

Effect of different treatment on Surface Morphology of laser bleached teeth: SEM Evaluation

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Abstract

Objective: The aim of this study was to evaluate and compare the effect of dental surface treatment with Er:YAG , Nd:YAG ,CO2 lasers and sodium ascorbate to recently laser bleached enamel by scanning electron microscope (SEM).

Methods: 15caries-free extracted human third molars were selected for this study. The samples were bleached by Heydent JW power activated by diode laser 810 nm. After 7 day, the bleaching procedure was repeated as same as first time. Then, the samples were divided to five groups randomly as follow: Group 1: treated using Nd:YAG laser with output power of 1 W, Group 2: treated using Er:YAG laser with output power of 0.5 W, Group 3: treated using CO2 laser with output power of 0.5 W, Group 4: sodium ascorbate 10%, Group 5: no surface treatment. After treatments, the surfaces were evaluated using Scanning Electron Microscope (SEM) analysis.

Results: The surfaces treated by Nd:YAG laser showed some melting area but the surface treated by Er:YAG laser showed irregular and micro porous surface. CO2 laser treatment of surfaces resulted in melting of superficial layer of dental substrate and micro cracks. Sodium ascorbate did not change the surface except changes raised from bleaching.

Conclusion: Laser conditioning of laser-bleached teeth can be beneficial for enhancing bond strength of resin material to recently bleached enamel.

Key words: Er:YAG laser, Nd:YAG laser, CO2 laser, Sodium ascorbate, Scanning Electron Microscope.

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Introduction:

According to development in modern dentistry, providing esthetic of teeth for patients becomes more important. In esthetic dentistry scope, tooth whitening is one of the more requested procedures that can be done by several methods like scaling and root planning in combination with polishing, enamel micro abrasion, bleaching and application of veneers and resin restoration (1,2). Nowadays, bleaching as a chemical procedure is widely used in dentistry. This procedure can be influenced by concentration of bleaching materials, light source for activation, pH, the rate of reactions, etc (3).

In-office bleaching can be done by several energy sources to accelerate the chemical reactions. Energy can be delivered to bleaching gel through plasma-arc, halogen lamp, LED and lasers (4). Among different lasers used in dentistry, diode lasers are usually used for this purpose. The mechanism of laser-assisted bleaching is called photochemical reaction that results in production of singlet oxygen radicals which have the ability to remove stains(5). On the other hand, these radicals may prevent complete polymerization of adhesive and resin composites (6). So, after bleaching, the interval of 1 to 3 weeks should be considered to have higher bond strength (7). To reduce these problems, antioxidant agents such as sodium

ascorbate and other catalyzed enzymes are used, although they are not used routinely in clinical procedures. (8,9). Recently, lasers can be used for different purposes in restorative dentistry like caries removal, surface conditioning, etc (10). Apart from their modifications on dental substrates; the application of lasers can produce heat on surface that may neutralize the radicals produced from bleaching process and enhance bond strength of resin material to recently bleached teeth (1). The aim of this study was to evaluate and compare the effect of dental surface treatment with Er:YAG, Nd:YAG, CO₂ lasers and sodium ascorbate to recently laser bleached enamel by scanning electron microscope (SEM).

Methods:

Fifteen caries-free extracted human third molars were selected for this study. The periodontal scaler (Sonic flex 2000, kavo, Biberach, Germany) was used to remove remaining tissues. All teeth were disinfected in 0.5% chloramine T solution (Chloramin T Trihydrat, Merck schucharat OHG 85662 Hohenbrunn, Germany) and then stored in 4°C distilled until use.

The teeth were examined under stereomicroscope (Nikon C-DS, Tokyo, Japan) with x50 magnification to exclude samples with fractures and hypoplastic lesion.

The samples were bleached by Heydent JW powder (production of frafan diagnostics co, Tehran-Iran, under license of Heydent, Germany) activated by diode laser 810 nm (CheeseTM, Wuhan Gigaa Optronics Technology Co, LTD, China). After combination of powder and liquid of bleaching pack according to manufacture's instruction, the thin layer of bleaching gel with thickness of 2mm was place on buccal surface of each tooth. Then, diode laser with wavelength of 810 nm and fiber of 600 μ was moved above the surface with distance of 6 mm. The output power of 1W in continuous mode was used. The irradiation time was 1 minute and the gel remained without irradiation for 3 minutes. This procedure was done 2 more times. Then, the samples were kept in artificial saliva. The solution was replaced every day. After 7 days, the bleaching procedure

was repeated as same as first time.

Then, the samples were divided to five groups randomly as follow:

Group 1: treated using Nd:YAG laser (FIDELIS, Fotona, Slovenia) with output power of 1 W, frequency of 10 Hz and pulse duration of 100μs with fiber of 300μm

Group 2: treated using Er:YAG laser (USD20, DEKA Dental laser systems, Florence, Italy) with output power of 0.5 W, frequency of 10 Hz and pulse duration of 230 μs in non-contact mode with distance of 4 mm above the surface

Group 3: treated using CO₂ laser (US-20D, DEKA Dental laser systems, Florence, Italy) with output power of 0.5 W, frequency of 10 Hz and pulse duration of 1.5 ms, non-contact mode with distance of 12.5 mm above the surface.

Group 4: sodium ascorbate 10% (Merck Darmstadt, Germany), 10 ml of solution with speed of 1 ml/min was poured on the surface of teeth for 10 min, then the enamel surface was rinsed with distilled water and dried.

Group 5: no surface treatment (control group)

After treatments, the surfaces were evaluated using Scanning Electron Microscope (SEM) analysis. Samples were fixed in 2.5% Glutaraldehyde for 12 hours (4°C), and then dehydrated in ascending grades of ethanol (25%, 50%, 75%, 90% and 100%). After that, the samples were dried and sputter-coated with gold. Finally, prepared surfaces were analyzed with a scanning electron microscope (FESEM, Hitachi S4160, Japan) at ×200 and ×2000 magnification.

Results:

The surfaces treated by Nd:YAG laser showed some melting and crystallized area (Fig.1,2). The surface treated by Er:YAG laser showed irregular and micro porous surface, the rough surface produced by this laser is characterized by flake pattern (Fig.3,4). CO₂ laser treatment of surfaces resulted in melting of superficial layer of dental substrate and micro cracks and also blistering area (Fig.5,6). Sodium ascorbate did not change the surface except changes arised from bleaching (Fig.7,8). Morphological changes in laser bleached teeth without any

surface treatment showed superficial dissolution and mild porous surface(Fig.9.10)

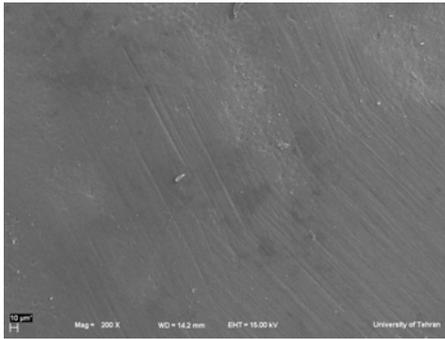


Figure 1- surface treated by Nd:YAG laser (Original magnification x200, bar=10µm)

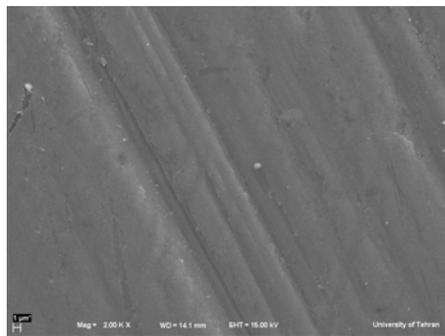


Figure 2- Surface treated by Nd:YAG laser (Original magnification x2000, bar=10µm)

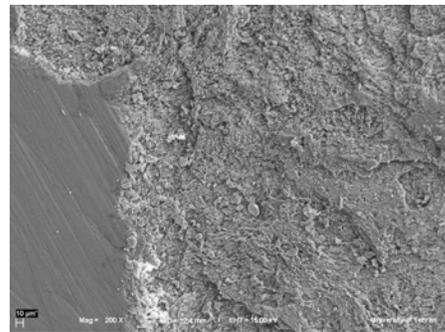


Figure 3- Surface treated by Er:YAG laser (Original magnification x200, bar=10µm)

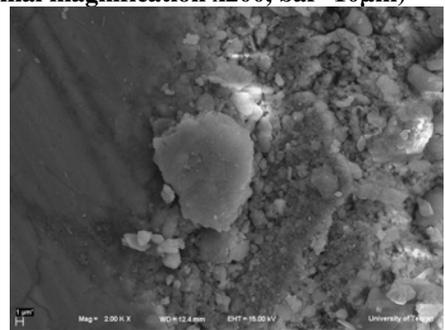


Figure 4- Surface treated by Er:YAG laser (Original magnification x2000, bar=10µm)

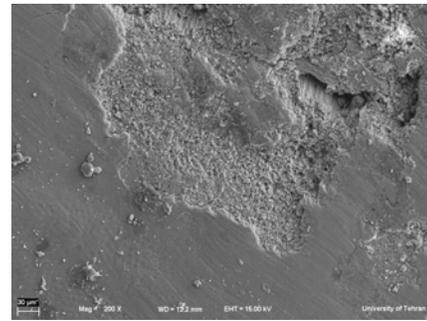


Figure 5- Surface treated by Co2 laser (Original magnification x200, bar=10µm)

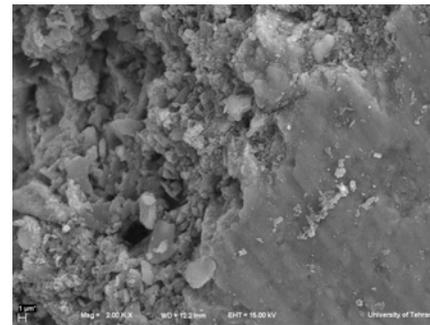


Fig.6: surface treated by Co2 laser (Original magnification x2000, bar=10µm)

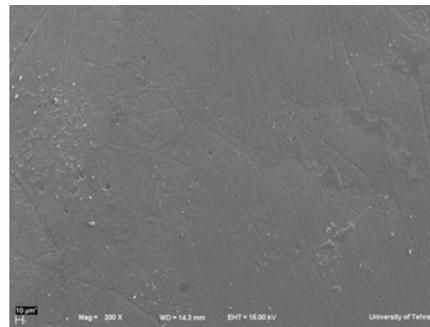


Figure 7- Surface treated by ascorbate (Original magnification x200, bar=10µm)

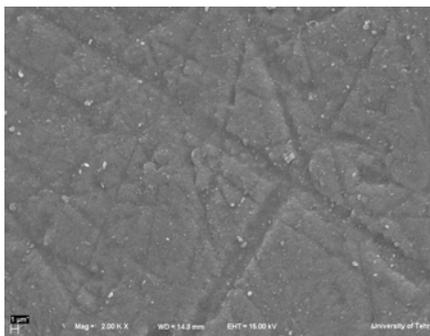


Figure 8- Surface treated by ascorbate (Original magnification x2000, bar=10µm)

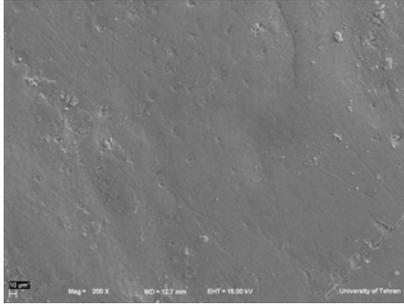


Figure 9- No treatment (Original magnification x200, bar=10µm)

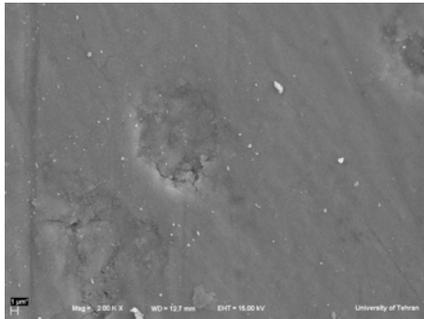


Figure 10- No treatment (Original magnification x2000, bar=10µm)

Discussion:

Aesthetic dentistry is usually considered dental bleaching followed by resin materials restoration (11). Dental bleaching leads to morphological changes in enamel and dentin like calcium and phosphate loss and changes in enamel crystal in surface, organic matrix destruction and oxygen accumulation in dental surface (12). These consequences followed by decrease in bond strength of materials to dental surface. So, different surface modifications should be done to eliminate these problems.

Er:YAG laser has a high absorption in water which followed by vaporization of hydrated

components results in micro explosion of inorganic substances which finally caused ablation of dental hard tissues (13). SEM images showed irregular surfaces with some melting area due to heat production in superficial layer of tooth that can eliminate the oxygen. The application of Nd:YAG laser on enamel surface produced changes in enamel morphology like fusion and recrystallization of surface due to alternation in organic components. These melting areas implicated that the heat produced on surface which is favorable for elimination of residual oxygen (9).

CO₂ laser has a peak absorption in hydroxyapatite and can melt the surface but in most conditions, it causes carbonization, fissures and cracks due to thermal side effects. So, the superficial temperature rise can reduce oxygen radical but side effects can affect the bond strength (14).

Sodium ascorbate has the ability to reduce oxidative components like free radicals of oxygen (15). The SEM images showed no alternation on surface compared to control group (no treatment).

More studies are needed to find the best pretreatment for elimination of residual oxygen after bleaching and also the materials that can best interact with pretreated bleached teeth.

Conclusion:

According to SEM images, except CO₂ laser which accompanied by side effects, other techniques, can be beneficial for oxygen reduction on bleached enamel surface due to enamel alternation through heat production and enhance bond strength of resin materials.

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