

Shear Bond Strength of Enamel Surface Treated with Air-abrasive System

Maria Cristina BORSATTO¹
Alma Blásida Elisaur Benítez CATIRSE³
Regina Guenka PALMA DIBB²
Telma Nunes do NASCIMENTO²
Renata Andréa Salvitti de Sá ROCHA²
Silmara Aparecida Milori CORONA²

*Departments of ¹Clinical Pediatrics, ²Restorative Dentistry and ³Dental Materials and Prosthesis,
Faculty of Dentistry of Ribeirão Preto, University of São Paulo, Ribeirão Preto, SP, Brazil*

The aim of this study was to evaluate the shear bond strength of a composite resin to dental enamel, using three different surface treatments. Fifteen sound third molars were randomly assigned to three groups. The mesial and distal surfaces were flattened and covered using adhesive tape with a central orifice delimiting the adhesion area (7.07 mm²). Group I, the enamel surface was conditioned with 37% phosphoric acid for 15 s; group II, the surface was treated using air abrasion with aluminum oxide; group III, the enamel surface was treated using an association of air abrasion with aluminum oxide and 37% phosphoric acid. The Single Bond (3M) adhesive system was applied and a Teflon matrix was placed and filled with composite resin Z-100 (3M) and light-cured. The shear bond strength test was performed with a universal testing machine. The acid etching technique and air abrasion with aluminum oxide associated with acid etching had the highest shear bond strength values. Data were subjected to statistical analysis using ANOVA and the Tukey test, and no statistically significant difference in shear bond strength was observed between group I (12.49 ± 2.85 MPa) and group III (12.59 ± 2.68 MPa). In contrast, both groups had statistically better shear bond strengths compared to group II (0.29 ± 0.56 MPa; p<0.05). Air abrasion with aluminum oxide does not substitute acid etching. The association of these methods to obtain adequate adhesion to the substrate is necessary.

Key Words: aluminum oxide jet, shear bond strength, enamel.

INTRODUCTION

Knowledge of bonding mechanisms of adhesive restorative materials to the dental substrate, enamel and dentin has led to more favorable clinical results, increasing the longevity of preventive and restorative procedures.

Enamel surface treatment, using the acid etching technique introduced by Buonocore (1), induces microscopic roughness, increasing the available surface area making mechanical adhesion possible. New technologies have since been introduced, providing increased comfort to the patient and professional, as well as enhancing adhesion of restorative materials to the dental structure, decreasing pain sensitivity, and preserving a greater amount of healthy dental structure. These

techniques may be accomplished using various systems, such as laser therapy and the application of air abrasion with aluminum oxide, allowing the reduction of the problems of heat generation, vibration and other mechanical stimulation during cavity preparation (2,3).

The use of air abrasion with aluminum oxide basically consists of the application of an abrasive jet with particles of different diameters and may be indicated for the removal of caries and restorative materials, repair of ceramic restorations and surface treatment of enamel and dentin, in addition to the possibility of increasing adhesion of restorative materials to tissues (4-11).

Some studies (12-14) have observed that air abrasive technology has the potential to prepare enamel bonding surfaces similar to those obtained by acid

etching. In contrast, other studies (6,15-19) evaluating the shear bond strength of the composite resin to enamel, have reported that the application of only air abrasion with aluminum oxide alone does not provide the appropriate surface treatment, demonstrating low values when compared to the conventional acid etching technique. Due to these conflicting results, it is important to conduct a detailed study to better understand the mechanisms of adhesion to enamel when the aluminum oxide jet is used.

Thus the aim of the present study was to evaluate, *in vitro*, the effects of air abrasion, acid etching, and the combination of both procedures, on the shear bond strength of a composite resin to an enamel surface.

MATERIAL AND METHODS

Fifteen sound human third molars, extracted within a six-month period and stored in saline solution, were selected and cleaned with a water/pumice slurry in a dental prophylactic cup.

The roots were sectioned 3 mm below the cemento-enamel junction, pulp residues were removed and the mesial and distal surfaces of the crown were delineated using Dura White stones (Shofu Inc., Kyoto, Japan) before standardizing with wet sandpaper of decreasing granulations, #180 to 600, using a polishing machine (Politriz, Struers A/S, Copenhagen, DK-2610, Denmark). The specimens were washed and stored in distilled water, under refrigeration, for 24 h.

Prophylaxis was carried out with pumice for 20 s. The teeth were washed by air/water spray for 20 s, to remove pumice residues, and dried by air spray for 20 s. Adhesive tape with a central orifice of 3 mm in diameter was applied to the enamel surface to demarcate the area (7.07 mm) to be treated.

The teeth were then randomly divided into 3 groups of 10 samples each. Group I: The demarcated area was conditioned with 37% phosphoric acid gel for 15 s, washed with air/water spray for 20 s, and excess water was removed with absorbent paper, leaving a shiny aspect. Group II: The enamel surface was treated with an air-abrasive system (Kreativ Mach 4.1, New Image do Brazil, São Paulo, Brazil), with a 0.011-inch nozzle opening, using a 27.5 µm aluminum oxide particles stream at 60 psi air pressure with an intensity of 4 g/min, continuously, for 10 s. This treatment was accomplished at a distance of approximately 2 mm and at

an angle of 45° to the occlusal surface. The application of the aluminum oxide jet was accomplished inside a closed transparent acrylic box, to avoid particle aspiration by the operator. Group III: The enamel surface was treated with an association of aluminum oxide jet and 37% phosphoric acid gel. After the use of aluminum oxide, the specimens were washed, dried for 20 s, and etched with 37% phosphoric acid gel for 15 s.

Two layers of the bonding system (Single Bond, #18089, 3M Dental Products, St Paul, MN) were applied using a brush saturated with the bonding agent for each layer. The surface was then slightly dried for 5 s and light cured for 20 s.

After surface treatment, a Teflon matrix of 3 mm in diameter and 2 mm in height, was carefully placed on the area previously delimited and a hybrid light-activated composite resin (Z-100, #9CX, 3M) was carefully inserted into the matrix. The composite resin was light-cured for 40 s (XL 3000, 3M) with an output of 450 mW/cm² and the matrix was longitudinally sectioned with a scalpel. The specimens were subsequently stored in distilled water at 37°C for 4 h and before being subjected to a thermocycling regimen of 500 cycles in 5°C and 55°C waterbaths. Dwell time was 1 min with a 3-s transfer time between baths.

The specimens were included in gypsum, contained in a circular form, which was positioned perpendicular to the base. A space between the composite resin cylinder and the gypsum was carefully maintained. The teeth were then immersed in distilled water and stored at 37°C for 14 h. The samples were dried by air spray and submitted to the shear bond strength test (Universal Test Machine, EMIC, Equipamentos e Sistemas de Ensaios Ltda, São José dos Pinhais, PR, Brazil), with load cell of 50 kg and a cross-head speed of 0.5 mm/min. The composite resin shear strength was measured in Kgf and converted to MPa.

The data were submitted to analysis of variance ($p < 0.001$) and Tukey's test was used to detect differences in means ($p < 0.05$).

RESULTS

The analysis of the shear bond strength data showed that group I (37% phosphoric acid; 12.49 ± 2.84 MPa) was statistically similar to group III (air abrasion aluminum oxide + phosphoric acid; 12.59 ± 2.68 MPa) and both groups presented superior results

when compared to group II (aluminum oxide jet; 0.29 ± 0.56 MPa) ($p < 0.05$).

DISCUSSION

The results of the present study demonstrated that the application of an aluminum oxide jet in association with the acid conditioning of the enamel presented shear bond strength resistance values statistically similar to those obtained by acid conditioning. Both methods presented better results than the aluminum oxide jet used alone, in agreement with other studies (6,15-19). However, conflicting results have also been reported in the literature, (12-14) in which air abrasive technology was shown to prepare enamel bonding surfaces to the standard of those obtained by acid etching.

In the morphological analysis of the enamel surface, Katora et al. (20) observed the presence of superficial irregularities, altering the surface of the enamel when aluminum oxide jet was applied, and Dotty et al. (12) reported that the group conditioned with phosphoric acid presented a honeycomb aspect, with depths of 6 μm , and the group treated with the aluminum oxide jet presented an irregular pattern with medium depths of 4-15 μm , suggesting that the air abrasion technology may potentially prepare the surface of the enamel in a similar manner to acid conditioning. These findings may explain the results of the present study, where the association of the aluminum oxide jet with acid etching demonstrated statistical similarity to acid conditioning.

When the air abrasive system was used alone, similar results to those of Olsen et al. (16) and Mulcahey et al. (17) were obtained. These authors evaluated the shear bond strength of a composite resin to enamel and reported that surface preparation with an aluminum oxide jet results in a significantly lower bond strength than the conventional acid etching technique. Van Waveren Hogervorst et al. (18) observed that, under certain conditions, the enamel loss associated with sandblasting is equal to, or smaller than, that achieved with acid etching, and concluded that air abrasion with aluminum oxide is not an alternative for the acid etching technique.

The aluminum oxide jet can influence the resistance of the shear bond strength of the composite resin to enamel, making the use of acid etching necessary whenever the aluminum oxide jet is used. Canay et al.

(19) analyzed the tensile bond strength of composite resin enamel and observed that the highest tensile strength was obtained with air abrasion followed by acid etching. In spite of the fact that the methodology was different, the results of our study did not show any significant difference between the group that received acid etching and the group that received air abrasion with aluminum oxide followed by acid etching.

Further investigation focusing on the long-term effects of ultrastructural changes observed in enamel substrate treated by the air-abrasive system may lead to an improvement of shear bond strength, as well as to a more widespread applicability of these new technologies in clinical practice.

RESUMO

Borsatto MC, Catirse ABEB, Palma Dibb RG, do Nascimento TN, Rocha RASS, Corona SAM. Resistência ao cisalhamento na superfície do esmalte tratada com sistema de ar abrasivo. *Braz Dent J* 2002;13(3):175-178.

O presente estudo tem por objetivo avaliar a resistência ao cisalhamento da resina composta ao esmalte, utilizando três diferentes tratamentos de superfície. Foram utilizados 15 terceiros molares, divididos aleatoriamente em três grupos. As superfícies mesial e distal foram planificadas e cobertas utilizando uma fita adesiva, com um orifício central delimitando a área de adesão (7,07mm²). No grupo I, a superfície de esmalte foi condicionada com ácido fosfórico a 37%, durante 15 segundos; no grupo II, a superfície foi tratada utilizando-se do jato de óxido de alumínio; no grupo III, foi utilizada a associação de jato de óxido de alumínio e ácido fosfórico a 37%. O sistema adesivo foi aplicado e uma matrix de teflon foi colocada e preenchida com resina composta Z-100 (3M) e fotopolimerizada. A resistência ao cisalhamento foi avaliada com a Máquina de Ensaio Universal. Os maiores valores de resistência ao cisalhamento foram obtidos por meio do condicionamento ácido e da associação jato de óxido de alumínio com condicionamento ácido. Os dados obtidos foram submetidos a análise de variância e teste de Tukey, no qual observou-se que não houve diferença estatisticamente significativa na resistência ao cisalhamento entre o grupo I - 12,49MPa ($\pm 2,85$) and group III - 12,59MPa ($\pm 2,68$) e ambos os grupos apresentaram diferença estatisticamente significativa com o grupo II - 0,29MPa ($\pm 0,56$). Abrasão a ar com óxido de alumínio não substitui o condicionamento ácido, e é necessário a associação destes métodos para obter uma adequada adesão ao substrato.

Unitermos: jato de óxido de alumínio, resistência ao cisalhamento, esmalte.

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