Journal of Lasers in Medical Sciences
J Lasers Med Sci 2015 Autumn;6(4):171-173
Original Article
http://www.journals.sbmu.ac.ir/jlms
doi 10.15171/jlms.2015.14

Amalgam Surface Treatment by Different Output Powers of Er:YAG Laser:SEM Evaluation

Mohammad Hashem Hosseini[1], Mehdi Hassanpour[2], Ardavan Etemadi[3], Ladan Ranjbar Omrani[4], Hojat Darvishpour[1], Nasim Chiniforush[3*]

[1]Department of Orthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran
[2]Department of Orthodontics, School of Dentistry, Qom University of Medical Sciences, Qom, Iran
[3]Laser Research Center of Dentistry, Dental Research Institute, Tehran University of Medical Sciences, Tehran, Iran
[4]Department of restorative, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

***Correspondence to**
Nasim Chiniforush, DDS; PhD Candidate of Laser Dentistry, Laser Research Center of Dentistry, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.
Tel: +98-2188994824;
Fax: +98-2188994824;
Email: n-chiniforush@farabi.tums.ac.ir

Published online 27 October 2015

Abstract

Introduction: The purpose of this study was to evaluate amalgam surfaces treated by different output powers of erbium-doped yttrium aluminum garnet (Er:YAG) laser by scanning electron microscope (SEM).

Methods: Twenty-one amalgam blocks (8 mm × 8 mm, 3 mm thickness) were prepared by condensing silver amalgam (into putty impression material. After keeping them for 24 hours in distilled water, they were divided into 7 groups as follow: G1: Er:YAG laser (1 W, 50 mJ), G2: Er:YAG laser (2 W, 100 mJ), G3: Er:YAG laser (3 W, 150 mJ), G4: Sandblast, G5: Sandblast + Er:YAG laser (1 W, 50 mJ), G6: Sandblast +Er:YAG laser (2 W, 100 mJ) and G7: Sandblast +Er:YAG laser (3 W, 150 mJ). Then after preparation of all samples, they were examined by SEM.

Results: The SEM results of amalgam surfaces treated by different output powers of Er:YAG laser showed some pitting areas with non-homogenous irregularities

Conclusion: It seems that the application of sandblasting accompanied by Er:YAG laser irradiation can provide proper surface for bonding of orthodontic brackets.

Keywords: Amalgam; Orthodontic bracket; Er:YAG lasers.

Introduction

Recently, orthodontic treatment has increased among adults. Most of these patients have amalgam restorations on posterior teeth which are considered a big challenge for orthodontist regarding the bonding procedure.[1,2]

In order to achieve desirable bonding to amalgam, different studies were performed including various surface treatments and the application of different types of resins and adhesives.[3,4]

Surface treatment can be done by diamond bur, sandblasting, and chemical corrosion to improve bonding to amalgam surface.[5]

The application of lasers for treatment of dental substrate has gained special attention. Among different lasers, Erbium family lasers are used for treatment of dental hard tissues.[6]

It was shown that erbium-doped yttrium aluminum garnet (Er:YAG) laser with a wavelength of 2940 nm can ablate amalgam surface and produce micro craters.[7] On the other hand, Oskoee et al[8] in assessing the bonding of orthodontic brackets to silver amalgam treated by erbium, chromium doped yttrium scandium gallium garnet (Er-Cr:YSGG) laser compared to the sandblasting technique concluded that laser treatment increased the shear bond strength of stainless steel orthodontic brackets to amalgam restorations.[8]

The aim of this study was to evaluate amalgam surfaces treated by different output powers of Er:YAG laser by scanning electron microscope (SEM).

Methods

Twenty-one amalgam blocks (8 mm × 8 mm, 3 mm thickness) were prepared by condensing silver amalgam (Kerr, Germany) into putty impression material (Speedex, Colten, Switzerland) and burnishing with instruments. The samples were kept in distilled water at room temperature for 24 hours. Then, the samples were randomly divided into 7 groups (Table 1).

Er:YAG laser was used with a pulse rate of 20 Hz, 4 mm above the surface accompanied by water and air spray in all laser groups. Pulse duration was 230 µsec in all groups. All the surface area was treated by laser with a beam diameter of 1 mm.

Sandblasting was done with Al_2O_3, particle size 50 µ, from 10 mm above the surface, with a pressure of 60 Psi for 5 seconds.

In G5, G6 and G7, laser irradiation was done after sandblasting. Then, all samples were prepared for SEM (TES-

Please cite this article as follows: Hosseini MH, Hassanpour M, Etemadi A, Ranjbar Omrani L, Darvishpour H, Chiniforush N. Amalgam surface treatment by different output powers of Er:YAG laser:SEM evaluation. *J Lasers Med Sci.* 2015;6(4):171-173. doi:10.15171/jlms.2015.14.

CAN VEGA, USA) evaluation at x1000, x2000 and x5000.

Results

The SEM results of amalgam surfaces treated by different output powers of Er:YAG laser showed some pitting areas with non-homogenous irregularities (Figures 1-3).

Figure 4 showed sandblasted amalgam surface with scratch- like irregularities.

More irregularities were achieved in sandblast + laser irradiation (Figures 4-6).

Table 1. Study Groups

Groups	Treatment
G1	Er:YAG laser (1 W, 50 mJ)
G2	Er:YAG laser (2 W, 100 mJ)
G3	Er:YAG laser (3 W, 150 mJ)
G4	Sandblast
G5	Sandblast + Er:YAG laser (1 W, 50 mJ)
G6	Sandblast +Er:YAG laser (2 W, 100 mJ)
G7	Sandblast +Er:YAG laser (3 W, 150 mJ)

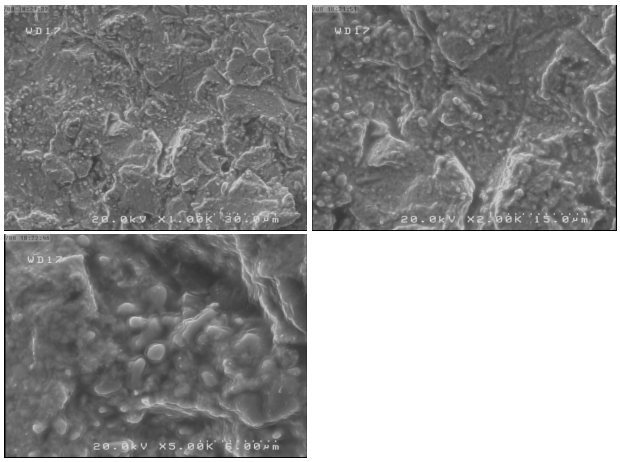

Figure 1. Amalgam surface treated by Er:YAG laser with output power of 1 W, 50 mJ (Original magnification x1000, x2000, and x5000).

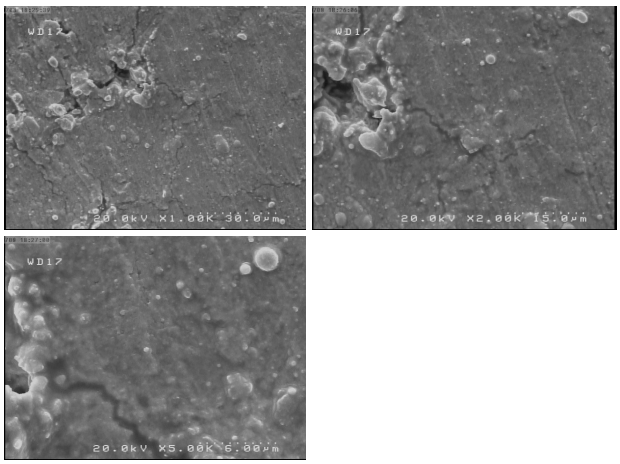

Figure 2. Amalgam surface treated by Er:YAG laser with output power of 2 W,100 mJ (Original magnification x1000, x2000, and x5000).

Discussion

Providing suitable bond strength between brackets and amalgam is one of the challenging problems in orthodontics.[9]

The purpose of this study was to evaluate amalgam surfaces treated by different powers of Er:YAG laser compared to laser irradiation following sandblasting in a qualitative manner.

Sandblasting is a conventional method for surface treatment. Amalgam surface after sandblasting showed scratched irregularities that may have positive effect on achieving higher bond strength. Several studies showed that this method can be beneficial for providing enough bond strength.[10, 11]

Skilton et al[12] in assessing the shear bond strength of brackets bonded to amalgam surfaces roughened by diamond bur or sandblasted by aluminum oxide concluded that sandblasting is more effective for providing higher shear bond strength compared to bur.

Er:YAG laser can ablate amalgam, which was reported by

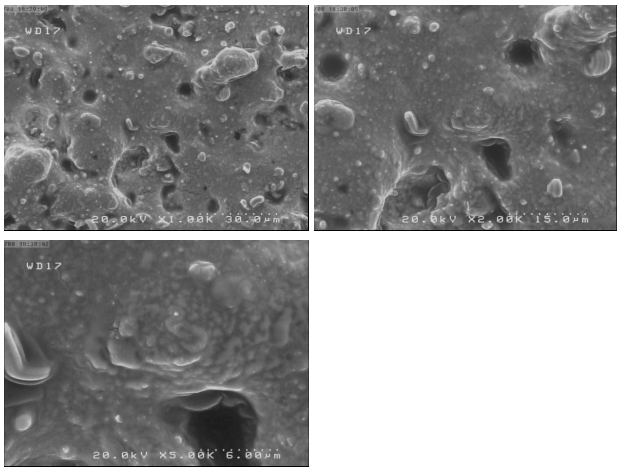

Figure 3. Amalgam surface treated by Er:YAG laser with output power of 3 W, 150 mJ (Original magnification x1000, x2000, and x5000).

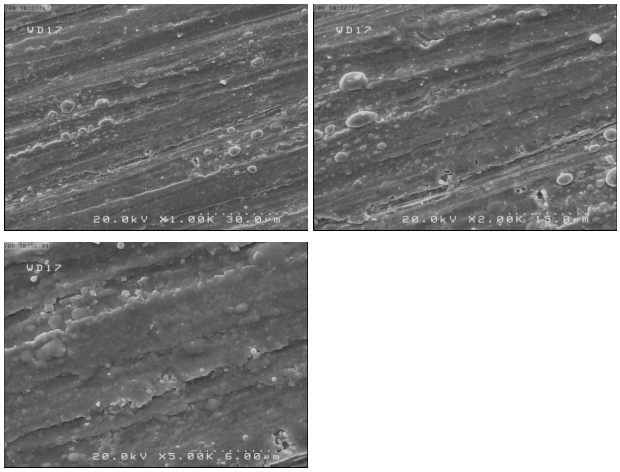

Figure 4. Amalgam surface sandblasted (Original magnification x1000, x2000, and x5000).

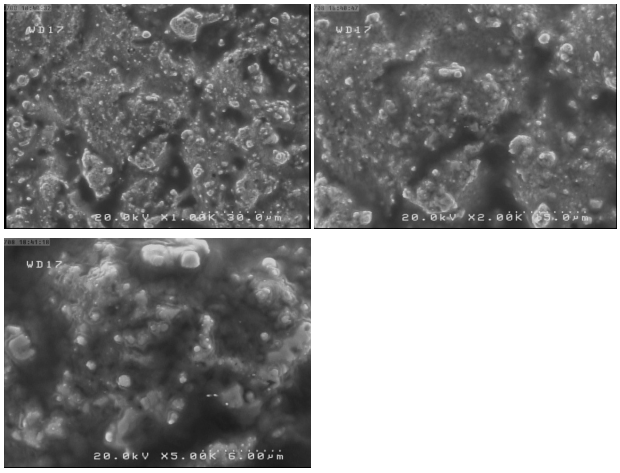

Figure 5. Amalgam surface sandblasted + Er:YAG laser irradiation with output power of 1 W, 50 mJ (Original magnification x1000, x2000, and x5000).

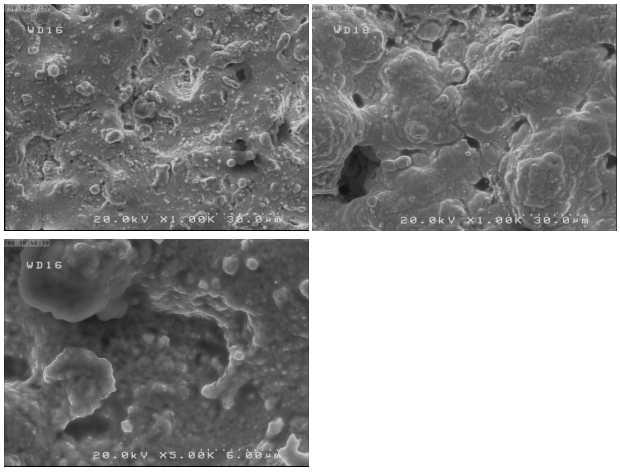

Figure 6. Amalgam surface sandblasted + Er:YAG laser irradiation with output power of 2 W, 100 mJ (Original magnification x1000, x2000, and x5000).

Hibst and Keller. Water irrigation does not have an effect on ablation efficacy. It can just control the temperature rise.[7] SEM images showed micro-irregularities after laser irradiation on amalgam surfaces.

Oskoee et al[8] in the evaluation of Er;Cr:YSGG laser on conditioning amalgam surfaces for bracket bonding compared to sandblasting technique came to the conclusion that erbium laser had positive effect on shear bond strength of brackets to amalgam.

Despite surface evaluation, mercury vapor release during laser ablation should be considered as a hazardous factor for dental staffs.[13]

Further studies are needed to assess the bond strength of orthodontic brackets to amalgam restorations besides mercury vapor release and thermal changes evaluation.

Conclusion

Based on SEM results, the application of sandblasting technique accompanied by Er:YAG laser irradiation can provide suitable surface for bonding of brackets.

Conflict of Interest

The authors have no conflict of interest to declare.

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