of feldspathic ceramics (shade 2M1, VITABLOCS Mark II, Vita Zahnfabrik, Bad Säckingen, Germany) were cut into 0.6 mm-thick veneers using a low speed diamond saw (IsoMet 1000, Buehler, Lake Bluff, IL, USA) under refrigeration.

For cementation on the composite resin substrate, the inner surface of each ceramic laminate was conditioned with 5% hydrofluoric acid (Condac Porcelana, FGM, Joinville, SC, Brazil) for 60 s, washed in running water for 20 s, and dried. A layer of silane coupling agent (Prosil, FGM, Joinville, SC, Brazil) was applied for 60 s, followed by a layer of the tested adhesives. For standardization purposes, the excess of adhesive was removed with a microbrush in all samples. The tested adhesives were: Scotchbond Multi-Purpose (hydrophobic adhesive, 3M ESPE, St. Paul, MN, USA), Single Bond Universal (3M ESPE), Gluma 2 Bond (Kulzer, Hanau, Germany), Ambar (FGM), and Ambar APS (FGM) (Fig. 1). The composition of the materials is presented in Table 1.

The composite resin disks were conditioned with 37% phosphoric acid (Condac 37, FGM) for 20 s, washed in running water for 20 s, and dried. Next, the same adhesive used on the inner face of the ceramic was applied, removing the excess with a microbrush. The adhesive layer was photo-activated for 10 s. The ceramic laminates were then cemented on the composite resin disks, using a photo-cured resin cement (shade E-Bleach, AllCem Veneer ; FGM) and each specimen was photo-activated for 40 s. The luting was performed under digital pressure until the ceramic veneers was completely bonded to the resin base, in order to simulate clinical conditions. After the cement photo-activation, the final thickness of the specimen was measured using a digital caliper, and all sets (resin base, cement, and ceramic veneer) measured between 1.8 and 2 mm.

The photo-activation of the adhesive layer on the inner surface of the ceramic laminates was carried

out under two conditions (n=10): i) adhesive and resin cement were polymerized separately (pre-cure of the adhesive), ii) adhesive and resin cement were polymerized simultaneously. In this second group, the adhesive layer was applied on the surface of the ceramic laminate and was not cured before the cementation. The cement was applied on the ceramic and the components placed into position, and the adhesive + cement layer was polymerized at the same time. Ten minutes after cementation, the specimens were stored in distilled water at 37 °C, changed weekly during the whole evaluation period.

Color stability after the cementation was evaluated with a spectrophotometer (EasyShade Advance, Vita Zahnfabrik, Bad Sackingen, Germany). For each reading, the specimens were removed from the water, dried with absorbent paper, and placed on a flat surface with a white standard background, in order to prevent any background interference. In addition, the spectrophotometer was always positioned in the center of the specimen, at a 90° angle to the surface, and it was calibrated before the readings. The initial color record was made 24 h after cementation (baseline), and after 7 days, 30 days, and 12 months.

Color stability was evaluated by measuring the color difference (ΔE) between color measurement readings after storage for various times and at baseline, utilizing the L*, a*, and b* coordinates of CIELab system, where L* indicates luminosity, a* stands for the amount of red or green (+a*=red, -a*=green) and b* corresponds to the amount of yellow or blue (+b*=yellow, -b*=blue). ΔE was calculated in accordance with the formula:

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

where ΔL^* indicates the luminosity difference between the final reading for the different times and the baseline, and Δa^* and Δb^* represent the difference between the parameters a* and b* for the baseline and the final reading at different times.

Data were statistically analyzed by two-way ANOVA (adhesive system and curing mode) with repeated measures and Tukey's HSD test, with a significance level of 0.05.

Results

Means and standard deviations for ΔE values are presented in Table 2.

The results showed significant statistical differences for adhesive system ($p<0.001$) and storage time ($p<0.001$). The curing mode was not statistically significant ($p=0.348$). All double interactions ($p<0.001$) and the triple interaction ($p=0.006$) were statistically significant.

For the adhesive system, the mean ΔE values varied as follows: Ambar-APS (1.6±0.5)[a] < Scotchbond Multi-Purpose (2.6±1.2)[b] = Gluma 2 Bond (2.7±1.2)[b] = Ambar (2.9±1.2)[b] < Single Bond Universal (3.5±1.5)[c]. The results for adhesive curing mode did not show statistically significant differences: adhesive pre-curing (2.6±1.3)[a] and simultaneous curing (2.8±1.4)[a]. As for storage time, mean ΔE values were: (1.7±0.7)[a] for 7 days, (3.5±1.2)[c] for 30 days and (2.9±1.3)[b] for 12 months.

Discussion

The color of an indirect restoration depends on

Table 1. Composition of materials for the cementation of the ceramic laminates

Material	Classification	Composition
Scotchbond Multi-Purpose (3M ESPE, St. Paul, MN, USA)	Etch-and-rinse, three-step adhesive system	Hydrophobic adhesive: Bis-GMA, HEMA, tertiary amines, and photoinitiators
Single Bond Universal (3M ESPE, St. Paul, MN, USA)	Universal adhesive system	Bis-GMA, HEMA, dimethacrylates, ethanol, camphorquinone, functional copolymer of polyalkenoic acids, ethylmethylketone, initiators, silica filler, MDP, and silane
Gluma 2 Bond (Heraeus Kulzer, Hanau, Germany)	Etch-and-rinse, two-step adhesive system	Methacrylate, photoinitiator, excipients, and glutaraldehyde
Ambar (FGM, Joinville, SC, Brazil)	Condition-and-wash adhesive systems, two steps	Methacrylic monomers, photoinitiators, co-initiators, stabilizer, inert filler (silica nanoparticles), and ethanol
Ambar APS (FGM, Joinville, SC, Brazil)	Etch-and-rinse, two-step adhesive system	MDP, methacrylic monomers, photoinitiating composition (APS, *Advanced Polymerization System*), co-initiators, stabilizer, silica nanoparticles, and ethanol
Charisma Diamond (Heraeus Kulzer, Hanau, Germany)	Composite resin	UDMA-based organic matrix (containing 64vol% filler, 5nm - 20μm), barium and aluminum fluoride glass and highly dispersed nano particles
Allcem Veneer (FGM, Joinville, SC, Brazil)	Light-cured resin cement	Methacrylic monomers, camphorquinone, co-initiators, stabilizers, pigments, glass particles of silanized barium-aluminum-silicate, and silicon dioxide

Bis-GMA: bisphenol A glycidyl methacrylate; HEMA: 2-hydroxyethyl methacrylate; UDMA: urethane dimethacrylate; MDP: 10-methacryloyloxydecyl dihydrogen phosphate

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several factors; among them, the optical properties of the restorative materials and materials selected for cementation, the thickness of these materials, and the color or type of substrate. The color stability of resin cements or the type and thickness of ceramics has been evaluated (14-15). However, an adhesive system is applied between the luting agent and the ceramics, and between the cement and the dental substrate, with the purpose of improving the wettability and bonding of the substrates. It has been demonstrated that the adhesives are an important factor for the color stability of direct composite resin

Figure 1. Visual appearance of the different adhesives evaluated in the present study. It is possible to note in the image the color difference among the tested adhesives.

restorations (5). A similar result was found by this study, as the tested adhesives influenced the color stability of thin ceramic laminates. Therefore, the first hypothesis, that the application of different adhesive systems on the internal surface of the ceramic would not influence the color of the thin ceramic laminates after cementation, was rejected.

The results of this study showed that the specimens where Ambar APS was used at the interface between ceramic and resin cement presented the lowest color change when compared to the other adhesive systems tested. One of the possible reasons for this may be the composition of this adhesive, which is free of Bis-GMA that would result in the absence of monomers containing aromatic rings that are frequently associated with processes of pigmented by-product formation. Also, the higher color stability of this adhesive may be the result of its differentiated photoinitiator system, using smaller quantities of camphorquinone. Therefore, this adhesive system, visually, is practically colorless, and avoids interference with the aesthetic result of the restorations, mainly thin ceramic laminate veneers in anterior teeth.

The result obtained by Scotchbond Multi-Purpose adhesive may be due to its hydrophobic characteristics in relation to other tested simplified adhesives, which have greater amounts of solvents, making them more hydrophilic and more likely to present greater degradation and color change (9). In a previous study, a hypothesis was proposed to explain color and translucency alteration after water storage in specimens containing a simplified adhesive system (16). Initially, the solvent molecules of the simplified adhesive were retained in the structure of the composite resin during polymerization. After the period of water immersion, the solvent had already been eliminated from a large part of the material, forming free spaces that, afterwards, could be filled up with water. This process would facilitate light propagation, increasing the translucency and influencing color changes. Regarding the Single Bond Universal, its unfavorable result with greater color change can be explained by the higher acidity. The literature reports that high acidity has been associated with hydrophilicity and water sorption, thus impairing color stability (17). For example, the pH values for conventional adhesives are between 3.4 and 5.9 (Scotchbond

Table 2. Means and standard deviations for ΔE values.

Adhesive system	Curing mode	Time		
		ΔE 7 days	ΔE 30 days	ΔE 1 year
Scotchbond Multi-Purpose	Pre-cure	1.6 ± 0.5 Aab	4.0 ± 0.4 Bbc	3.3 ± 0.9 Bbc
	Simultaneous	1.5 ± 0.2 Aab	3.4 ± 0.4 Bbc	1.6 ± 0.9 Abc
Single Bond Universal	Pre-cure	1.6 ± 0.4 Aab	4.0 ± 0.8 Bc	4.2 ± 1.2 Bc
	Simultaneous	2.8 ± 0.9 Ac	4.8 ± 1.0 Bc	3.6 ± 1.8 Abc
Gluma 2 Bond	Pre-cure	1.1 ± 0.4 Aa	3.2 ± 0.6 Bbc	3.0 ± 0.9 Bbc
	Simultaneous	2.0 ± 0.2 Aab	4.2 ± 0.4 Bc	2.6 ± 0.8 Aab
Ambar	Pre-cure	1.0 ± 0.1 Aa	3.1 ± 0.4 Bb	3.1 ± 0.7 Bbc
	Simultaneous	2.3 ± 0.4 Ab	4.4 ± 0.7 Cc	3.4 ± 1.0 Bbc
Ambar APS	Pre-cure	1.4 ± 0.4 Aa	1.6 ± 0.4 Aa	1.9 ± 0.4 Aa
	Simultaneous	1.1 ± 0.3 Aa	1.7 ± 0.6 Aa	1.8 ± 0.2 Aa

In each row, values followed by the same capital letters are statistically similar (p>0.05). In each column, values followed by the same lowercase letters are statistically similar (p>0.05).

Multi-Purpose and Single Bond 2); for the self-etching and universal adhesives (Clearfil SE Bond and Single Bond Universal), the pH tends to be lower, ranging from 1.4 to 2.6 (18,19).

The final color change of the cemented ceramic laminates was determined after aging for 7 days, 30 days, and 12 months in distilled water at 37°C. The configuration of the specimens used in this research simulates a clinical situation in which the adhesive interfaces are protected from contact with water by the subjacent resin, representing the dental substrate, and by the ceramic restoration. However, the adhesive interfaces at the margins of the restoration can be exposed to oral fluids and, consequently, to hydrolytic degradation and staining. Storage in water is frequently used as a means of in vitro aging. It is known that water sorption can lead to the degradation of the adhesive through the plasticization of the polymer network and reduction of the shear forces between the polymer chains (20). Water sorption occurs due to the small size of the water molecule, which can diffuse into the spaces between the polymer chains of the adhesive network (21). In addition, the evaluated adhesives have methacrylate monomers, like Bis-GMA and HEMA, with polar functional groups, such as carboxyl, phosphate, and hydroxyl groups. The hydrogen bond between the water molecules and the polar groups in the polymer matrix disrupts the hydrogen bonds between the chains and may result in structural damage, changes in refraction index, and color alteration (22).

Studies report that ΔE values above 3.3 are considered to be clinically unacceptable (23). The results showed that, for all evaluated adhesives and conditions, the color change was clinically acceptable after 7 days. However, after 30 days of water storage, 60% of the groups had ΔE values above 3.3. If the 12-month aging condition is considered, only the Ambar APS group, with and without pre-curing, presented ΔE values below 3.3 in all situations and had no statistically significant difference between the results for different storage times. In the present study, the ΔE values could be considered relatively low, even after one year of storage in distilled water. With these low ΔE values, the differences in the deltas of the individual coordinates (ΔL*, Δa* and Δb*) tend to be equivalent or even smaller than ΔE. In an attempt to how a different perspective on the results, the deltas of individual coordinates were calculated. After one year, ΔL* ranged from 0.28 to 2.68, Δa* ranged from -0.65 to 0.45 and Δb* ranged from 0.60 to 3.13, indicating that the specimens tended to become a little darker, more red and more yellow.

The second hypothesis, that pre-curing of the adhesive layer applied to the internal surface of the ceramic would not influence the final color of thin laminate veneers after cementation, was accepted, since the curing mode of

the adhesive system did not show statistically significant differences.

The internal surface of the ceramic restoration must be treated in accordance with its microstructure and composition. For feldspathic ceramics and glass-ceramics, an application of 5% hydrofluoric acid, for 60 s and 20 s, respectively, is recommended, followed by the application of a layer of silane coupling agent, for 60 s. The protocol is clear up until this step, practically without significant variations in the literature. However, from this point on, the sequence can vary depending on the type of restoration (veneers or onlays, and crowns) and on the manufacturers of the ceramics, adhesive systems, and resin cements. For thicker restorations, like onlays and crowns, it is generally recommended that a layer of the adhesive system be applied after the silane, and that this adhesive layer be pre-cured, before inserting the resin cement. In contrast, for ceramic veneers and laminates, the protocols can vary or are not so specific and mostly recommend the application of an adhesive system layer without pre-curing, if specified by the adhesive manufacturer (24). Some manufacturers, in their technical profiles, indicate this procedure, recommending that the adhesive system not be pre-cured, but photo-activated simultaneously to the resin cement. However, a significant number of instructions of use for adhesive systems or even the recommendations of ceramic producers neither offer specific directions for the treatment of the internal surface of the ceramic (for both thicker restorations and laminate veneers), nor clearly specify whether the adhesive should be pre-cured or not.

Of the two layers of adhesive used for cementing ceramic laminate veneers to the dental substrate with conventional resin cements - one layer of adhesive applied between the resin cement and the ceramic laminate and another applied between the dental structure and the resinous cement - more importance has been given to the one applied between the cement and the dental structure. For this layer, recommendations regarding pre-cure of the adhesive are also controversial. One can infer that the pre-cure of this layer would assure a better-polymerized hybrid layer with improved mechanical properties and higher bond strength.

The influence of polymerized and non-polymerized adhesive systems on the layer thickness and dentin bond strength after inlay cementation was investigated in a previous study. Scanning electron microscopy revealed that without adhesive photopolymerization, no adhesive layer could be distinguished from the resin cement. The isolated photopolymerization of the adhesive produced a thicker film, the thickness depending on the region along the inner edge of the indirect restoration; however, the adhesive photo-activation had no significant effect on the

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bond strength for most of the tested adhesive systems (25). The effects of adhesive system application techniques (with or without pre-cure) on the microleakage and marginal adaptation of composite resin indirect veneers showed that the highest and lowest microleakage values appeared at the dentin margins of the groups cemented with etch-and-rinse adhesive system with and without adhesive layer pre-cure, respectively. No adhesive layer was seen for the adhesives using simultaneous photo-activation with the cement. The adhesives pre-cured showed better resistance to dye penetration, although the film thickness of these materials was slightly increased (26).

Finally, it should be pointed out that the main reason for not pre-curing adhesive layers before insertion of the indirect restorations is that pooling of the adhesive could interfere with the complete seating of the restoration (26).

Composite resin was used to standardize the substrate as much as possible for all specimens, eliminating the influence of factors that could not be controlled when using natural teeth, such as differences in opacity and shade among the teeth, differences in enamel and dentin thickness, and differences in the hybrid layer formed on each substrate. Using composite resin as substrate, the variations could be minimized because shade, thickness and the degradation of the substrate were similar in all groups. It is also important to note that visual color alteration was not observed in any of the evaluated groups. Qualitative analyzes, using visual shade guides, were not used in the present study, because they contain limited shades when compared with instrumental color analysis. Additionally, visual shade matching is affected by factors such as viewer interpretation, environmental influences and illumination conditions. Thus, quantitative analyzes performed with spectrophotometers are recommended to evaluate the color differences more accurately.

The adhesive cementation of ceramic restorations is a complex procedure, which requires knowledge of adhesion principles and strict observance to the clinical protocol in order to assure bonding between the dental structure and the restorative material. The application of a properly chosen adhesive system, with the correct technique, will allow successful clinical results more predictability in the long term. It can be concluded that adhesive systems used in the cementation of thin ceramic laminate veneers influenced the final color of the restorations. The pre-curing of the adhesive layer did not present a significant effect on the color stability of the thin ceramic laminates.

Resumo

O objetivo deste estudo foi avaliar a estabilidade de cor de laminados cerâmicos de espessura fina em função do momento de ativação de diferentes sistemas adesivos na superfície interna das cerâmicas. Foram utilizados 5 sistemas adesivos (Scotchbond Multiuso, Single Bond Universal, Gluma 2 Bond, Ambar and Ambar APS) e o cimento resinoso fotoativado (Allcem Veneer) para cimentação de lâminas de cerâmica feldspática (Mark II) com 0,6 mm de espessura, sobre substratos de resina composta (Charisma Diamond). Os grupos, de acordo com o sistema adesivo utilizado, foram divididos em dois subgrupos (n=10): i) adesivo e cimento resinoso foram polimerizados separadamente (polimerização isolada do adesivo), ii) adesivo e cimento resinoso foram polimerizados ao mesmo tempo (polimerização simultânea). Os parâmetros de cor do sistema CIELab foram determinados com um espectrofotômetro nos tempos de 24 h (baseline), 7 dias, 30 dias e 12 meses. Os dados foram analisados por ANOVA a dois fatores e teste de Tukey (α=0,05). Os resultados indicaram diferenças estatísticas significantes para os sistemas adesivos e tempo. O momento da fotoativação do sistema adesivo não foi estatisticamente significante: polimerização prévia (2,6±1,3) e polimerização simultânea (2,8±1,4). Para o sistema adesivo, os valores médios de ΔE variaram na seguinte ordem: Ambar APS (1,6±0,5)<Scotchbond Multi-Purpose (2,6±1,2)=Gluma 2 Bond (2,7±1,2)=Ambar (2,9±1,2)<Single Bond Universal (3,5±1,5). Para o fator tempo o ΔE foi: 7 dias (1,7±0,7), 30 dias (3,5±1,2) e 12 meses (2,9±1,3). Pode-se concluir que os diferentes sistemas adesivos utilizados na cimentação de laminados cerâmicos de espessura fina influenciaram na cor final das restaurações. O momento da fotoativação, isolada ou simultânea ao cimento resinoso, não apresentou efeito significativo na estabilidade de cor dos laminados cerâmicos de espessura fina.

Acknowledgements

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Pre-curing adhesives on color of veneers