Original Article

Effect of Air Abrasion and Erbium-Doped Yttrium Aluminum Garnet (Er: YAG) laser preparation on Shear Bond Strength of Composite to Dentin

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Abstract:

Introduction: The aim of this study was to assess shear bond strength of composite to dentin after air abrasion and laser treatment.
Methods: 40 human extracted molars divided into 4 groups (n=10) received the following treatments. Group 1: carbide bur, Group 2: air abrasion with aluminum oxide 50 µm, Group 3: irradiated with Erbium-Doped Yttrium Aluminum Garnet (Er: YAG) laser (150 mJ/20Hz), Group 4: irradiated with Er:YAG laser (150 mJ/20Hz)+ air. Specimens in all groups were chemically etched with phosphoric acid 37% and treated with bonding agent (single bond 3M). Then, composite build-up was performed by tygon tube. After storage in distilled water at 37°c for one week, all specimens were subjected to a shear bond strength test with universal testing machine. Data were analyzed with ANOVA and T-Test.
Results: The mean and standard deviation of shear bond strength of the 4 groups were 20.8±6.76, 14.98±3.98, 11.43±4.36 and 14.95± 3.18 MPa, respectively.
Conclusion: Air abrasion after laser treatment improved the shear bond strength.
Keywords: Er-YAG laser; dental air abrasion; dentin

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Introduction

Recently, development in caries removal techniques leads to minimally invasive protocols [1]. Efficacious and fast caries tissue removal accompanied by providing satisfactory cavity design and least smear layer production is considered as a main goal in restorative dentistry [2].

Nowadays, common caries removal procedure was done by carbide and diamond bur which induces some disadvantages like producing pain, vibration, noise and thermal changes resulting in pulp irritation. To eliminate these consequences, new methods such as air abrasion can replace them that form irregular rough surface and help to increase the wet ability of adhesive systems [3, 4]. Another alternative method is laser systems. Among different lasers, the Erbium laser family seems the most efficacious for dental hard tissue removal due to its peak absorption in water and hydroxyapatite without any damage to the pulp [5, 6]. Laser application for cavity preparation has some benefits such as no smear layer production, selective removal of tissue, no or least need for local anesthetic, inducing walls with high resistance to acid solution, reduction of recurrent

caries, no microfracture in dentinal surface and less postoperative hypersensitivity [7, 8].

Some studies showed that laser application caused lower bond strength of composite to dentinal surface [9, 10].

The aim of this study was to assess shear bond strength of composite to dentin after air abrasion and laser treatment.

Methods

40 caries-free extracted human third molars were selected for this study. The teeth with restorations, fractures and superficial defects were excluded. The teeth were stored in chloramines T 0.5%. Then, the samples were embedded in acrylic molds with size of 1 cm× 3 cm×3 cm.

The buccal surface of samples was abraded with silicone carbide 120 to 600 grit.

After abrading enamel, 0.5 mm of dentin surface was removed. Then, the samples were randomly divided in to four groups of 10 in each.

Group 1 (Bur): the surface was prepared by carbide bur size #0.8.

Group 2 (Air abrasion): the surface was air abraded by Al2O3 particle with size of 50μ from 6 mm above the surface with pressure of 50 Psi for 60 sec.

Group 3 (Er:YAG laser): the surface was prepared by Er:YAG laser (US20D, DEKA, Italy) with wavelength of 2940 nm, output power of 3W, energy of 150 mJ and frequency of 20 Hz for 20 sec. The irradiation was accompanied by water and air spray in non-contact mode with a distance of 4 mm above the surface and pulse duration of 450 μsec. The energy density was 30 J/cm^2.

Group 4 (Er:YAG laser + Air abrasion): the surface was irradiated by Er:YAG laser with same parameters of group 3. Then, the surface was air abraded as done in group 2 for 10 sec.

Then, the samples were acid-etched for 15 sec, rinsed for 10 sec and air-dried. In all samples, single bond was used and cured for 20 sec. Tygon tube with diameter of 3 mm was placed on dentin surface and filled incrementally by composite to produce a cylindrical shape with 3 mm height. After 24 hours, the tygon tube was removed and samples were placed in incubator (37ºC) for 1 week. Then, the shear bond strength of composite to dentin were measured by universal testing machine (STM, Santam, Tehran, Iran) with crosshead speed of 0.5 mm. The data were analyzed by 2-way Anova. T-test and bone feroni adjustment were used for evaluation of differences between groups.

Results

The mean and standard deviation of shear bond strength of 4 groups were 20.8±6.76, 14.98±3.98, 11.43±4.36 and 14.95± 3.18 MPa, respectively. Group 3 showed no significant difference with group 2 (P=0.054) and group 4 (P=0.987) but group 1 showed significant difference with group 3 (P=0.03) and group2 (P=0.02).

Discussion

Recently, new techniques were introduced for caries removal. One of the main goals in these techniques is providing less damage to tooth structure during caries removal [11, 12]. Among new techniques, Er:YAG laser showed promising results [13].

The results of present study showed that air abrasion after laser treatment could improve the effect of laser irradiation on surface and increase the shear bond strength up to air abrasion group.

In agreement with these results, Souza-Zaroni et al. in assessing shear bond strength of laser prepared teeth concluded that there was significant difference between shear bond strength of composite resin to dentin surface in laser and bur prepared groups [14].

This difference between bur and laser group can be attributed to morphological changes of dentin surface and mechanism of adhesion to dentin [15]. Tooth preparation by bur or air abrasion is accompanied by smear layer production. This layer contains enamel and dentin debris, caries particles and bacteria which prevents resin penetration in to dentinal tubules [16]. Acid-etching leads to smear layer and smear plug demineralization and increases porosity of intertubular dentin. Also, the surface energy of smear layer is low which results in lower tendency for adhesion to enamel or dentin [15]. When dentin surface is ablated by laser, no smear layer is produced and some melting area can be observed that decrease the penetration of adhesive agents. Also, irregularities prevent suitable wetting of surface by adhesive agents [14].

Ceballo et al. reported that dentin ablation by Er:YAG laser led to fusion and adhesion of collagen fibrils, so resin penetration to subsurface of interfibril space is limited that is considered as a main factor in

reduced shear bond strength of laser treated surface compared to acid-etched ones [15]. The mechanism of bonding in rotary and acid-etch technique is mainly micromechanical but in laser irradiated surfaces, it is related to penetration of resin tags into dentinal tubules that has a small portion in adhesive bonding forces in normal hybrid dentin [17]. Another reason for reduced bond strength is trapped water in irregularities formed by lasers. After air drying, it may remain and reduce the etching process [18, 19]. According to results, changes in superficial layer of dentin irradiated by laser did not provide suitable condition for composite bonding; therefore air abrasion as a conservative method was used for surface layer removal. Studies showed that air abrasion produced rough irregularities and developed the surface area followed by increase in mechanical retention and total surface, but there is a possibility that Al2O3 particles have a negative effect on penetration of adhesive to dentin which explained the lower shear bond strength of air abrasion group compared to bur group. SEM evaluation of air abraded surface showed smear layer that should be removed for higher bond strength [10].

As a final point, different parameters of Er:YAG laser in various studies were used with controversial results [10, 14]. There is need for more studies to standardize the parameters which are suitable for dentin preparation. Also, finding the adhesive agent that can best interact with laser prepared surface is required.

Conclusion

According to results, bur group showed the highest bond strength among groups. On the other hand, air abrasion after laser treatment improved the shear bond strength compared to laser group alone.

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