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MICROLEAKAGE AT THE COMPOSITE-REPAIR INTERFACE: EFFECT OF DIFFERENT ADHESIVE SYSTEMS

MICROINFILTRAÇÃO NA INTERFACE COMPÓSITO-REPARO: EFEITO DE DIFERENTES SISTEMAS ADESIVOS

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ABSTRACT

The purpose of the present study was to evaluate the microleakage at the composite-repair interface using different bonding systems. Composite resin specimens (Filtek Z250 – 3M-ESPE) were divided into five groups (n=20) according to the following bonding mechanism: C - control - etching with 35% phosphoric acid; SB1 - etching and application of one coat of Single Bond (3M-ESPE); SB2 - etching and application of two coats of Single Bond (3M-ESPE); SMP1 - etching, application of Scotchbond Multi-Purpose primer (3M-ESPE) followed by the adhesive and, SMP2 - etching, application of Scotchbond Multi-Purpose adhesive (3M-ESPE) without the primer. Thereafter, all groups received new resin application. Samples were thermocycled (500 cycles / 5ºC - 55ºC [±2]) and immersed for 4h in 2% methylene blue buffered dye solution (7.0 pH). Three examiners measured the extent of microleakage in a stereoscope microscope, using four representative scores. For all experimental groups, no significant difference in microleakage at the repair was identified by Kruskal-Wallis test ($p > 0.05$). Therefore, different types of bonding systems presented the same effect on the dye penetration along the repair interface.
Uniterms: Repair; Composite resin; Microleakage.

RESUMO

O objetivo do presente estudo foi avaliar o efeito de diferentes sistemas adesivos sobre a microinfiltração na interface de reparos em resina composta. Corpos-de-prova do compósito Filtek Z250 (3M-ESPE) foram divididos aleatoriamente em cinco grupos (n=20) de acordo com a forma de confecção do reparo: C - controle - condicionamento com ácido fosfórico a 35%; SB1 - condicionamento ácido e aplicação de uma camada do agente de união Single Bond (3M-ESPE); SB2 - condicionamento ácido e aplicação de duas camadas de Single Bond; SMP1 - condicionamento ácido, aplicação do primer e do adesivo do sistema Scotchbond Multipurpose Plus (3M-ESPE) e SMP2 - condicionamento ácido e aplicação apenas do adesivo do ultimo sistema. O reparo foi finalizado com a inserção de nova camada do compósito restaurador. As amostras foram termocicladas (500 ciclos / 5-55°C [±2]) e imersas por 4h em solução tamponada de azul de metileno 2% (pH 7,0). A penetração do corante na interface do reparo foi avaliada em lupa estereoscópica (40x) por três examinadores utilizando quatro escores representativos. A análise estatística não encontrou diferenças entre os grupos experimentais (Kruskal-Wallis / $p > 0.05$). Dessa maneira, os diferentes sistemas adesivos mostraram comportamento semelhante sobre a microinfiltração na interface do reparo.
Unitermos: Reparo; Resinas compostas; Microinfiltração.

INTRODUCTION

Repair is an alternative to the total replacement of a defective composite resin restoration. Indications for such treatment include fractures [4]; discolored or worn areas [2]; poor anatomic form; secondary caries; tooth fracture and pain/sensitivity [12]. Also, according to Turner, et al.[23] (1993) repair situations occur regardless of the technique used or type of resin; whether macrofill, hybrid, microfill, chemically cured, light-cured, heat-cured, direct or indirect composite resin.

Complete removal of defective composite restorations may lead to larger cavities with further loss of tooth structure [6, 10]. Such treatment involves difficulties like recognizing the composite-tooth interface and the need for removing previously etched enamel to enable a new bonded restoration to be made [18, 20]. In addition, total replacement increases pulpal trauma and the cost of the procedure [6].

However, the repair procedure can also result in weaker restorations [18, 20]. Therefore, successful resin repair requires development of an adequate interfacial bond between the old and new resins. Several composite repair studies have shown that a surface treatment and the use of an intermediate bonding agent enhances the repair bond significantly[2, 11, 13, 15, 16, 19, 22]. While surface roughness promotes mechanical interlocking, the bonding agent advances surface wetting and chemical bond with the new composite [2].

Various surface treatment methods and bonding agents have been indicated for the repair procedure[2, 11, 13]. The choice of a surface treatment seems to depend on the substrate surface to be repaired (i.e. the hydrofluoric acid seems to have little effect on microfilled resins)[6]. However, there is little information regarding the behavior of different bonding systems on the repair procedure.

According to Lewis, et al.[10] (1998) the efficiency of the repair is related to the magnitude of the bond strength obtained at that interface. However, a clinically adequate bonding should also be able to prevent microleakage at its interface[7]. This leakage leads to deterioration of the bond and accelerates failure[4, 17]. In addition, interfacial staining could compromise esthetics, especially in anterior teeth, and as a result the entire restoration needs to be replaced[6].

Therefore, this study aimed at evaluating the effects of different bonding systems on microleakage at the composite-repair interface using a qualitative dye penetration analysis.

METHOD AND MATERIALS

Composite resin specimens were made in a quadrangular acrylic resin mold with an internal space of 6 x 6 x 2mm. A removable acrylic resin spacer was inserted to make half-length specimens (3 x 6 x 2mm) in the first part of this study. Initially, half the mold was filled with composite resin Filtek Z250 (3M-ESPE, St. Paul, MN, USA), in a single increment. A glass microscope slide was placed over the mold and pressed to remove excess material. Each specimen was light-cured through the slide for 10 seconds using a visible light-curing unit (Optilight 600 - Gnatus, Riberão Preto, SP, Brazil). The tip of the curing light was kept at a 90-degree angle to the top surface, in contact with the glass to achieve maximum curing depth. After the top surface had been cured, the specimens were carefully removed from the mold and another light exposure of 40 seconds was applied to specimen surfaces.

A hundred half-length specimens were then stored in artificial saliva[21] at 37ºC for ten weeks in order to restrict bond mechanism to micromechanical retention, thus avoiding chemical bonding between methacrylate radicals from substrate resin and repair resin[23]. After this period, they were randomly allocated into five groups according to the following surface treatment methods (n=20):

Group C: control - no bonding agent application;

Group SB1: application of one coat of Single Bond (3M-ESPE, St. Paul, MN, USA) cured for 10 seconds;

Group SB2: application of two consecutive coats of Single Bond cured for 10 seconds;

Group SMP1: application of one coat of Scotchbond Multi-Purpose primer (3M-ESPE, St. Paul, MN, USA) with 5 seconds of delay, and followed by the SMP adhesive (3M-ESPE, St. Paul, MN, USA), cured for 10 seconds;

Group SMP2: application of one coat of Scotchbond

TABLE 1- Materials used in this study

Material	Manufacturer	Lot no.	Chemical composition
Filtek Z250	3M ESPE, St Paul, MN, USA	A1 - 0CJ C4 - 9AF	Bis-GMA, UDMA, Bis-EMA
Single Bond	3M ESPE, St Paul, MN, USA	9ED	Bis-GMA, HEMA, PAA, water, ethanol
Scotchbond Multi-Purpose Primer	3M ESPE, St Paul, MN, USA	0YE	HEMA, PAA, water
Scotchbond Multi-Purpose Adhesive	3M ESPE, St Paul, MN, USA	0LR	Bis-GMA, HEMA

Abbreviations: Bis-GMA: bisphenol-glycidil methacrylate; UDMA: urethane dimethacrylate; Bis-EMA: Ethoxylated bisphenol-A-dimethacrylate; HEMA: 2-hydroxyethyl methacrylate; PAA: polyalkenoic acid copolymer.

Multi-Purpose adhesive cured for 10 seconds, without previous application of the SMP primer.

Materials used and their chemical composition are described in Table 1.

Before the bonding procedure, each specimen's surface, including those of the control group, was air-abraded with 50-ìm aluminum oxide particles for 10 seconds (Microetch - Bioart, São Carlos, SP, Brazil). Then, they were rinsed with distilled water for 20 seconds and dried with compressed air for 10 seconds. The samples were cleaned with 35% phosphoric acid etchant (3M-ESPE, St. Paul, MN, USA) for 60 seconds, rinsed vigorously with tap water, and dried with oil-free compressed air. After the surface treatment, the bonding procedure was performed and each specimen was placed back into the mold with no spacer inserted. The repair composite was applied and cured as described above, completing repair procedure. A dark shade was chosen as the repair material (C4) and a lighter one as the substrate (A1) – so that there could be better assessment of the repair interface. Finishing procedures were made after 24 hours with a decreasing abrasive sequence of aluminum oxide disks (Sof-Lex - 3M-ESPE, St. Paul, MN, USA).

The repaired specimens were removed from the mold and stored in distilled water for 24 hours. The external surfaces of each sample were coated with two layers of nail varnish, with the exception of the side directly exposed to the curing light unit. Then they were thermocycled for 500 cycles between 5ºC (±2) and 55ºC (±2) with a one-minute dwell time at each temperature and then immersed for 4 hours in a 2% methylene blue buffered dye solution (pH 7.0).

Microleakage

The samples were transversely sectioned with a double-faced diamond disk (n.7020, KG Sorensen, Barueri, SP, Brazil). Three independent examiners measured the extent of dye penetration at the composite-repair interface in a stereoscope microscope (40x) according to the following scores:

0 = absence of dye penetration;

1 = up to ½ of repair interface;

2 = over ½ of repair interface, without total involvement;

3 = complete repair interface involvement.

The three evaluators were pre-calibrated before the onset of this project. The inter-rater reliability of the scores was expressed as Cohen's Kappa [14]. Data were analyzed statistically using a non-parametric Kruskal-Wallis test at a significance level of 5% [5, 8].

RESULTS

The overall values of the inter-rater reliability ranged from good to excellent (0.77 to 0.90 Kappa values).

The median scores of all experimental groups were not significantly different from one another (Kruskal-Wallis; p > 0.05). Results showed little or no dye penetration at the repair interface – including the control group (Score variation from 0 to 1) (Table 2).

DISCUSSION

Microleakage at the composite-repair interface can compromise the repair procedure, as the interfacial staining damages esthetics and the leakage leads to deterioration of the interface[4, 6, 17]. Therefore, repair techniques and materials chosen should be able to increase the repair strength and also to promote an adequate interfacial sealing.

This study was conducted to determine the effect of different bonding systems on the composite-repair microleakage. The evaluation comprised a single-component system, applied in one and two coats (Single Bond), a multi-component system (ScotchBond Multi-Purpose) and an unfilled resin (ScotchBond Multi-Purpose Adhesive). Single-component bonding agents seem to simplify the bonding procedures and save time, however there is little information about their performance on composite repair.

Results indicated that the bonding systems used (SB1, SB2, SMP1, SMP2) did not show a significant difference in dye penetration along the repair interface. All groups demonstrated a good interfacial sealing, presenting scores ranging from 0 to 1 – including the control group, only air-abraded with aluminum oxide particles.

A previous study demonstrated that microleakage at the composite-repair interface was not influenced by different surface treatments [3]. As bond application was standardized

TABLE 2- Distribution of dye penetration scores

Groups	Score			
	0	1	2	3
Control (C)	15	5	-	-
Single Bond 1 (SB1)	13	6	1	-
Single Bond 2 (SB2)	17	3	-	-
Scotchbond Multi-Purpose (SMP1)	16	4	-	-
Scotchbond Multi-Purpose Adhesive (SMP2)	20	-	-	-

* Kruskal-Wallis / p > 0.05

for all groups, those authors suggested that it may have been the main reason for the groups' behavior, masking possible effects of the surface treatments tested (air abrasion with 50-ìm aluminum oxide particles, roughing with diamond bur, and jet prophylaxis with sodium bicarbonate particles).

On the other hand, the present study indicated that air abrasion of the repair surface with 50-ìm aluminum oxide particles (control group) was also able to prevent dye penetration at the repair interface. This group presented no significant differences from the other experimental groups. Relating this results with those of the previous study[3], it can be suggested that both surface treatment (air abrasion) and bond application present good results, preventing microleakage at the composite-repair interface. In addition, considering that their association also enhances repair bond significantly[11, 18, 23], it should be established that both of them are essential to optimize the repair procedure.

Otherwise, the results of this study are for repaired specimens stored for 24 hours in water and aged by 500 thermal cycles. Longer storage or increased thermocycling may present other results[1,9]. Also, the relationship between microleakage and bond strength on the repair procedure remains undetermined. Therefore, further studies should be conducted to investigate the effect of these variables on composite repair.

CONCLUSIONS

Within the limitations of this *in vitro* study, the following conclusion may be drawn:

- The type of bonding system did not influence microleakage at the composite-repair interface.

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