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Influence of disinfectant solutions on the tensile bond strength of a fourth generation dentin bonding agent

Efeito de substâncias desinfetantes na adesão à dentina de um adesivo de quarta geração

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The purpose of the present study was to evaluate the influence of different disinfectant solutions on the tensile bond strength of a fourth generation dentin bonding agent. Forty non carious human molars were selected. Teeth were embedded in acrylic resin and ground until the exposure of a flat superficial dentin surface. Teeth were randomly divided in 4 groups and treated as follows: Group 1 – 2.5% NaOCl for 40 seconds; Group 2 – 2% chlorhexidine for 40 seconds; Group 3 – 1.23% acidulated fluoride for 4 minutes; and Group 4 – control (without disinfectant solution). Following treatments, Scotchbond Multipurpose Plus® (3M) was used according to the manufacturer's instructions. After that, the test specimens were built with composite resin (Z100®-3M), using a standard Teflon matrix. The specimens were stored in distilled water for 24 hours at a temperature of 37ºC. The tensile strength test was performed using a Mini Instrom testing machine. The mean values obtained for each group, in MPa, were: Group 1 – 7.37 (± 2.51); Group 2 – 11.25 (± 4.65); Group 3 – 9.80 (± 3.11); and Group 4 – 10.96 (± 3.37). The results were submitted to statistical analysis using the ANOVA test, and no statistical significant differences among the groups were found. It can be concluded that the different disinfectant substances used in this research do not adversely affect dentin adhesion.

UNITERMS: Dentin-bonding agents; Smear layer; Disinfectants.

INTRODUCTION

Success in operative dentistry depends on the total removal of the infected structures and on the achievement of a good sealing against microleakage. New generation dentin bonding agents has increased the bond strength between composite resin and tooth structure[8]. This improvement in adhesion have allowed to prevent marginal leakage, avoiding bacterial contamination, which could cause secondary caries and pulp alterations[11].

Secondary caries could also result from inadequate removal of bacteria after the initial preparation, especially when a good seal against microleakage is not obtained. BRANNSTROM[6] (1986) indicated that bacteria can multiply from within the smear layer even with a good seal from the oral cavity, and this can be a source of bacterial toxins, which can diffuse through the dentin causing irritation of the dental pulp. A method to determine the presence of infected dentin is the use of caries detecting solution[2,16]. However, a histological study by BOSTON; GRAVER[5] (1989) noted that the use of a dye does not correlate exactly with complete removal of bacteria-infected dentin. These investigators found that even after removal of the dentin stained with a 0.5% fuchsin dye in propylene glycol, 25% of teeth still had bacteria present as deep as 2.4 mm into dentinal tubules. It has also been shown by DEMARCO *et al.*[13] (1998) and PALMA *et al.*[22] (1998) that the use of caries detection solutions can adversely affect the adhesion to caries-unaffected and affected dentin *in vitro*.

An alternative approach to eliminate residual bacteria left in a cavity preparation would be the

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treatment with a disinfectant wash[19,26], and different antibacterial agents have been tested. MEIERS; SCHACHTEL[20] (1984) showed that a commercially available oral disinfectant can reduce the number of *S. mutans* found in occlusal fissures.

Chlorhexidine is an effective agent to disinfect dentin. SILVA *et al.*[27] (1998) reported a significant decrease in the number of bacteria in the dentinal tubules after application of 0.2% chlorhexidine for 5 minutes. It is also effective in reducing the levels of *S. mutans* found on exposed carious root surfaces[15].

It has been demonstrated that sodium hypochlorite has an efficient antibacterial effect caused by its high pH and by the release of oxygen and chlorine when contacting organic substrate[18]. Sodium hypochlorite is also used as a disinfectant and hemorrhage control solution, before the acid etching, when pulps are submitted to adhesive capping[1].

Fluoride based solutions have also been indicated as antibacterial agents to be used previously to cavity restoration[4]. An over 60% decrease in recurrent caries was observed when cavities were previously treated with a fluoride solution[2]. PIMENTA *et al.*[24] (1998) stated that fluoride deposition on the tooth/restoration interface could reduce microleakage and serve as a fluoride storage when the tooth was subjected to the cariogenic challenge.

Several papers have demonstrated that adhesion could be impaired by a series of previous treatments[13,14,25]. One of the problems, when using disinfectants previously to a dentin bonding agent, is that they may adversely affect the adhesion to dentin. The results in the literature are still controversial.

RABELLO, COELHO[26] (1998) found no adverse effect of chlorhexidine in the bond strength of an adhesive system. Similar results were found by DAMON *et al.*[12] (1997). When studying the effect of two disinfectant solutions, MEIERS; SHOOK[19] (1996) verified that the adhesion of a self-etching dentin bonding agent was affected, but the total etch dentin bonding agent suffered no influence of these solutions. TULUNOGLU *et al.*[30] (1998) found a remarkable increase in the microleakage of two dentin bonding agents (Prime & Bond 2.1 and Syntac) when cavities were previously treated with a chlorhexidine based solution.

The purpose of this study was to evaluate the influence of three different surface disinfectant substances on the tensile bond strength of a fourth generation dentin bonding agent to dentin.

MATERIAL AND METHODS

Forty caries-free human molars, recently extracted, were used. The teeth were embedded in acrylic resin, and then were ground with a polishing machine to create a flat superficial dentinal surface. A # 600 grit sand paper was used to create a smear layer on the dentinal surface. The teeth were randomly divided in 4 groups (n = 10) and treated as follows:

- Group 1: The dentin surface was treated with 2.5% sodium hypochlorite for 40 seconds, then the surface was washed with air/water spray.
- Group 2: 2% chlorhexidine (Concepsis®, Ultradent) was applied for 40 seconds on the dentinal surface and then washed with air/water spray.
- Group 3: The dentin was treated with 1.23% acidulated fluor phosphate gel at for 4 minutes, and then the gel was removed from the surface using a cotton pellet.
- Group 4: Dentin in this group received no treatment and was used as a control.

After the treatment with disinfectant solutions, the dentin bonding agent (Scotchbond Multipurpose Plus®, 3M Dental Products) was applied on all specimens, following manufacturer's instructions. First, the dentin was conditioned with 35% phosphoric acid, for 20 seconds, then it was washed with water and the surface was dried using an absorbent paper, in order not to over-dry the surface. The dentin primer was applied on the surface and left for 30 seconds, then the fluid resin was applied and light cured for 20 seconds. After that, the test specimens were built with composite resin (Z100®, 3M Dental Products), using an inverted cone shaped Teflon matrix, in which the bonding area had 3 mm in diameter, and the superior area, 6.5 mm. A standardized table was used to fix the specimens during the preparation of the samples. The composite resin was applied in three increments, each one being light cured for 40 seconds. The light source was a XL 1500® (3M), with an energy higher than 450 mm/mW, as measured by a curing radiometer (Demetron Corporation). After that, the test specimens were stored in distilled water for 24 hours at 37°C. Then, the tensile test was performed using a Mini Instrom testing machine, at a cross speed of 0.5 mm/min. The procedure used for the preparation of the test specimens and for the tensile test is presented in Figure 1. The results were obtained at the moment of the specimen fracture and calculated in MPa, according to the surface area of adhesion. Data were submitted to statistical analysis using ANOVA.

RESULTS

Since the data had a normal distribution, a parametric test was used (ANOVA). The mean results and the standard deviations (SD) for each group are listed in Table 1. When ANOVA test was performed, it was possible to see that none of the disinfectant solution had influence on the tensile bond strength of the dentin bonding agent tested ($p > 0.05$).

DISCUSSION

Secondary caries is the most common reason for the replacement of restorations[21]. It can be a result of the polymerization shrinkage, which originates a gap between the material and the tooth structure, allowing bacterial penetration[7]. Another source of secondary caries is the presence of bacteria in the smear layer, after cavity preparation, which can remain viable for long periods of time[6]. A disinfectant solution, which eliminates these residual bacteria, could be useful after cavity finishing. The efficacy of these disinfectant solutions have been reported in a series of studies[2,9,10,15,17,21,29]. As demonstrated by several papers[13,14,25], different surface treatments could cause a decrease in the adhesion of resinous materials. Thus, it could be supposed that disinfectant solutions may affect the mechanism of adhesion of dentin bonding agents.

In the present study, no significant difference was observed when dentin was treated with different disinfectant solutions prior to the use of a dentin bonding agent. This result is in accordance with that of previous papers published in the literature[12,19,23,26].

MEIERS, SHOOK[19] (1996) verified that two disinfectant substances had no influence on the dentin shear bond strength, when a total etch technique fourth generation adhesive system was used. PERDIGÃO *et al.*[23] (1994) have also obtained similar results when chlorhexidine was applied after the dentin acid etching. Similar results were found in other studies[12,26].

Opposingly, disinfectant substances may impair adhesion of the self etching dentin bonding agents[19]. Only one study[30] found increased microleakage in a total etch technique dentin bonding agent, after disinfectant solution application. However, the interference in adhesion seems to be related to dentin bonding agents from previous generations, which do not remove smear layer[19].

In our study, we employed Scothbond Multipurpose Plus® (SBMP), a fourth generation dentin bonding agent. SBMP is a total etch technique adhesive system, in which the acid etching is performed with 35% phosphoric acid. Acid etching promotes removal of the smear layer and demineralization of the subjacent dentin, exposing a collagen network. Following that, the hydrophilic primer and adhesive are applied, encapsulating the collagen and forming the hybrid layer[28]. Disinfectant solutions may act only on the smear layer or penetrate in the superficial dentin[29]. Thus, since the smear layer and the subjacent dentin are removed by the acid etching, the potential deleterious effect of the disinfectant solution on dentin bond strength can be avoided.

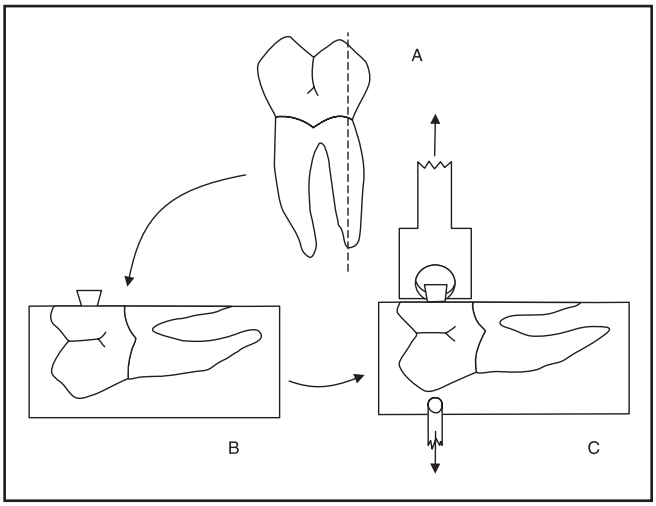

FIGURE 1 - Tensile test used. A. After enamel removal, the superficial dentin is exposed; B. After tooth embedding in acrylic resin, the test specimen is built with a standard matrix; C. Sample subjected to tensile test.

CONCLUSION

Based on the methodology used in the present study, it was possible to conclude that application of disinfectant substances caused no modification on the tensile bond strength of a fourth generation dentin bonding agent to dentin.

TABLE 1 - Means and Standard Deviations (SD) obtained for different groups in the tensile test.

	Mean (MPa)	SD
Group 1	7.37	± 2.51
Group 2	11.25	± 4.56
Group 3	9.80	± 3.11
Group 4	10.96	± 3.37

No statistical difference was found among the groups using ANOVA.

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O objetivo do presente trabalho foi avaliar a influência de diferentes substâncias de desinfecção cavitária na resistência à tração de um sistema adesivo de quarta geração. Foram selecionados 40 molares humanos livres de cáries. Os dentes foram incluídos em resina acrílica e desgastados até expor dentina superficial. Os dentes foram divididos aleatoriamente em 4 grupos e assim tratados: Grupo 1 – NaOCl a 2,5% por 40 segundos; Grupo 2 – clorexidina a 2% por 40 segundos; Grupo 3 – flúor-fosfato acidulado a 1,23% por 4 minutos; e Grupo 4 – controle. Após os diferentes tratamentos superficiais o sistema adesivo Scotchbond Multipurpose Plus® (3M) foi aplicado na dentina, de acordo com as instruções do fabricante. Os corpos-de-prova foram confeccionados com resina composta Z100® (3M) utilizando uma matriz padronizada. Após armazenagem em água destilada por 24 horas, os espécimes foram submetidos ao teste de tração em uma máquina universal Mini Instrom. Os resultados em MPa para os diferentes grupos foram: Grupo 1 – 7,37 (± 2,51); Grupo 2 – 11,25 (± 4,65); Grupo 3 – 9,80 (± 3,11); e Grupo 4 – 10,96 (± 3,37). Os dados foram submetido à análise estatística de variância, a qual não permitiu detectar diferenças estatisticamente significantes entre os grupos. Foi possível concluir que as substâncias desinfetantes não ocasionaram alteração na capacidade adesiva do sistema adesivo de quarta geração empregado.

UNITERMOS: Adesivos dentinários; Camada de esfregaço; Desinfetantes.

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