UNIVERSIDADE DE UBERABA

ENI DE FÁTIMA ZANATTA

EFEITO DA CICLAGEM TÉRMICA SOBRE A RESISTÊNCIA DE UNIÃO DE SELANTES DE FÓSSULAS E FISSURAS AO ESMALTE DENTAL.

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EFEITO DA CICLAGEM TÉRMICA SOBRE A RESISTÊNCIA DE UNIÃO DE SELANTES DE FÓSSULAS E FISSURAS AO ESMALTE DENTAL.

Dissertação apresentada ao programa de Mestrado em Odontologia da Universidade de Uberaba - UNIUBE, para a obtenção do Título de Mestre em Odontologia - Área de concentração em Biomateriais.

Orientadora: Profª. Dra. Maria Angélica Hueb de Menezes Oliveira

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Resumo

Objetivo: Analisar os efeitos da ciclagem térmica sobre a resistência de união ao microcisalhamento de 2 selantes resinosos e 1 a base de ionômero de vidro modificado por resina ao esmalte. Material e Método: Sessenta dentes molares humanos hígidos obtidos pelo banco de dentes da faculdade de Odontologia de Uberaba, onde raízes foram separadas das coroas e estas seccionadas no sentido mésio-distal e divididos em 6 grupos (n = 10) de acordo com o selante a ser aplicado: GI - selante resinoso Defense Chroma, GII – selante resinoso Fluroshield e GIII – selante de ionômero de vidro modificado por resina Vitremer. Os selantes foram aplicados na superfície plana do esmalte, em matrizes de 0,8 mm de diâmetro, de acordo com as recomendações dos fabricantes. Os espécimes foram armazenados em água destilada a 37°C por 24 horas. Em seguida, metade das amostras foram submetidas a 1000 ciclos térmicos em banhos de 30 segundos, a temperaturas entre 5ºC e 55°C. O ensaio de microcisalhamento foi realizado com auxilio de uma máquina de ensaio, a uma velocidade constante de 0,5 mm /min e força de 50 kgf. Os valores de resistência de união foram submetidos a análise de variância de 2 fatores e teste de Tukey ($p<0,05$). Resultado: A análise estatística revelou haver diferença significativa de resistência de união entre os selantes ($p>0,5$). Não houve interação entre os fatores (selante x ciclagem) ($p=01,69$) e os ciclos térmicos não influenciaram de forma significativa os valores de resistência de união ($p=0,053$). Análise do padrão de falha mostrou que fraturas adesivas predominaram em todos os grupos com exceção do G3B que apresentou os três tipos de padrões. Houve uma tendência de redução na frequência de falhas adesivas nos grupos em que os ciclos térmicos foram aplicados, elevando o número de fraturas mistas, ou não no caso G3B mistas e coesivas. Conclusão: ciclos térmicos não influenciaram os valores de resistência de união dos selantes testados. O desempenho dos materiais resinosos foi superior ao do selante ionomérico.

Palavras-chave: selantes de fóssulas e fissuras, ciclagem térmica, microcisalhamento.

Sumário

TITLE: Effect of thermalcycling on bond strength of pit and fissures sealants to dental enamel.

Short Title: Bond strength of dental sealants

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Abstract

Propose: To study the influence of thermal cycling on the microshear bond strength of different sealants and resin modified glass ionomer to enamel. **Methods:** Sixty molar healthy human crowns were divided in three different groups (n=20) according the sealant type: G1– Defense Chroma (resin sealant), G2–Fluroshield (resin sealant), and G3–Vitremer (resin modified glass ionomer). The sealants were applied on the flattened enamel surface (0.8 mm in diameter) according to the manufacturer instructions. Each group was subdivided (n=10) in A, without treatment, and B, submitted to 1,0000 thermal cycles of 30 seconds of bathes at 5°C and 55°C, repeated successively. The microshear bond strength was performed to all groups with a blade (0.5 mm in thickness) at a constant speed of 0.5 mm/min / 50kgf. The bond strength values were subjected to 2-away ANOVA and Tukey Test ($p < 0.05$). **Results:** The results showed significant differences in bond strength values between the sealants ($p > 0.5$). There was no interaction between factors ($p = 01.69$) and thermal cycling did not influence the bond strength values ($p = 0.053$). The failure mode showed predominance of adhesive failures in all groups, excepted at the G3B that had uniform failures distribution. At the groups submitted to thermal cycling, the adhesive failures tended to reduce, with mixed failures for G1 and G2, and mixed and cohesive for G3. **Conclusions:** The thermal cycles did not influence the bond strength of the sealants tested. The performance of resin materials was superior to the resin modified glass ionomer.

Keywords: pit and fissure sealants, thermal cycling, microshear

Introduction

The dental caries is the most prevalent disease at the oral cavity associated to inadequate hygiene and diet[1]. Around 1970 the dental caries notable decreased in developed and emergent countries, particularly due the use of fluoride in dental pastes and at the public water abasteciment of different cities[2,3]. The fluoride's use is effective in to decrease the caries disease at smooth dental surfaces, however the oclusal dental morphology difficult its action due the plaque cumulus and self-hygiene difficulty[4], what implied to particularly additional preventives practical to avoid the caries developed, especially at the high risk patient[5,6]. The oclusal surfaces sealing method was introduced at the end of 1960´s and consists in the application of fine layer of resin at the oclusal surface to avoid food debris and plaque accumulation to facility the dental cleaning. According previous studies, the sealants are recognized as an important method to prevent pit and fissure caries and/or prevent the development of incipient lesions with rapidly developing[7, 8]

The sealing materials available are classified in resinous (methacrylate monomers) or ionomeric (acid-base reaction)[9], and may contain fluor, present different opacity, inorganic charge and different forms of activation[10]. The resin sealants are suitable materials to prevent food retention on the occlusal surface, facilitating the self-cleaning and hygienization[5, 6, 11] and promote significant reduction at the *Streptococcus mutans* level on the occlusal surfaces of molars, remaining six months after application[12]. Nowadays, the majority of resin sealants are epoxy-acrylic resins, dimethacrylates result of the product from ether of bisphenol A and glycidyl methacrylate (Bis-GMA) reaction[11].

On the other hand, the use of glass ionomer cement as sealant was introduced in 1974[13] and when compared with no sealed surfaces, promoted better fissures sealing and more resistance to demineralization, even after clinical visible material loss, with residual material at the bottom of the fissure[9]. Compared with the resin sealant, cement glass ionomer has disadvantages as lower bond strength and tenacity[14], high solubility and disintegration in the oral environment, what implies in very low retention rates. However, the resin-modified glass ionomer was introduced as a sealant to reduce the undesirable properties of conventional glass ionomers cement and approaching their properties inherent of the resin materials[15]. These materials presents light activation, controlled work time, short setting time and enhanced mechanical strength. Nevertheless, when the conditioned enamel is infected with saliva and humidity, the mechanical properties of resin-modified glass ionomer are reduced[16,18].

A light-cured resin sealant containing thermochromic pigments that change its color to blue at temperatures below 31°C, facilitating the product visualization after application, was developed and has been used in the pediatric clinic, but they are required scientific studies that prove its effectiveness in different properties such as bond strength resistance and degradation.

According the explained above, the objective of this study was to evaluate the influence and the effect of thermal cycling on the bond strength of two resin sealants and one resin-modified glass ionomer sealant to enamel using microshear bond strength test.

METHODS AND MATERAILS

Tooth preparation

60 intact human third molars were selected from Faculty of Dentistry stock teeth, University of Uberaba and approved by the Research Ethics UNIUBE under protocol number CAAE 11432912.80000.5145. The teeth were stored in distilled water under refrigeration until use. The roots were cut from the crowns 2,0 mm below the cement-enamel junction using double sided diamond disc under refrigerated air and water in metallographic cutter (1000 Isomet, Buehler, Lake Bluff, Ill, USA). The crowns were cleaned and sectioned in the mesio-distal direction and divided in 6 groups (n = 10). The materials used are shown in Table 1.

Preparation of the specimen

Prior the inclusion and dental prepare, matrixes were obtained with the light body of addiction silicone (Express 3M/ESPE) with 0.5 mm in thickness and 0.8 mm in internal diameter, maintained in repose for 24 hours before use.

The buccal dental surfaces were included at PVC (Tigre S.A. Joinvile, SC, Brazil) with acrylic resin auto-activated. After the inclusion procedures, the buccal surfaces were polished with silicium carbetum sandpaper with granulation of 180, 400 and 600 under water cooling until to obtain flat enamel surface. Forward, the samples were washed with jets of air/water and divided into 6 groups (n = 10) (Table 2).

The samples photoactivation was performed with a LED source (Radii-calSDI Ltd. Bayswater, Victoria, Australia) with irradiance of 645 mW/cm^2. After curing, the specimens were stored at 37ºC for 24 hours at 100% relative humidity. After the storage period the groups were subdivided randomly into two subgroups, A - no thermal cycling, B - with 1,000 thermal cycles. The A subgroup specimens were stored at 37ºC during the same taken time for the thermal cycles. After that all the groups were submitted to microshear bond-strength (Figure 1).

Thermal cycling

After 24 hours of the photopolymerization, 10 specimens of each group were subjected to 1,000 thermal cycles of alternatively 30s baths at temperatures of 55°C to 5°C. Samples that were not thermo-cycled remained in the oven for another 24 hours for the same time was consequent adhesion between the two groups for the test microshear.

Microshear-bond test

The specimens were bonded to rectangular metallic device and placed in a universal testing machine (Emic 3000, St. Joseph's Pinhais, Brazil) for microshear bond-test. A stainless steel blade with 0.5 mm in thickness was fixed at the top of the testing machine and the microshear bond test was applied on each cylinder separately with the speed of 0.5 mm/min until the moment of rupture. The bond strength values (MPa) were subjected to 2-away ANOVA and Tukey Test ($p < 0.05$).

Analysis of the failure mode

After the microshear bond-strength test the specimens were stored in a dry environment for 24h and the failure mode was evaluated by stereomicroscopy (Nikon 88286, Honshu, Japan) with the increase of 40x. The failures were classified in adhesive (ADV) when presented at least 75% of failure localized at the interface between the sealant and enamel, mixed (MIS) when both substrates were between 25 and 75% of the fracture area and cohesive (COE) when at least 75% of the bonding area was covered by the sealant..

RESULTS

Statistical analysis revealed significant differences in bond strength between the sealant p> 0.05). However, there was no interaction between factors (sealant x cycling) p = 0.169) and thermal cycling did not influence significantly the values of bond strength p = 0.053). The bond strength values are shown in Table 3.

The failure mode analysis showed that adhesive fractures predominated in all groups except G3B that showed uniform distribution between all modes. There was tended to reduction the adhesive failures in the groups submitted to thermalcycling, increasing the mixed fractures, or in the case of G3B mixed and cohesive (Figure 2).

DISCUSSION

In this study, Defense Chroma bond strength values were statistically higher than the others, followed by FS. Both resin sealants analyzed showed an

important great difference comparing to the resin-modified ionomer VM. These results occurred due to mechanical imbrication of resin monomers polymerized inside the regularities obtained by previous acid etching of the enamel surfaces. The efficiency of etching to promote the penetration of resin monomers to enamel was demonstrated in previous study that showed significant increase in bond strength when compared to adhesive systems that did not use phosphoric acid etching[1]. Another study shows that the length of the extensions of resin monomers can positively influence the bond strength of resin materials to enamel[19]. The difference between the bond strength of the materials founded in this study may be direct affected by the viscosity difference between them[19]. FS was more viscous during the matrix filling compared to DC. However, the use of rheometer or film thickness test is needed to confirm this supposition.

Different factors may have contributed to the low VM bond strength values: the absence of previous acid etching combined to the high viscosity of this material what may have limited their penetration into the pits and fissures of the oclusal dental enamel. This hypothesis is supported by previous study that evaluated the resin sealant depth penetration to enamel of VM and FS[20]. Differing from the present study, the authors did not found significant difference between the materials, what can be explained by the use of phosphoric acid etching prior to the VM application, even without manufacturer´s instructions. Another study found similar results of shear bond strength to FS and VM, used according to the manufacturer's recommendations[21]. The VM powder/liquid ratio recommended by the manufacturer (1:1) may have contributed to their improved performance to shear bond strength, as shown in a previous study[21] where the powder/liquid ratio altered the compressive strength of VM with

statistical higher values to the ratio 1:1 compared to 1:2 and 1:3. However the use of this ratio in this study would not be possible due to high viscosity that the material presents when the proportioning is used and applied to the small diameter of the microshear specimen (0.8 mm). It is important to note that the same difficulty to fill the matrix following the ratio recommended by the manufacturer can be found to filling fissures or occlusal grooves, which could result in bubbles or flaws in filling these fissures. However the manufacturer does not specifies the proportion to the use of this material as a sealant. This lack of standardization leaves possibility for controversial results as that found by Fracasso et al (2005)[20] that changed the powerd/liquid ratio of VM and obtained the statistical similarity data when the specimens were submitted to penetration test, contrasting with the results of Baseggio et al (2010)[22] that found the higher retention values to FS comparing to VM, in accordance with the present study.

In this study thermocycling was performed in order to simulate temperature variations that occur daily in oral cavity[19]. The non-significant difference in bond strength values found in this study corroborates Titley et al[23], which reported that the effect of thermocycling did not alter the bond strength of the materials to enamel. The absence of water in the enamel can be a favorable factor for the durability of bond strength after thermal cycling since its presence in the substrate can conduced water absorption of the adhesive, allowing hydrolysis at adhesive interface after thermal cycles, damaging the bond strength[24]. Thus, other clinical and laboratory studies should be performed to confirm the results observed in this study. However the tendency to reduce the number of adhesive fractures after thermalcycling may suggest the deleterious

effects of temperature variation inside the bodies of the materials, increasing intrinsic defects of the same. This may have occurred at the interface between the glass particles and the resin and ionomer matrix present at the VM leading to degradation of this interface and reducing the values for cohesive strength of the material.

CONCLUSION

Within the limitations of the study it is possible to conclude that the thermalcycling did not influence the bond strength values the tested sealants.

The performance of resin materials was higher when compared to glass ionomer sealant, which requires the determination of an adequate proportioning determination to its selection as an occlusal surfaces sealant.

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Tables and Figures

Table 1. Materials used.

Materials	Composition	Batch	Manufacturer
Defense Chroma	Bis-GMA, urethane modified, triethylene, borosilicate barium aluminum, sodium fluoride	20927	Ângelus, Brazil
Fluoroshield	urethane modified, triethylene, borosilicate barium aluminum	L582950D	Dentsply Caulk, Milfor, USA
Vitremer	Powder: flúor-aluminum-silicato crystals, potassium persulfate, ascorbic acid Liquid: polialcenoic acid, water, HEMA, canforaquinon	1205100238	3M/ESPE Dental Products St Paul, MN, USA
Phosphoric Acid	Phosphoric acid gel 35%	4063243C	Products St Paul, MN, EUA

Table 2. Groups division.

Groups	Sealer	Description	Termocycling
G1A	Defense Chroma (DC)	Acid etching for 30s, water washing for 10s, cement insertion on the matrix with explorer number 5 and polymerization for 20s.	No
G1B			Yes
G2A	Fluroshield® (FR)	Acid etching for 30s, water washing for 10s, cement insertion on the matrix with explorer number 5 and polymerization for 20s.	No
G2B			Yes
G3A	Vitremer (VM)	Enamel treatment with primer for 30s, air jet for 5s, primer photoativation for 20s, cement insertion on the matrix with explorer number 5 and polymerization for 20s.	No
G3B			Yes

Table 3. Microshear bond strength values (MPa) and standard deviation.

Groups	No thermalcycling (A)	Thermalcycling (B)
G1	32,21 (5,8) a	28,87(6,4) a
G2	29,72 (5,0) b	23,58 (3,9) b
G3	5,77 (2,6) c	6,1 (1,6) c

The same small letters in column indicate statistical similarity (P<0.05).

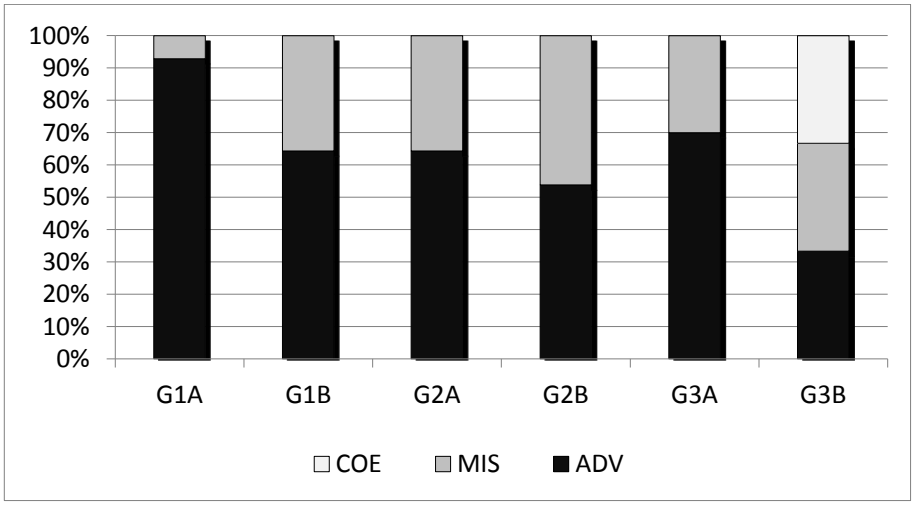

Figure 2. Failure mode distribution.