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Effect of filler and application mode on micro-shear bond strength of etch-and-rinse adhesive systems

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ABSTRACT

Objective: To evaluate the effect of the application modes and the presence of filler of etch-and-rinse adhesive systems on the micro-shear bond strength test (μSBS) to bovine dentin.
Methods: Twenty bovine teeth had the enamel removed and dentin surface exposed. Dentin was etched with 37% phosphoric acid and the following adhesive systems were applied: One Step and One Step Plus with two modes (no rubbing action and vigorous rubbing action). To each tooth six Tygon cylinders with internal 0.76 mm were filled with flowable composite resin. All cylinders were light polymerized for 40 s (Optilux 501). The μSBS was performed in a universal testing machine (Instron 5565), with specimens held in place by a wire (0.2 mm) loop, and force loaded to failure. The fracture mode was evaluated. The results in MPa were statistically analyzed by two-way ANOVA and Holm–Sidak tests ($\alpha = 0.05$).
Results: The two-way ANOVA detected no interactions between factors ($p = 0.865$), but only differences between the adhesive systems ($p = 0.042$) and application modes ($p = 0.014$). One Step Plus obtained a higher μSBS than One Step, and vigorous application increased bond strength of adhesives systems. The predominant failure modes of all groups were adhesive-mixed.
Conclusion: The adhesive systems showed the best μSBS results with presence of filler and active mode application.

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Efeito da carga e do modo de aplicação na resistência ao micro-cisalhamento de sistemas adesivos

Palavras-chave:
Adesivo
Técnica adesiva
Dentina
Resistência ao cisalhamento

RESUMO

Objetivo: Avaliar o efeito do modo de aplicação e da presença de partículas de carga de sistemas adesivos com condicionamento ácido total na resistência de união à dentina bovina.
Métodos: Vinte dentes bovinos tiveram o esmalte removido e a dentina exposta foi condicionada com ácido fosfórico a 37% onde os seguintes sistemas adesivos foram aplicados: One Step e One Step Plus aplicados de dois modos (sem agitação e com vigorosa agitação). Em cada dente foram confeccionados 6 cilindros de resina fluída através do preenchimento de microtubos plásticos (0,76 mm de diâmetro interno) que foram polimerizados por 40 s (Optilux 501). Os espécimes foram alocados em um dispositivo acoplado à uma máquina de ensaios mecânicos universal (Instron 5565), e um fio ortodôntico de 0,2 mm de diâmetro foi fixado à máquina e posicionado na interface adesiva ao redor do cilindro de resina e aplicada uma carga até o rompimento da união adesiva, para avaliação da resistência de união ao micro-cisalhamento. O modo de fratura foi analisado com lupa estereoscópica. Os resultados em MPa foram analisados estatisticamente pelo teste Anova de dois fatores e teste de Holm–Sidak para contraste de média (α=0,05).
Resultados: A análise estatística demonstrou que a interação dos fatores não foi significativa (p=0,865), havendo apenas diferença entre os adesivos (p=0,042) e modo de aplicação (p=0,014). O One Step Plus obteve os maiores valores de micro-cisalhamento quando comparado com o One Step, e o modo de aplicação vigoroso aumentou os valores de resistência adesiva dos materiais testados.
Conclusão: Os sistemas adesivos mostraram o melhor desempenho quando a carga estava presente e quando aplicados de forma vigorosa.

Introduction

In an effort to improve the mechanical properties of adhesives and minimize microleakage, discolorations and loss of retention, leading to restoration failure, some manufacturers have reinforced adhesives systems adding fillers to their formulation.[1] Therefore, this material could act as a stress absorbing layer due to its lower elastic modulus, allowing deflection between composite/dentin and improving marginal sealing. These features provide the advantage of better mechanical properties and high elasticity forces to compensate the resin polymerization contraction during restoration build-up and masticatory stresses.[2]

Unfilled adhesives provide lower mechanical properties and usually provide no radiopacity, which could mislead clinicians to interpret the adhesive radiotransparency as gap formation or recurrent caries at the restoration margin.[3]

On the other hand, adhesives with fillers have high viscosity, that make it difficult for the monomers to penetrate into the collagen fibers until it infiltrates into the dental tubules, and this correct infiltration is an essential factor to form the hybrid layer.[4–6] It has been shown that when unfilled adhesives are vigorously rubbed onto dentin surfaces, high immediate and long-term bond strengths to demineralized dentin can be obtained.[7,8] The application mode, particularly for systems containing fillers, could play an important role in the bonding process, if they are agitated on dentin during application in order to improve their properties.[2]

This application mode increases the bond strength because the diffusion rate of the monomer is a function of both penetrability into dentinal substrate and the diffusibility of the adhesive solution itself.[9,10]

For instance, it was demonstrated that application significantly improved the bond strength values for adhesive system,[11] however, unfortunately, the influences of bonding performance of adhesive with filler are unclear in the literature.

Therefore, the aim of the present study was to evaluate the effect of application mode (with and without agitation) on the microshear bond strength to bovine dentin of filled and unfilled two-step etch-and-rinse adhesive systems. The null hypothesis was that the application mode could not interfere in the bond strength of adhesives with and without filler.

Materials and methods

The roots of 20 bovine teeth kept in 0.5% chloramine T at 4 °C were sectioned using a diamond disk (Isomet 1000, Buehler; Lake Bluff, IL, USA) and the coronal pulpal tissue removed. The crowns portions were mounted in plastic rings with acrylic resin (Jet Clássico Ltda, São Paulo, SP, Brazil). The enamel was removed from the labial surface using 120-grit sand paper (Norton, São Paulo, SP, Brazil) under running water. The flat dentin surface was wet ground with 600-grit SiC abrasive paper (Norton, São Paulo, SP, Brazil) for 60 s to obtain a standard smear layer. After this, the teeth were randomly