Brazilian Dental Science
Ciência Odontológica Brasileira
unesp
UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"
Instituto de Ciência e Tecnologia
Campus de São José dos Campos

ORIGINAL ARTICLE
doi: 10.14295/bds.2015.v18i2.1101

Bond strength of a resin composite and a resin-modified glass-ionomer cement associated or not with chlorhexidine to eroded dentin

Resistência de união de uma resina composta e um cimento de ionômero de vidro modificado por resina com e sem a aplicação de clorexidina à dentina erodida

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ABSTRACT

Objective: Although resin composites and glass-ionomer cements are widely used for dental cervical region restorations, under erosive condition they can wear out quickly. This study aimed to compare, by means of microshear bond strength, the performance of a resin composite (RC) and a resin-modified glass-ionomer cement (RMGIC) to eroded dentin and its association with 2% chlorhexidine (CHX) up to 6 months. **Material and Methods:** Eighty sound third molars teeth were cut to obtain flat coronal dentin, which were subsequently embedded in self-curing acrylic resin circular molds. Teeth were divided into two groups, according to the treatment with the Adper Single Bond 2 + RC Filtek Z250 (Z) or the RMGIC Vitremer (V). Half of the specimens were immersed in artificial saliva-AS (control groups) and half subjected to 3x/1 min daily immersion in Regular Coca Cola ®-RC for 5 days. Half of the specimens for each described condition were treated with water and half with 2% chlorhexidine for 1 min prior the restoration. For all groups, the specimens were stored in artificial saliva weekly renewed up to tests. The microshear bond strength was evaluated after 1 month and 6 months. Data, in normal distribution, were analyzed with four-way ANOVA and Tukey ($p < 0.05$). **Results:** The factors materials, substrate and time were statistically significant and also the interaction between material and time. Treatment (water x CHX) was not a significant factor. Restorations with Z showed significantly higher bond

RESUMO

Objetivo: Apesar da resina composta e o cimento de ionômero de vidro serem amplamente usados para restaurações cervicais, sob condições erosivas estas podem desgastar mais rapidamente. Este estudo objetivou comparar a resitência adesiva ao microcisalhamento de uma resistência de união (RC) e um cimento de ionômero de vidro modificado por resina (RMGIC) à dentina erodida associada à Clorexidina 2% num período de até 6 meses. **Material e Métodos:** Oitenta terceiros molares humanos foram cortados e uma dentina regular foi obtida, e subsequentemente, foram inclusos com resina acrílica em tubos de PVC. Os dentes foram divididos em dois grupos, de acordo com o tratamento recebido: Adper Single Bond 2 + RC Filtek Z250 (Z) ou RMGIC Vitremer (V). Metade dos corpos de prova foram imersos em saliva artificial (AS) por 24 h (grupo controle) e metade foi erodido artificialmente 3x/1 min diariamente com Coca Cola ®-RC por 5 dias. Metade dos corpos de prova, para cada condição descrita, recebeu água e outra metade a clorexidina 2% por 1 min, antes da restauração. Para todos os grupos, os corpos de prova foram armazenados em saliva artificial renovada semanalmente até os testes. A resistência de união ao microcisalhamento foi avaliado após 1 e 6 meses. Os resultados foram analisados com teste ANOVA 4 critérios e Tukey ($p < 0,05$). **Resultados:** Os fatores materiais, substrato e tempo foram estatisticamente significantes, além da interação entre o material e o tempo. O tratamento (água X clorexidina) não foi um fator significante.

strength compared to V in all situations. There was a reduction in bond strength values over time for all tested conditions. **Conclusion:** For both sound and eroded dentin, the resin composite presented higher bond strength compared to resin-modified glass-ionomer material. The bond strength performance was overall reduced with time and the use of chlorexidine itself did not interfere on bond strength through time. Resin composite showed greater bond resistance compared to resin-glass ionomer-cement.

KEYWORDS

Resin composite; Resin-modified glass-ionomer cement; Chlorhexidine; Erosion; Dentin; Bond strength.

As restaurações com Z demonstraram resistência de união significantemente maior comparada ao V, em todas as situações. **Conclusão:** Tanto para a dentina sadia quanto erodida, a resina composta apresentou maior resistência de união comparada ao cimento de ionômero de vidro. O tempo e uso da clorexidina não interferiu na resistência de união. A resina composta demosntrou maior resistência adesiva quando comparada ao cimento de ionomero de vidro.

PALAVRAS-CHAVE

Resina composta; Cimento de ionômero de vidro; Clorexidina; Erosão; Dentina; Resistência adesiva.

INTRODUCTION

In oral environment, there are different chronic and destructive processes, which can affect teeth beyond the dental caries, resulting in loss of minerals that culminate in irreversible loss of tooth structure [1]. Non-carious lesions can be caused by mechanical events as abrasion, attrition, and abfraction or due to chemical process as erosion [1-3]. Currently, the dental erosion stands out, among these events, consisting on a multifactorial condition in which chemical, biological and behavioral factors interact and determine why some individuals exhibit a greater erosion level than others [4,5]. Erosive process is defined as a process that involves two steps: smoothing of the surface, which under continuous chemical challenge associated or not to abrasive process, can be wear out, exposing a new sub layer [6,7]. The acidic condition, buffer capacity of saliva, frequency and intensity of erosive challenge are relevant factors to modulate this process [8].

The interest in studying dental erosion has increased in recent years, mainly due to the increasing consume of drinking acidic products, especially soft drinks and citric juices [9-11].

When erosion involves dentin, it is likely to cause dentin hypersensitivity, and in severe cases, can also provoke pulp exposure and fracture of the affected tooth. In cases of intense dental loss, restorations are frequently indicated. Resin composite and glass-ionomer cement are the preferable materials [12,13], due to esthetic characteristics, wear resistance, adhesiveness to the hard tissues. Professionals' choice may consider substrate characteristics and their resistance to degradation, as their resistance to acidic challenge [14].

In general, it is known that the resin composites are widely used for restorations, but the glass-ionomer cements also present a reliable performance in the dental cervical region for having the elasticity modulus similar to the tooth among their properties [15]. Resin-modified glass-ionomer cement becomes an adequate option as it preserves the advantages of glass-ionomer cement associated to more resistant property, which prevents the fracture of the material in this region and avoid cracks as this material can support [15].

Strong evidences have pointing out the successful strategy of the adjunctively use of endogenous enzymatic inhibitors to preserve the bonding interface, by means of the preservation of no involved denuded collagen after acid conditioning [16,17]. A recent study also attested this successful strategy for eroded dentin [18].

Therefore, this study aimed to evaluate the effect of 2% chlorexidine on microshear bond strength of a resin composite and a resin-modified glass-ionomer cement to eroded dentin, up to 6 months.

MATERIAL AND METHODS

Ethical aspects

This study approved by the local Scientific Review Committee and Committee for the Protection of Human Subjects (protocol 2010/19385-1).

Experimental design

This *in vitro* study was conducted involving four factors: material, erosive agent, use of chlorhexidine and time, all in two levels. The response variable used was the analysis of the microshear bond strength.

Preparation of the specimens

Eighty sound third molars teeth were obtained and stored in 0.1% sodium azide solution at room temperature up to 30 days. After cleaning, teeth were taken in the cutting machine Isomet Saw Low Speed (Buelher Ltd., Lake Bluff, IL, USA), fixed with thermo-activated godiva (Kerr Corporation, Orange, CA, USA) on an acrylic plate. The cuts were made in mesio-distal direction with a double-sided diamond disk (High diamond concentration, wafering Blade-102 mm x 0.3 mm x 12.7 mm / Extec Corp., Enfield, CT, USA, 12205 Ref. 1.3 cm), at 3 mm from the cement-enamel junction. Following, the enamel of the occlusal surface was also cut to obtain a flat dentin surface.

Standardization of dentin surfaces

To standardize the dentin surfaces, #600 sandpaper was used for 30 s at low speed and cooling (APL-4 polishing AROTEC, Cotia, SP) and cleaned in ultrasonic machine (Mod Ultrasonic Cleaner USC 750, Unique Electronics Ind. E Com Ltda., São Paulo, SP, Brazil).

These surfaces were examined under a stereomicroscope (Leitz, Wetzlar, Hessen, Germany- 40x) to ensure that the enamel would be present strictly at the periphery of the dentin surface.

Erosive protocol

The carbonated beverage selected for the study was the Coca Cola ®, by being considered a high-consumed soft drink, due to its low pH and erosive ability [10]. The specimens were divided into two groups according to each solution (Artificial Saliva-AS or Regular Coca Cola ®-RC), presented in Table 1. Specimens of artificial saliva group were maintained undisturbed. Specimens from the group challenged with Regular Coca Cola ® were immersed for one minute, three times daily for five days. During the intervals, they were stored in artificial saliva.

Restorative Procedures

For each condition, normal or previously eroded, the specimens were divided into two subgroups (n = 10), according to the restorative material tested, according to Table 2.

For the groups treated with Z, the specimens were conditioned with 37% phosphoric acid (Dentsply Ind, Rio de Janeiro,

Table 1 - Chemical composition of the solutions

Immersion solution	Constitution
Artificial Saliva (AS)*	$Ca(NO_3)2$; H_2O 1.5 mmol/L Na_2HPO_4; $2H_2O$ 0.9 mmol/L KCl 150 mmol/L $H_2NC(CH_2OH)_3$ (TRIS) 0.1 mol/L NaF 0.05 μg/mL
Regular Coca Cola ® (RC)	Carbonated water, sugar, kola nut extract, caffeine, caramel coloring IV, INS 338 acidifier and natural aroma. pH = 2.1

* AS was prepared in the Laboratory of Biochemistry, Bauru Dental School, Bauru, SP, Brazil. pH was measured in the same laboratory.

Table 2 - Composition of restorative materials used

Restorative Materials	Composition
Vitremer, 3M ESPE, St. Paul, MN, USA (V)	Powder: silicate glass-aluminum fluoride Liquid: based on polycarboxylic acid, hydroxyethylmethacrylate and water Primer: Hydroxyethylmethacrylate Glaze: Bis-GMA, TEGDMA
Filtek Z250, 3M ESPE, St. Paul, MN, USA (F)	Matrix resin: UDMA, Bis-EMA and Bis-GMA Inorganic Fillers: 66% in volume Zirconium glass and Coloidal silica

Abbreviations: UDMA – urethane dimethacrylate, Bis-EMA – bisphenol-A polyethylene glycol diether dimethacrylate and Bis-GMA – bisphenol-A glycidil ether dimethacrylate; TEGDMA – Triethyleneglycol dimethacrylate

RJ, Brazil) for 15 s and washed out for 30 s with water. Twenty specimens were preatreated with 2% chlorhexidine (FGM, Joinville, SC, Brazil) for 1 min with disposable microbrush (KG Sorensen, Cotia, SP, Brazil), and were dried afterwards with absorbent paper. The other half (n = 20) were only dried with absorbent paper after rinsing. In all teeth, Adper Single Bond 2 ® (3M ESPE, St. Paul, MN, USA) adhesive system was applied in two thin layers using a disposable microbrush and light cured for 10 s (Radi cal, SDI, Bayswater, Victoria, Australia). For each dentin specimen, six cylinders in a single increment of composite resin were placed and light cured for 20 s each, using Tygon-type tubes (1.0 mm high x 0.79 mm diameter), which were removed 1 h after restorative procedures.

For V groups, half of the specimens received the application of 2% chlorhexidine for 1 min and were dried with absorbent paper. The other half specimens were only washed with water. Following, the 40 teeth received priming system application, according to the manufacturer's instructions and Vitremer was applied using a Centrix syringe into the Tygon-type cylinder. For each sample, six Vitremer cylinders were made and light cured for 20 s. The tubes were removed 1 h after restoration, with the care necessary to induce the lowest strength possible at the interface.

For all groups, the restored specimens were stored in artificial saliva for 1 month and 6 months. The artificial saliva was renewed weekly and stored at oven at 37 ºC.

Microshear bond strength test

The microshear was performed by the application of steel wire with 0.2 mm of diameter at a crosshead speed of 0.5 mm/min and a 50 kg load at the Universal Test machine (Emic, São José dos Pinhais, PR, Brasil). This test was performed after the first month and after 6 months, testing half of the cylinders at each time.

Statistical Analysis

The data, in normal distribution, were analyzed by four-way analysis of variance (ANOVA)(material x substrate x treatment x time) and Tukey test, ate 5% of significance ($p < 0.05$).

The mean values and standard deviation in MPa of the microshear resistance are shown in Table 3.

Table 3 - Means and standard deviation in MPa according to material, substrate, treatment and time

Material	Time Challenge	1 month		6 months	
		C	CHX	C	CHX
V	AS	1.78/0.60 a	1.09/0.59a	1.24/0.39 a	1.56/0.33 a
	RC	3.11/0.87 abc	2.74/0.67 ab	0.76/0.18 a	1.88/0.51 a
Z	AS	12.19/0.39 f	10.30/4.63 ef	7.05/ 6.40 cde	5.89/2.98 bcd
	RC	13.30/ 2.80 f	12.09/3.35 f	6.77/2.80 cde	6.97/2.40 de

N=10, p<0.05

Different letters indicate statistical significant differences among the comparisons.

RESULTS

The factors materials ($p < 0.0001$), substrate ($p = 0.003$) and time ($p < 0.0001$) showed statistically significant differences. Only chlorhexidine factor was not statistically significant ($p = 0.226$). The interaction between material and time was significant ($p < 0.0001$).

For Z groups, the bond strength significantly decreased with time. For V, the bond strength values were significantly lower compared to Z groups for all tested situations. Nevertheless, the bond strength values were not significantly reduced with time for V groups.

DISCUSSION

The adhesion of restorative materials to dental substrates is a desirable property as it is able to prevent the displacement of material and marginal leakage, ensuring the chances of longevity of the restorations [19-21].

In cervical restorations, bonding to cavity walls is a relevant property to improve the retention of the material as their design and location turn them susceptible to lost [22]. Adhesive materials have been mostly used for this purpose. In general, it is known that the resin composites are widely used for restorations but the glass-ionomer cements also should present a reliable performance in the dental cervical region for having the elasticity modulus similar to the tooth among their properties [15].

Studies have shown that failure of cervical restoration is mainly attributed to low retention rates of resin composite restorations [23-26] and poor color stability for glass-ionomer restorations [27,28].

Further subjected to an erosive condition, these restorations can wear out more quickly [6]. Resin-modified glass-ionomer cement could be an interesting alternative as it preserves the advantages of glass-ionomer cement associated to more resistant to degradation property due to the resin component [15].

Values of bond strength were reduced in all tested situations, both for one and 6 months, with and without 2% chlorhexidine previous application. It indicates that chlorhexidine was not able to improve the original performance of Vitremer. Thus, this strategy is not necessary when resin-modified glass-ionomer is used.

On the other hand, the resin composite demonstrated more interesting performance as greater bond strength was observed in all the situations. Therefore, the resin composite showed a higher adhesion capacity in relation to resin-modified glass-ionomer cement, and time was significant to indicate the decrease of bond strength for both materials.

Regarding the use of chlorhexidine, the dental literature shows controversial performance. Some authors showed that the disinfectant application negatively interfered to the bonding process [29-31]. Others showed that it did not impair the bonding process [32-34]. Although others found that it enhanced the bonding process [35,36].

Brackett et al. [37] and Campos et al. [38] reported that the application of the chlorexidine did not affect the initial bond strength, however it promoted the stability of the bond after 6 months service in vivo. Thus, although some studies show a significant effect of chlorhexidine on the bond durability, this factor was not statistically relevant in this study.

CONCLUSION

Based on the results of the present study, chlorhexidine did not influence bond strength to sound and eroded dentin associated either with resin composite or resin-modified glass ionomer cement. In the comparison between both restorative materials, resin composite showed greater bonding ability. However, both materials were not able to preserve it overtime.

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Date submitted: 2015 Jan 26

Accept submission: 2015 May 11