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COMPARATIVE STUDY OF THE SHEAR BOND STRENGTH OF COMPOSITE RESIN TO DENTAL ENAMEL CONDITIONED WITH PHOSPHORIC ACID OR Nd:YAG LASER

ESTUDO COMPARATIVO DA RESISTÊNCIA À FORÇA DE CISALHAMENTO DA RESINA COMPOSTA AO ESMALTE DENTAL CONDICIONADO COM ÁCIDO FOSFÓRICO OU LASER Nd:YAG

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EDUARDO, C. P. *et al.* Comparative study of the shear bond strength of composite resin to dental enamel conditioned with phosphoric acid or Nd:YAG laser. **Rev Odontol Univ São Paulo**, v. 11, n. 4, p. 245-248, out./dez. 1997.

This study has been focused on a comparison between the shear bond strength of a composite resin attached to dental enamel surface, after a 35% phosphoric acid etching and after a Nd:YAG laser irradiation with 165.8 J/cm^2 of energy density per pulse. After etching and attaching resin to these surfaces, the specimens were thermocycled and then underwent the shearing bond strength tests at a speed of 5 mm/min. The results achieved, after statistical analysis with Student's t-test, showed that the adhesion was significantly greater in the 35% phosphoric acid treated group than in the group treated with the Nd:YAG laser, thus demonstrating the need for developing new studies to reach the ideal parameters for an effective enamel surface conditioning as well as specific adhesives and composite resins when Nd:YAG laser is used.
UNITERMS: Lasers; Phosphoric acids; Dental enamel; Acid etching, dental.

INTRODUCTION

The development of microporosities on the enamel surface has been described as being favorable to providing the adhesion of composites to dental structure.

BUONOCORE[3] (1955) described the enamel surface etching technique using 85% phosphoric acid. The concentration more often used nowadays is 35%. However, variations have been found from 10 to 37%.

More recently, various authors have been evaluating the feasibility of using the Nd:YAG laser irradiation on the dental enamel surface to form rough surface that will make it possible for the composites to attach to it, as reported by ABED *et al.*[1] (1990), HESS[7] (1990), MYERS; HESS[11] (1990), WHITE *et al.*[13] (1991), ROBERTS-HARRY[12] (1992), JAMJOUM; PEARSON[8] (1993), MYAKI *et al.*[10] (1994), and EDUARDO *et al.*[4] (1995), but this also applies to dentine, as reported by GUTNECHT; STRAUB[6] (1994). However, there is great divergence among the authors regarding the effectiveness of this kind of enamel surface treatment.

The purpose of this *in vitro* study is to compare the shear bond strength of a composite resin

with the dental enamel surface when 35% phosphoric acid is used and when the pulsed Nd:YAG laser using 165.8 J/cm^2 of energy density per pulse is applied. This parameter for laser irradiation has been described by EDUARDO *et al.*[4](1995).

MATERIAL AND METHODS

In this study, twenty impacted third molars, extracted by clinical indication, were kept in a physiological saline solution until the time of the experiment.

The teeth were divided into two trial groups.

In group 1 (n = 10), the specimens were previously subjected to a pumice paste prophylaxis with a low-speed handpiece. They were thoroughly washed with water and dried by air jets provided by a triple syringe. The specimens were then conditioned with a 35% phosphoric acid gel (*Vivadent*) for 30 seconds on the medium third of the buccal surface. The specimens were then washed with air-water spray for 30 seconds and then dried with air jets.

Group 2 specimens (n = 10) underwent the same previous prophylactic procedures as those in group 1. Since the Nd:YAG laser is better absorbed by the enamel on previously blackened surfaces, the specimens were painted with black India ink as recommended by MORIOKA *et al.*[9] (1984), on the medium third of the buccal surface. The Nd:YAG laser irradiation was then performed. The laser device was adjusted to emit a light beam with 165.8 J/cm^2 of energy density per pulse, 133 mJ of energy per pulse, mean power of 2.0 watts, 15 hertz for 30 seconds, pulse width of 150 m sec, keeping the fiber optics point perpendicular to the enamel surface and point by point scanning.

In both groups, a fine adhesive coat (*HelioBond*/Vivadent) was applied, photopolymerized for 30 seconds through an *Optilux 400* (Demetron) device with a light intensity of 400 mW/cm^2.

The composite resin (*Prisma TPH*/Dentsply) was attached to the enamel using a Teflon mould with a 5 mm diameter. The polymerization was performed for 60 seconds using the same previously described light unit.

All the specimens underwent a thermocycling process (700 cycles) at 5º and 55ºC temperatures and 1 minute immersion time to simulate weather aging conditions.

The shear bond strength test was conducted on a Wolpert Werke instrument (Germany) with a 5 mm/min crosshead speed.

RESULTS

The results achieved in the study of shear bond strength of the composite resin attached to dental enamel, subjected to statistical analysis with Student's t-test, demonstrated that the composite resin adhesion was significantly greater in group 1, treated with 35% phosphoric acid (21.22 MPa), than in group 2, which was conditioned by the Nd:YAG laser with 165.8 J/cm2 of energy density per pulse, 133.3 mJ of energy per pulse, mean power of 2.0 watts, 15 hertz during 30 seconds (2.06 MPa), as described in Table 1.

TABLE 1 - Shear bond strength values of the composite resin attached to dental enamel after etching with 35% phosphoric acid or Nd:YAG laser irradiation.

Treatment	Sher bond strengh (Mpa)
35% phosphoric acid	21.22
Nd:YAG laser	2.06

DISCUSSION

The use of different types of lasers for etching the enamel surfaces has been described in the last few years, there being, however, an agreement among the various authors who have assessed this technique as far as the comparison with acid etching is concerned.

After laser irradiation, depending on the type of energy density employed and the irradiation time, there may be a formation of several rough spots as a result of enamel melting and recrystallization, as demonstrated by HESS[7] (1990), MYERS; HESS[11] (1990), GROSS *et al.*[5] (1992), ARCORIA *et al.*[2] (1993), MYAKI *et al.*[10] (1994) and EDUARDO *et al.*[4] (1995). Although there is an agreement regarding the formation of a rough enamel surface, the same does not happen regarding the effective adhesion of composites to the enamel surface.

In this regard, HESS[7] (1990) noted that, after Nd:YAG laser irradiation with energy density of 95.5 J/cm^2, there is a formation of craters with diameters ranging from 230 to 250 m m. MYERS; HESS[11] (1990), using the Nd:YAG laser with an energy density of 100 J/cm^2, noted that the depth of these craters ranged from 40 to 50 m m. These depths are similar to those found in the group treated by phosphoric acid. ARCORIA *et al.*[2] (1993) assessed several laser treatments, such as the CO_2/Nd:YAG (CW), CO_2, Nd:YAG (CW), Nd:YAG (Q-switched), Argon (CW) and Ar:F excimer. They noticed that the CO_2/Nd:YAG laser irradiation produced a surface roughness similar to that of the acid etching, and that the irradiation with Ar:F excimer laser was the only one that did not show such characteristic.

The study by EDUARDO *et al.*[4] (1995) compared the morphological differences of the enamel surface etched with phosphoric acid and with the Nd:YAG laser with three different energy densities. They noted that the best results were achieved by using phosphoric acid and Nd:YAG laser with a 2.0 W power, 15 Hz during 60 seconds. Our study used these parameters for laser irradiation, applying 30 seconds of irradiation, instead of 60 seconds.

The results showed that the shear bond strength of the composite resin to dental enamel was significantly greater in the specimen group treated with phosphoric acid (21.22 MPa) than in the group treated with Nd:YAG laser (2.06 MPa), thus conforming to the results reported by JAMJOUM; PEARSON[8] (1993), who obtained 14.3 and 3.7 MPa, respectively.

The worse adhesiveness of the composite resin to dental enamel surface can be better understood if we refer to the study made by MYAKI *et al.*10 (1994). Although the authors used different parameters (0.75 W and 1.0 W power rates and 15 Hz frequency for 90 seconds), the enamel conditioning pattern, as seen through SEM, was similar to the one found by EDUARDO *et al.*4 (1995), who used the same parameters as in this study. MYAKI *et al.*[10] (1994) also noted that tag penetration of a pit and fissure sealant was more uniform in the group treated with phosphoric acid than in the groups treated with Nd:YAG laser. MATSUMOTO**** (1995) suggested that the irregular tag formation is caused by the laser pulsed irradiation, there being rough enamel zones with smooth enamel zones in between.

This study also showed the need to develop other studies in order to identify ideal parameters for an effective treatment of the dental enamel surface, as well as specific adhesives and composite resins to be used on the surfaces etched by Nd:YAG laser.

CONCLUSIONS

1. The shear bond strength of the composite resin attached to dental enamel was greater in the group treated with 35% phosphoric acid for 30 seconds (21.22 MPa) than in the group treated with Nd:YAG laser with 165.8 J/cm2 of energy density, 133 mJ of energy per pulse, mean power of 2.0 W, 15 Hz for 30 seconds, pulse width of 150 m sec (2.06 MPa).

2. New studies are required to determine the laser irradiation conditions at ideal levels to provide an effective adhesiveness of composites to the dental enamel surface. Furthermore

other types of adhesives and composite resins must be evaluated since they might interfere in the results.

EDUARDO, C. P. *et al.* Estudo comparativo da resistência à força de cisalhamento da resina composta ao esmalte dental condicionado com ácido fosfórico ou laser Nd:YAG. **Rev Odontol Univ São Paulo**, v. 11, n. 4, p. 245-248, out./dez. 1997.

Este estudo foi conduzido a fim de comparar a resistência à força de cisalhamento de uma resina composta aderida à superfície do esmalte dental após condicionamento com ácido fosfórico a 35% ou com a irradiação de um laser Nd:YAG, com densidade de energia de 165,8 J/cm2 por pulso. Após o condicionamento e a adaptação da resina a essas superfícies, os espécimes sofreram ciclagem térmica e foram, então, submetidos ao teste de resistência à força de cisalhamento em uma velocidade de 5 mm/min. Os resultados encontrados, após análise estatística pelo teste *t* de Student, revelaram que a adesão foi significantemente maior no grupo tratado pelo ácido fosfórico a 35% do que no grupo tratado pelo laser Nd:YAG, revelando, dessa forma, a necessidade do desenvolvimento de novos estudos, a fim de se alcançarem os parâmetros ideais para o condicionamento da superfície do esmalte, bem como adesivos e resinas compostas específicas, quando o laser Nd:YAG é utilizado.
UNITERMOS: Lasers; Ácidos fosfóricos; Esmalte dentário; Ataque ácido dentário.

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