UNIVERSIDADE DE UBERABA

ANA LUIZA SILVESTRE ABRAHÃO

AVALIAÇÃO DA ESTABILIDADE DE COR E DA RESISTÊNCIA DE UNIÃO DE CIMENTOS ODONTOLÓGICOS SUBMETIDOS AO ENVELHECIMENTO ARTIFICIAL ACELERADO

UBERABA-MG

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Dissertação apresentada ao Programa de Mestrado em Odontologia da Universidade de Uberaba, para obtenção do Título de Mestre em Odontologia, área de concentração em Biomateriais.

Orientador: Prof. Dr. Luciano de Souza Gonçalves

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Dissertação apresentada como parte dos requisitos para obtenção do título de Mestre em Odontologia do Programa de Pós-Graduação em Odontologia da Universidade de Uberaba.

Área de concentração: Biomateriais

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"Sabemos o que somos, mas não sabemos o que poderemos ser."

William Shakespeare

Resumo

Um desafio comumente encontrado na clínica odontológica em restaurações livres de metal é a avaliação e reprodutibilidade de sua cor. Cimentos Resinosos sofrem alteração de cor com o tempo gerando muitas vezes uma coloração amarelada nos laminados cerâmicos onde foram cimentos. Visando análisar a alteração de cor sofrida pelo material, o objetivo do presente estudo foi avaliar a estabilidade de cor (ΔE) e a resistência de união (RU) de diferentes cimentos odontológicos utilizados para a cimentação de laminados cerâmicos, submetidos ao Envelhecimento Artificial Acelerado (EAA) e sua correlação entre as variáveis testadas. Foram confeccionados 40 discos cerâmicos (8 mm de diâmetro e 0,5 mm de espessura) na cor LTA2 (IPS E-max Press, Ivoclar Vivadent) divididos em 4 grupos (n=10), cimentados sobre esmalte dental bovino. Para cada um dos grupos foi utilizado um agente cimentante: cimento resinoso autoadesivo (RelyX U200, 3M ESPE), cimento resinoso autopolimerizável (Multilink, Ivoclar Vivadent), cimento resinoso de presa dual (Variolink II, Ivoclar Vivadent) e cimento resinoso fotopolimerizável (Variolink II – apenas a pasta Base, Ivoclar Vivadent). Os discos foram cimentados de acordo com a recomendação de cada fabricante e armazenadas em ambiente escuro com umidade relativa a 37º C. As amostras tiveram sua cor aferidas por espectrofotômetro (Easyshade, Vita) em dois momentos diferentes, previamente e após a realização do EAA para quantificar ΔE dos cimentos resinosos avaliados. As amostras ficaram expostas em uma câmara de condensação simulando ciclos de umidade e luz ultravioleta UV-B por 384 horas para o teste de EAA. Após a leitura final de cor os grupos foram submetidas à avaliação da RU por cisalhamento em máquina de ensaio universal (EMIC DL 2000). Foi realizada a classificação em relação ao padrão de falha de cada amostra e submetidos a análise em Microscopia Eletrônica de Varredura (MEV). Os valores obtidos de RU (MPa) e ΔE foram submetidos à análise estatística não paramétrica de Kruskal Wallis e não houve diferença estatística entre L, a e b. A ΔE e RU foram analisadas pelo teste de Correlação de Pearson, porém não houve correlação entre as variáveis testadas. Concluiu-se que Todos os cimentos resinosos avaliadas apresentaram ΔE clinicamente detectável, especialmente U200 e Multilink, que foram considerados inaceitáveis. Não houve correlação entre ΔE e RU para os cimentos de resinosos testados, independentemente do tipo de sistema de polimerização ou de adesão ao esmalte dental.

Palavras chave: Materiais dentários, Cimentos dentários, Cerâmica odontológica, Cor

Abstract

A challenge commonly found in dental clinic in metal-free restorations is the evaluation and reproducibility of color. Resin cements undergo color change with time often a yellowing in ceramic laminates which were cement. To analyze the color change undergone by the material, the aim of this study was to evaluate the color stability (ΔE) and the bond strength (SBS) of different dental cements used for cementation of ceramic laminates subjected to the Accelerated Aging Artificial (AAA) and the correlation between the variables tested. Forty ceramic discs were made (8 mm diameter and 0.5 mm thick) in LTA2 color (IPS E-max Press, Ivoclar Vivadent) were divided into 4 groups (n = 10) cemented on bovine enamel. For each group we used a cementing agent: Self-adhesive resin cement (RelyX U200, 3M ESPE), self-etch resin cement (Multilink, Ivoclar Vivadent), dual resin cement (Variolink II, Ivoclar Vivadent) and light-cured resin cement (Variolink II - only the base, Ivoclar Vivadent). The discs were bonded in accordance with the recommendation of each manufacturer and stored in dark conditions with relative humidity at 37 C. The samples were measured for their color spectrophotometer (Easyshade, Vita) at two different times, before and after the AAA to quantify ΔE of the evaluated resin cements. Samples were exposed in a humidity condensing chamber simulating cycles and UV-B ultraviolet light over 384 hours for the test AAA. After the final reading color groups were evaluated for their SBS in a universal testing machine (EMIC DL 2000). Was classified in relation to the failure pattern of each sample and subjected to analysis in scanning electron microscopy (SEM). The values obtained from SBS (MPa) and ΔE were subjected to statistical analysis nonparametric Kruskal Wallis and there was no statistical difference between L, a and b. The ΔE and the SBS were analyzed using Pearson's correlation test, but there was no correlation between the variables tested. Conclusion: all cements showed clinically detectable ΔE, especially U200 and Multilink, which were considered unacceptable. There was no correlation between ΔE and BS, independent of the curing system or type of adhesion to the dental enamel.

Keywords: Resin cement, color change, ceramic, aging, dental materials

SUMÁRIO

COLOR STABILITY AND BOND STRENGTH OF RESIN CEMENTS SUBJECTED TO ARTIFICIAL ACCELERATED AGING

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COLOR STABILITY AND BOND STRENGTH OF RESIN CEMENTS SUBJECTED TO ARTIFICIAL ACCELERATED AGING

ABSTRACT

Objective: to evaluate the color stability and the shear bond strength (SBS) of different dental cements subjected to Artificial Accelerated Aging (AAA). Method and Materials: Forty ceramic discs (8 mm in diameter and 0.5 mm thick) IPS E-max Press were made and divided into 4 groups of 10 samples cemented on bovine enamel. A resin cement was used for each group: RelyX U200, Multilink, Variolink II and Variolink II base. After the cementation, all samples were stored under relative humidity at the temperature of 37^{o} C. The color of the samples was measured in a spectrophotometer before and after the AAA in order to quantify the total color change (ΔE). The samples were placed in a chamber simulating moisture condensation cycles and ultraviolet light UV-B during 384 hours in AAA. After the final color reading, the groups were submitted to evaluation of the SBS. The classification in respect to the failure mode was carried out for each sample and submitted to analysis through Scanning Electron Microscopy (SEM). Results: the values of SBS (MPa) and ΔE were subjected to Kruskal Wallis statistical analysis, and there was no statistical difference between L, a and b. ΔE and SBS were analyzed using the Pearson's correlation test, except for U200, and there was no correlation between the variables tested. Conclusions: All cements showed clinically detectable ΔE, especially U200 and Multilink, which were considered unacceptable. There was no correlation between ΔE and BS, independent of the curing system or type of adhesion to the dental enamel.

Keywords: Resin cement, color change, ceramic, aging, dental materials

1. Introduction

With the emergence of porcelain veneers in the late 80s, cosmetic procedures started attracting patients in search of the perfect smile at dental clinics [1]. Among these materials, dental ceramics are able to mimic the dental structures providing the translucency and color stability required for satisfactory aesthetic treatment.

A material often used in the manufacture of veneers is reinforced by ceramic crystals, as vitreous ceramics with crystals of lithium disilicate, for example. Their clothing is given through the lost-wax technique and injection by heat and pressure. The laminate thicknesses range from 0.5 to 1.0mm[2,3], allowing the preservation of the tooth structure, without dentin exposure. These properties provide natural characteristics to ceramic restorations. However, the success of the final aesthetic result depends on an adequate selection of the bonding agent color, according to the adjacent teeth, which represents a meticulous procedure [4].

The use of adhesive cementing agents has contributed to the clinical success and patient satisfaction[5]. However, a color change of these luting agents is caused by the degradation of residual amines and oxidation of carbon double bonds of unreacted monomers, which can form yellowing compounds. In addition, the thickness of the film and the type of cement agent used may interfere with the final color of ceramic restorations[6]. Intrinsic factors, such as changes in temperature, humidity, visible light and ultraviolet irradiation (UV-B) can also generate color change [7].

Artificial Accelerated Aging (AAA) is a technique used to evaluate the stability of color, simulating the conditions that materials acquire over time, and reproducing atmospheric effects that occur when the material is exposed to sunlight and humidity[8,9,10]. With the use of spectrophotometry, it was possible to evaluate the color stability of resin cements[11,12]. The spectrophotometer is essential for viewing color before and after the AAA, because it objectively compares the amount of light absorbed by a material. For the determination of the color, parameters recommended by Commission Internationale de l'Eclairage (CIE) CIELab are used. These parameters give three attributes to colors: L*, a* and b*, where L* represents the brightness, a* corresponds to the Red-Green axis and b corresponds to the yellow-blue axis[13].

The bond strength is related to the durability of the restoration. Previous studies have shown that after subjected to aging techniques, the resin cement does not show changes, such as the bond strength[14]. There are no studies in the literature that simultaneously evaluate the effect of the AAA on color and bond strength or, if the yellowing process can be related to the reduction of the bond strength in aesthetic restorations. Therefore, it is important to evaluate if the color changes can be correlated with the longevity of the restoration adhesion.

Based on these observations, the aim of this study was to evaluate the total color change and shear bond strength of resin cements after AAA and observe whether there exists a correlation between ΔE and Shear Bond Strength (SBS).

2. Material and methods

2. 1- Preparation of samples

Forty recently extracted bovine incisors were selected, hand cleaned and stored in distilled water at a temperature of 4° C for a maximum period of 30 days. The crowns were sectioned in a metallographic cutter (1000, Buehler Isomet Ltd., Lake Bluff, Illinois, USA) with a diamond wheel (Diamond Waferingblades, Buehler Ltd., Lake Bluff, Illinois, USA), 1.0 mm below the cervical portion in mesiodistal direction. The crown was placed in PVC rings with self-curing acrylic resin (Jet Classic, São Paulo, Brazil). After the polymerization of the acrylic resin, the samples received polishing on the enamel surface using a polishing machine (PFL, FORTEL IND. With. Ltda. São Paulo, Brazil) with 600-grit silicon carbide sandpapers.

To obtain the wax patterns (Geo wax, Classic Renfert, Germany) for the preparation of the discs, a Teflon matrix (8.0 mm in diameter and 0.5 mm thick) was used. The insulation was performed with mineral oil and the excess was removed with absorbent paper and adjusted with a 0.5-mm spacer. The wax patterns were wrapped with phosphate-based material (Esthetic Speed; Ivoclar Vivadent AG, Schaan, Liechtenstein) and heated to 850°C for 1 hour in an oven (Turbomix, EDG Equipment and Controls Ltd. São Carlos, SP, Brazil). The ceramic was then heat pressed into the molds, using the EP 5000 furnace (Ivoclar Vivadent AG, Schaan, Liechtenstein). After cooling down to room temperature, the specimens were divested from the feeding conduits, polished with 1,200-grit SiC papers, ultrasonic water cleaned (10 min) and both sides of the discs were glazed. Samples were randomly divided into 4 groups (n=10, being 10 crown samples included in PVC and 10 ceramic inserts each) according to the cement agent used**.**

2. 2- Cementation

Prior to cementation, all samples had undergone surface treatment. The ceramic surface received 10% hydrofluoric acid treatment (Dentsply, Petrópolis, RJ, Brazil) during 20 s, and following received silanization agent Monobond S (Ivoclar Vivadent AG, Schaan, Liechtenstein) application. The enamel was etched with 37% phosphoric acid (Villevie, Joinville, SC, Brazil) during 20 s. As cements with different curing characteristics and composition were used, each of them was handled in accordance with the recommendations of the respective manufacturers.

Moreover, for standardizing the cement agent thickness, the samples were positioned under a Needle of Gilmer with approximately 453g during 1 min. The cement excess was removed from the tooth surface with the aid of applicators (Cavibrush, FGM produtos Odontológicos, Joinvile, SC Brazil).

Multilink cement (Ivoclar Vivadent, Liechtenstein) comes in two bottles of Primer: Primer A and Primer B were manipulated in 1:1 proportion and applied on the tooth enamel dry surface for 30 s, followed by a strong jet of air. The cement agent was manipulated in 1:1 proportion, applied to the ceramic surface and taken to the tooth surface with a spatula for inserting and removing the excess. As it is a self-curing cement, it took 120 s for polymerization.

The Variolink II dual setting cement (Ivoclar Vivadent, Liechtenstein) was used after the process of conditioning of the enamel and ceramics. The adhesive ExciTE F DSC (Ivoclar Vivadent, Liechtenstein) was applied to the enamel and ceramics for 10 s followed by strong jets of air. The cement agent was manipulated in 1:1 proportion (Base Paste and catalyst), applied to the ceramic disc and taken to the tooth surface. After the excess removal, the cement was light cured (Radii-Cal, SDI, New Zealand) for 40 s through the application of light on the ceramic disc.

For the use of Variolink II Base cement (Ivoclar Vivadent, Liechtenstein), the cementation of the ceramic discs was performed as previously described for the Variolink II dual (Ivoclar Vivadent, Liechtenstein), with two modifications: the ExciTE

F DSC adhesive (Ivoclar Vivadent, Liechtenstein) after being applied, received strong jets of air and was cured, for 10 s, prior to the application of the cement agent. Only the cement base paste was applied, the excess was removed and photo polymerized for 30 s.

Finally, the Rely X cement was manipulated at a 1:1 proportion (dispenser Clicker) and was applied to the ceramic disc surface and taken to the tooth surface. The resin cement excess was removed and it was light-activated for 20 s. A period of 6 minutes was allowed to complete the cement polymerization.

After the cement curing, the samples were stored for 24 hours in a dark environment at 25 ± 1° C in relative humidity.

2.3 Color analysis, Artificial Accelerated Aging (AAA), Scanning Electron Microscopy (SEM)

After stored, the samples were submitted to initial color evaluation with a spectrophotometer (Easyshade, Vita, Germany), positioned at the top of the disc. The equipment was started and the L, a and b axes were found. Three color readings were performed for each sample and the values were added up and divided by 3, obtaining the mean values of L, a and b for each sample.

For the AAA test (Accelerated Aging - System of non-metallic materials, UV-B Condensation, Adexim-Comexim industry, Brazil), the 40 samples were fixed in aluminum plates and inserted into the condensation chamber. This system consists of eight fluorescent 40-watt lamps with concentrated emission in the ultraviolet region B; a 280/32 nm radiation. The work program was standardized for four-hour exposure to UV-B light at 50 ° C and four-hour condensation at 50 ° C. The distance between the light sources was 50 mm and the aging maximum time period was 384 hours. After this test, all the samples were submitted to the final color evaluation.

The total color change (ΔE) was calculated using the initial and final color values, according to the following formula: $\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{½}$ where ΔL corresponds to the variation of initial and final L, Δa the corresponds to the variation of a, and Δb corresponds to variation of b. The values of ΔE determine how much the total change of color is noticeable to the human observer. Color differences with ΔE>1.0 are considered clinically detectable and values above 3.3 are considered clinically unacceptable. [15,16,17]

For the samples SBS test, a matrix of loading for chisel with a guillotine system was used, and its contact with the ceramic surface was 2-mm thick. The matrix was placed on the Universal Testing Machine Emic DL2000 (Emic, São José dos Pinhais, PR) with a load cell of 100 kgf, and 1mm in speed, connected to a computer with the Mtest software, which is able to register the maximum force value in MPa (Megapascal) at the time of rupture.

The values obtained from ΔE and SBS tests were subjected to statistical analyses following the verification of normality. The failure modes have been classified as: adhesive between cement and enamel, adhesive between cement and ceramics, cohesive and mixed. After the classification, the specimens were sputtering-coated with gold, and one sample of each failure was analyzed through Scanning Electron Microscopy (SEM) (JSM 5600 Lv JEOL. Akishima, Tóquio, Japão).

2.4 Statistical Analysis

The data obtained from ΔE and SBS tests were submitted to One-way ANOVA (α=0.05). The parameters (L, a and b) were submitted to Kruskal-Wallis test (α=0.05). The statistical analysis was performed using the BioEstat 5.3 software (Fundação Mamirauá, Manaus, AM, Brazil).

3. Results

The results of all analyses are shown in Table 2. It was not possible to evaluate the SBS of U200 because the specimens failed during the placement on the testing machine and no significant difference was found with respect to the other groups (p=0.3334). The SBS failure mode was predominantly adhesive between the cement and the ceramic interface (Figure 1). Figure 2 shows an example of this failure. Although there were no statistical differences among the groups (p=0.0846), both groups of Variolink presented clinically detectable changes, while U200and Multilink showed unacceptable ΔE. Individual of L, a and b were analyzed by Kruskal Wallis and presented no statistical differences L (p=0.5486), a (p=0.0536) and b (p=0.7112). No correlation was found between the values of SBS and ΔE for Multilink (Figure 3), Variolink II Dual (Figure 4) and Variolink II (Figure 5).

4. Discussion

After the AAA, all groups showed clinically detectable color change values (ΔE>1), corroborating with other authors[18,15,17]. When composites are activated with the interposition of glass slide, such as the ceramic discs used in this study, the composite tends to present a rich organic matrix surface with a low amount of filler particles in contact with the ceramic. This results in more susceptibility to absorbing water, which affects and increases their color instability[19.] That was what occurred to all analyzed groups. Moreover, there are several factors that can influence ΔE of composites, such as their nature, type and concentration of monomers, filler and type of photoinitiator[20,21]. Therefore, the differences among the studied cements can be analyzed according to these properties. For Variolink II groups (photoactivated and dual), the AAA caused a discoloration of the composite, as expected for cements in which the light-cure is used. Nevertheless, for chemically-activated cements, the presence of higher concentration of aromatic tertiary amine leads to color change to yellowish or brownish tints[22,23]. For Multilink and U200, the ΔE values were considered clinically unacceptable (ΔE>3.3). Multilink is a chemically activated cement, and its polymerization occurs exclusively by the chemical interaction between the benzoyl peroxide and the tertiary amines. Therefore, the ΔE values obtained can be explained by the degradation of residual amines and oxidation of the double bond unreacted carbon, which can form yellowish compounds[23]. Despite its dual-cure mechanism, U200 presented an unacceptable ΔE similarly to Multilink. In addition, SBS could not be tested for the U200 group because after the AAA, the ceramic discs debonded from the substrate during the adaptation of the specimens to the testing machine. Due to these results, higher photo activation time may be suggested, in order to improve the polymerization and clinical performance of the U200, especially when light-cured through ceramic restorations.

Previous studies have shown that when self-adhesive cements are used, the pre-treatment of the substrate with phosphoric acid can influence the bond strength, increasing their values[24,25] due to the increasing of the surface energy and the moisture of the enamel[26]. Most samples of all groups presented adhesive failure between the cement and ceramic. Several factors, such as humidity, temperature variation and UV-B irradiation[25,27,28] may have contributed to the cement degradation. The SBS analyses showed no statistical differences among the groups, which can be explained by the similarity of types of surface treatment and cementing agents used. The treatment of the tooth surface with 37% phosphoric acid enables the creation of micro retentions, allowing better cement flowing. The surface of the ceramic discs received the surface treatment with 10% hydrofluoric acid and silane application, promoting chemical union between ceramics and cement[29], except for the U200. The high viscosity of this cement that was observed during the manipulation may have limited the filling of irregularities on the etched ceramic surface. In addition, the silane used in this study may have negatively influenced the performance of U200. In this research, Monobond S was used as the silanization agent, according to the recommendation of the ceramic manufacturer, however, in a previuos study[30], a reduction of the bond strength of U200 was reported when the cement was used with a silane agent from a different manufacturer, which could be related to a higher polarity of this cement as compared to others. This is an important aspect to be considered during the cementation of metal-free restorations, because cementation is a key step for the success of restorative treatments. Another study[31] considers that the surface etching for ceramics with high content of silica, as the e.max PRESS, requires more effective conditioning using longer times of hydrofluoric acid application to increase the surface roughness, which can improve the adhesiveness between the ceramic and the resin cement. This procedure could avoid the occurrence of adhesive failure at the interface ceramic/cement obtained in this study (Figure 2).

In this research, the adhesive system was used only with Variolink II. However, no differences among the tested groups were found regarding SBS, because the chemical adhesion promoted by the self-adhesive cements containing phosphate monomers to enamel was similar to the total etching systems. This similarity can be proved by the failure mode, since more than 90% of the failures occurred in the interface between the cement and ceramic (Figure 1). The action of self-adhesive cements may have been enhanced by etching with H_3PO_4, increasing the surface energy and the soaking of the enamel, similarly to what occurs with the conventional technique[27].

According to Figures 3, 4 and 5, in respect to the Pearson's linear correlation, from the results obtained and with the arrangement of the points formed, in an attempt to bring them together in a greater number to form a straight line. Therefore, it was noticed that the ΔE and SBS did not influence each other, because the color change is related to oxidation of tertiary aromatic amines[22] and the bond strength is related to adhesion promoted by adhesive systems between the ceramic, cement and enamel[26]. Hence, there was no correlation between the variables tested. The U200 was not subjected to correlation analysis, as there were no bond strength values to be correlated with color change. The Pearson correlation test was performed for analyzing if the detectable color change could be related to a deterioration of the resin cement, which compromises the bond strength, justifying a replacement of the restoration. Nevertheless, no correlation was observed between ΔE and BS. Therefore, the restoration replacement would be only justified for aesthetic reasons, because ΔE above 3.3 did not indicate a decrease of the bond strength.

5. Conclusion

Within the limitations of this study, it was possible to conclude that:

All resin cements evaluated showed clinically detectable total color change, especially U200 and Multilink, which were considered unacceptable.

There was no correlation between ΔE and SBS for the tested resin cements, independent of the curing system or type of adhesion to the dental enamel.

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Table1	Groups analyzed in the study		
Resin Cement	Description	Adhesion mode	Activation Mode
RelyX U200	Color A3 3M ESPE St. Paul, Minnesota,USA	Self-adhesive	Dual
Multilink	Color Yellow Ivoclar Vivadent AG, Schaan, Liechtenstein	Self-etch	Dual
Variolink II	Color A3 Ivoclar Vivadent AG, Schaan, Liechtenstein	Conventional	Dual
Variolink II Base	Color A3 Ivoclar Vivadent AG, Schaan, Liechtenstein	Conventional	Light curing

Table1:The analized groups on study and used cements

Table 2.	Values of ΔE and SBS				
	SBS (MPa)	**ΔE**	**L**	**a**	**b**
U200	-	4.13 (1.9)	-0.55 (-1.9 to 6.2)	1.15 (0.6 to 2.4)	-1.45 (-3.4 to 5.3)
Multilink	9.4 (7.1)	4.24 (1.5)	1.1 (-4.2 to 5.6)	2.1 (0.6 to 2.9)	1.3 (-4.0 to 2.9)
Variolink II Dual	16.8 (9.3)	3.09 (1.6)	1.4 (-0.7 to 5.3)	1.4 (0.7 to 1.9)	-1.1 (-1.6 to 0.4)
Variolink II	15.0 (14.3)	2.64 (0.9)	0.6 (-2.4 to 3.7)	1.0 (0.4 to 1.9)	0.7 (-3.7 to 0.6)

Table2: The table show values of ΔE and SBS and their variations on axes L, a and b. The data were presented and analyzed in respect to median

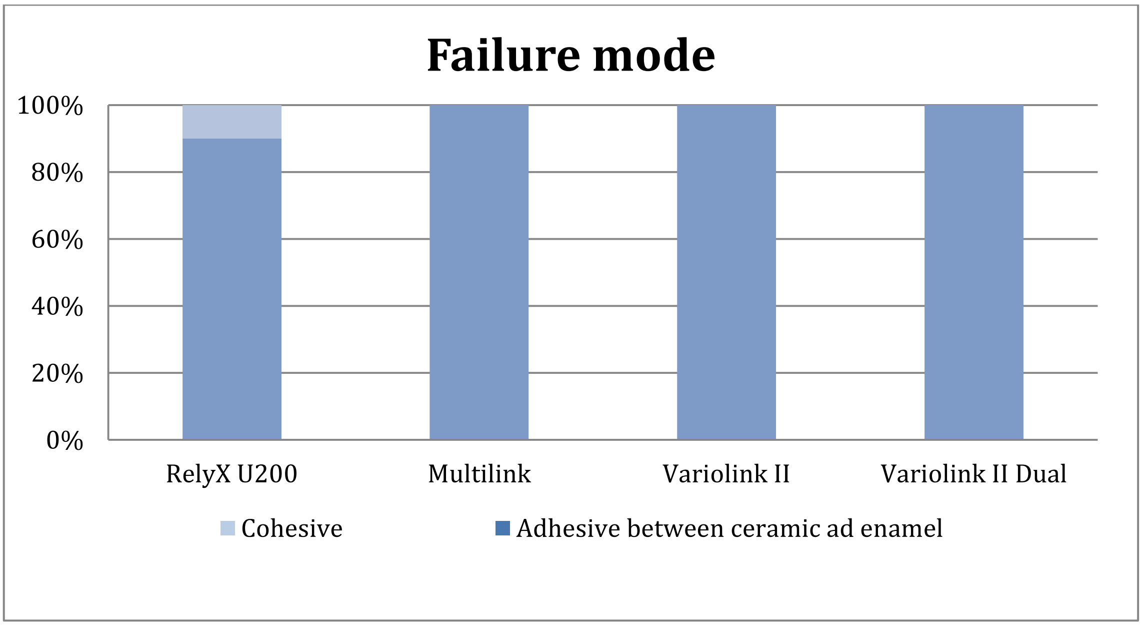

Figure 1. Distribution of the failure mode. Although RelyX U200 was not subjected to the SBS test, it was analyzed to check the group failure mode.

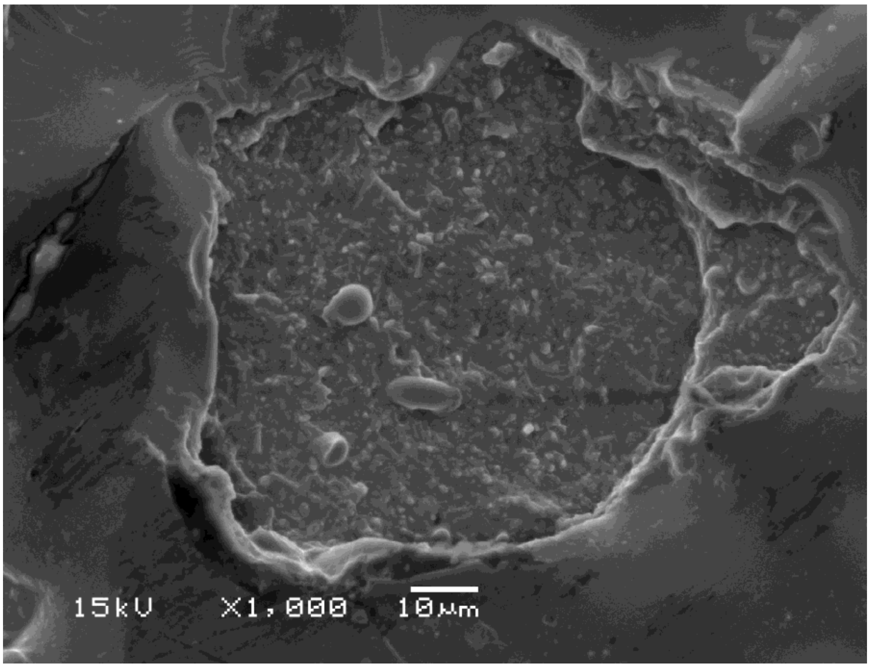

Figure 2: SEM image of the adhesive failure between cement and ceramic

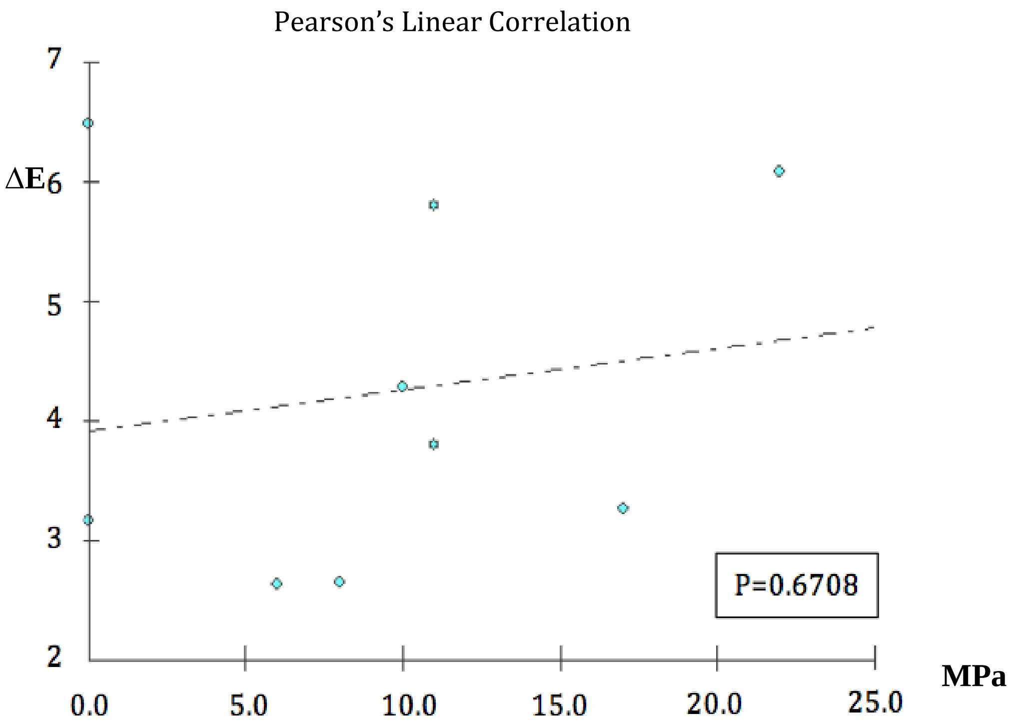

Figure 3. Pearson's analysis of Multilink: ΔE and SBS

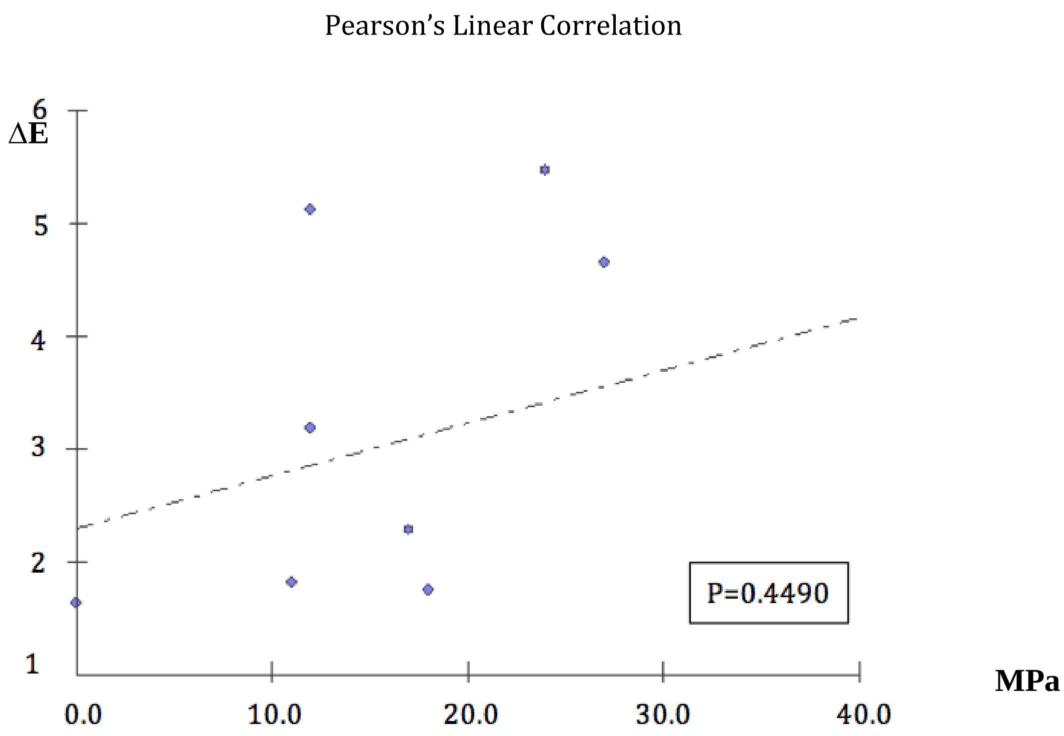

Figure 4. Pearson's analysis of Variolink II Dual.: ΔE and SBS

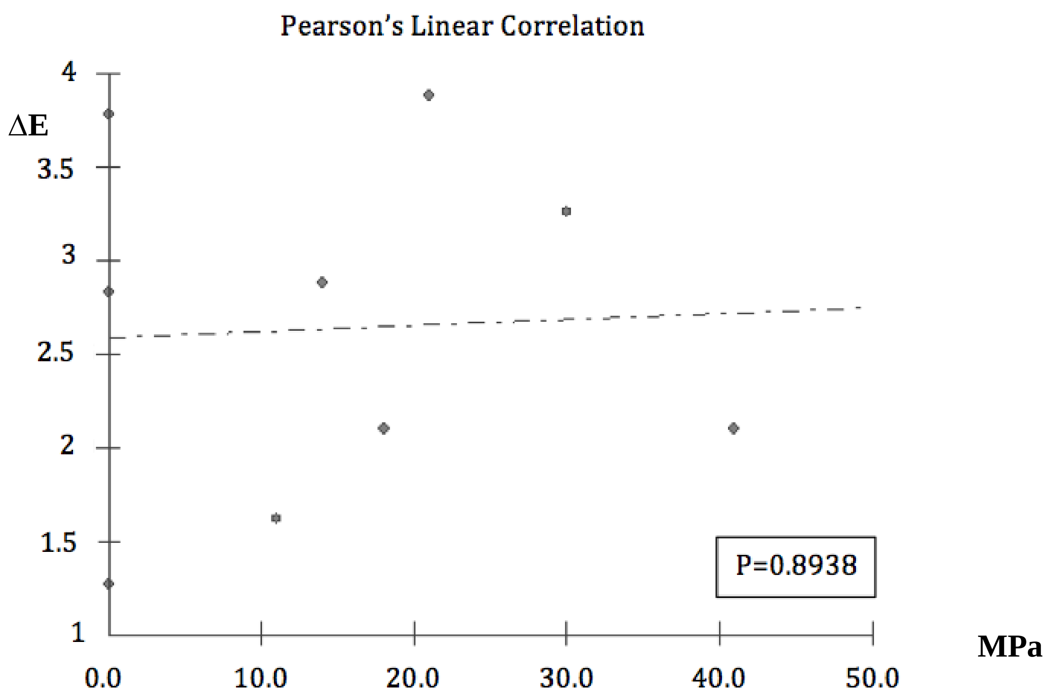

Figure 5. Pearson's analysis of Variolink II Lightcured.: ΔE and SBS

Apêndice 1: Imagens dos materiais e métodos.

1- Corte dos dentes

2- Matriz de teflon

3- Coroas incluídas em PVC

4- Discos de cera

5- Discos de cerâmica

6- Após a cimentação

7- Máquina de Ensaio Universal

8- Câmara de Envelhecimento Artificial Acelerado

9- Placas de alumínio fixadas na câmara

10- Leitura de cor com Espectrofotômetro

11- Classificação do Padrão de falha

12- Classificação do Padrão de Falha

13- Preaparação da amostra para Microscopia

14- Microscópio Eletrônico de Varredura (MEV)

Anexos 1: Normas Quintessence

QUINTESSENCE INTERNATIONAL

GUIDELINES FOR AUTHORS

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Specify contributors to the article other than accredited authors. Also include any funding sources for the study, as well as any potential conflicts of interest.

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The presentation must clearly convey clinical reports, research findings, or review objectives. Try to avoid using technical jargon, but clearly explain where its use is inevitable. Titles, abstracts, and main text should be written in language readily intelligible to any dentist.

Abbreviations/Acronyms:
Abbreviations should be kept to a minimum, particularly those that are not standard. Terms and names referred to as abbreviations or acronyms should be written out when first used with the abbreviation in parenthesis. Standard units of measurement need not be spelled out.

Names of Teeth:
The complete names of individual teeth must be given in the text. Only in tables and figures, individual teeth can be identified using the FDI 2-digit system if full tooth names are too unwieldy.

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Include a title page, *Abstract*, main text, *References*, *Acknowledgments*, and tables, figures, and legends as appropriate.

Title Page:
Include the title of the article and the full name, degrees, title, and professional affiliation of every author. If the paper was presented in a

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Tables and Figures:
Illustrations and tables should be numbered and cited in the text in order of appearance and grouped at the end of the text. When necessary, high-resolution images must be sent to the Managing Editor upon article acceptance: Elizabeth Ducker (elizabeth.ducker@googlemail.com).
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Figure legends should begin with a brief title for the whole figure and continue with a short description of each panel and the symbols used.

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Standard Scientific Journal:
Benoliel R, Eliav E. Neuropathic orofacial pain. Oral Maxillofac Surg Clin North Am 2008;20:237–254.

Journal Supplement:
Bartlett D, Ganss C, Lussi A. Basic Erosive Wear Examination (BEWE): A new scoring system for scientific and clinical needs. Clin Oral Investig 2008;12(Suppl 1):S65–S68.

Standard Text Book:
Kielbassa AM (ed). Radiotherapy of the Head and Neck. Implications for dentists, ear-nose-throat physicians, and radiologists [in German]. Hannover: Schlütersche, 2004:43.

Book Chapter:
Paul S. Nonmetal posts: How do they fare in daily dentistry? In: Sadan A (ed). Quintessence of Dental Technology 2008. Chicago: Quintessence, 2008:61–70.

Thesis:
Müller J. Penetration and sealing ability of different adhesives in subsurface lesions of enamel [in German]. Berlin: Doctoral Thesis, 2005:28.

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The review *Abstract* should have not more than 250 words and include: *Objectives*, *Data Sources*, and *Conclusion*.
The main text should be divided into *Introduction*, *Data Sources*, *Resources Selection*, *Review*, *Discussion*, and *Conclusion*. Search strategies must be described and the use of evidence-based systematic approaches is expected. The *Discussion* and *Conclusion* should address the relevance to the general practitioner and should be supported with clinically relevant photographs.

Original Scientific Articles:
Original scientific articles must reach the highest international standards in the field and should be relevant to dental practice. The articles should describe significant and original experimental observations and provide sufficient details so that the observations can be critically evaluated and, if necessary, repeated.

The article *Abstract* should be no more than 250 words giving details of what was done, using the following structure: *Objectives*: A clear statement of the main goal of the study and any tested hypotheses. *Method and Materials*: Describe the methods, study design, and data analysis. *Results*: Main results of the study, including the outcome of any statistical analysis. *Conclusion*: State the major conclusions of the study and their implications and relevance to the practice of dentistry.

The main text should include *Introduction*, *Method and Materials*, *Results*, *Discussion*, and *Conclusion* sections.

The *Introduction* should summarize the background of the research objectives and should emphasize the relevance of the study to the practice of dentistry.

The *Method and Materials* section must contain sufficient detail such that, in combination with the references cited, all clinical trials and experiments reported can be fully reproduced. Manufacturers of materials should be named, known methods should be referenced, and data analysis should be described.

The *Results* section should be presented in a logical sequence in the text, tables, and illustrations.

The *Discussion* section should include association to previous studies, and implications of the findings to the practice of dentistry should be included.

The *Conclusion* section should not summarize the findings. Instead, the conclusions should relate to the aims of the study and the relevance to dental practice. The conclusions should be supported by the data.

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Method Presentation Articles: The method presentation must offer significant improvements in clinical practice (a novel technique, technological breakthrough, or practical approaches to clinical challenges). The main text should be divided into an *Introduction*, *Report*, and *Discussion*. All parts should be well-illustrated with clinical images, radiographs, diagrams, and, where appropriate, supporting tables and graphs.

Anexo 2: Carta de submissão

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Progress and review history manuscript: 8680

Manuscript title: Color stability and bond strength of lithium disilicate glass-ceramic cemented with different resin cements submitted to artificial accelerated aging
Manuscript type: Original Article
All Authors: Ana Luiza Abrahão, Janisse Martinelli, Ailla Carla Lancellotti, Thiago Valentino, Fernanda Pires-de-Souza, Luciano de Souza Gonçalves,
Keywords: aging, ceramic, color change, dental materials, resin cement.

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