Original Article

Effect of Laser Treatment on Surface Morphology of Indirect Composite Resin: Scanning Electron Microscope (SEM) Evaluation

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Abstract:

Introduction: The aim of this study was to evaluate and compare the Scanning electron microscope (SEM) of indirect composite conditioned by Erbium-Doped Yttrium Aluminum Garnet (Er:YAG) laser, Neodymium-Doped Yttrium Aluminium Garnet (Nd:YAG) laser and Carbon Dioxide (CO_2) laser.
Methods: 18 indirect composite blocks (GC Gradia DA2, Japan) with 15 × 10 × 10 mm dimensions were made. The bonding surface of these blocks were polished, then the samples were divided into six groups as follow: Er:YAG laser with output power of 0.5 W and frequency of 10 Hz, Nd:YAG laser with output power of 0.25, 0.5 W and frequency of 10 Hz, CO_2 laser with output power of 0.5 W and frequency of 10 Hz and 5 Hz, and no treatment. Then, the surfaces were evaluated by SEM.
Results: Irregularities were observed in Er:YAG laser samples compared to control group that produced suitable retention for adhesion of cements. Nd:YAG and CO_2 lasers showed melting areas.
Conclusion: Among different lasers, Er:YAG laser can be used as an alternative technique for surface treatment of indirect composites.
Keywords: Er:YAG laser; Nd:YAG lasers; CO_2 laser

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Introduction

According to development in bonding systems, curing procedure and mechanical characteristics of resin systems, newer generation of composite resins shows more wear resistance and color stability than older ones but polymerization shrinkage is still an important problem in adhesive techniques[1-3].

Indirect composites are designed to overcome limitations of direct composites such as polymerization shrinkage and conversion degree to improve mechanical features of this extra-oral procedure, thus providing better proximal contacts, better morphology and occlusal adjustment can be achieved by these materials[4-7].

Post curing in higher temperature leads to more release of stress in direct composites rather than indirect ones. This reduced stress results in better bonding and improved sealing[8].

Clinical application of indirect composites depends on bonding of cement to teeth and material, achieving this adhesion is very difficult[9].

Primary purpose in cementation process is providing stable bonding and marginal adaptation to teeth and restorations. Resin cement by distribution of stress in interface of resin and restoration leads to optimum bond to indirect composites[10,11].

Surface treatment of indirect composites can be done by several techniques like sand blasting, HF, silane, etc. The application of silane leads to chemical adhesion between organic fillers and organic matrix[4,12].

Laser is one the methods of surface treatment used for improving micromechanical retention and bond strength of resin cement to composites[13].

The aim of this study was to evaluate and compare the Scanning electron microscope (SEM) of indirect composite conditioned by Erbium-Doped Yttrium Aluminum Garnet (Er:YAG) laser, Neodymium-Doped Yttrium Aluminium Garnet (Nd:YAG) laser and Carbon Dioxide (CO_2) laser.

Methods

18 indirect composite blocks (GC Gradia DA2, Japan) with 15× 10 × 10 mm dimensions were made in glassy mold according to manufacturer's instruction. The bonding surface of these blocks were polished using 600 grit silicon sandpaper for 15 seconds under running water to make an even surface. Then, the samples were divided to six groups as follow:

Group 1: treated using Er:YAG laser (2940D plus, Deka, Italy)with output power of 0.5 W and frequency of 10 Hz

Group 2: treated using Nd:YAG laser (Fotona, Slovenia) with output power of 0.25 W and frequency of 10 Hz

Group 3: treated using Nd:YAG laser with output power of 0.5 W and frequency of 10 Hz

Group 4: treated using CO_2 laser (Smart US20D, Deka, Italy) with output power of 0.5 Wand frequency of 10 Hz

Group 5: treated using CO_2 laser with output power of 0.5 W and frequency of 5Hz

Group 6: For this group no surface treatment was done as a control group.

After laser treatment, the surfaces were evaluated using Scanning Electron Microscope (SEM) analysis. Samples were fixed in 2.5% Glutaraldeheyde 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 at ×500, ×1000 and ×5000 magnification.

Results

The surfaces treated by Er:YAG laser showed irregular and micro porous surfaces. The surfaces treated by Nd:YAG laser also showed some irregularities but melting areas could be observed. CO_2 laser treatment of surfaces resulted in melting of superficial layer of materials (Figures 1-6).

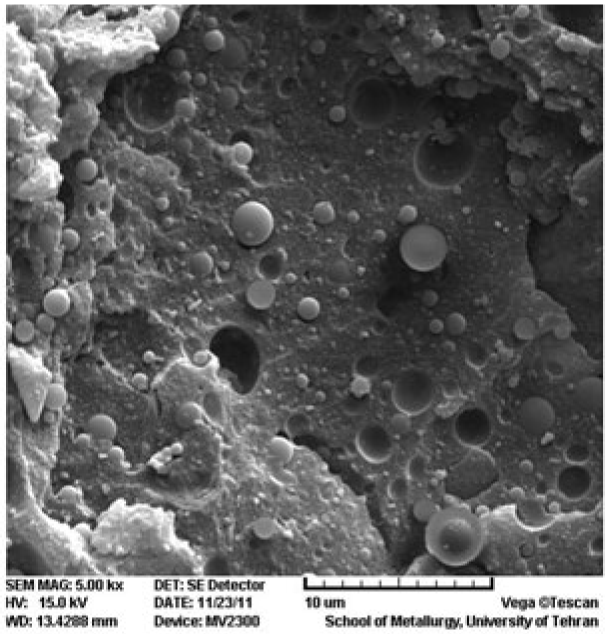

Figure 1. Surface treated by Er:YAG laser with output power of 0.5 W (Original magnification ×5000, bar=10μm)

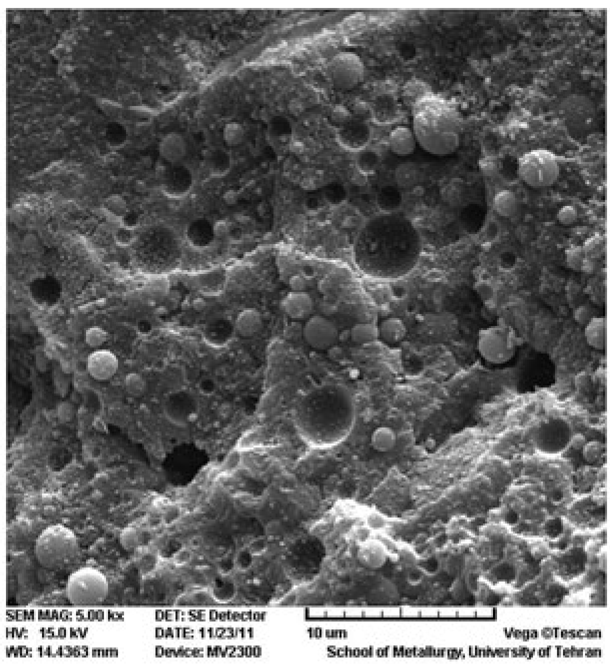

Figure 2. Surface treated by Nd:YAG laser with output power of 0.25 W (Original magnification ×5000, bar=10μm)

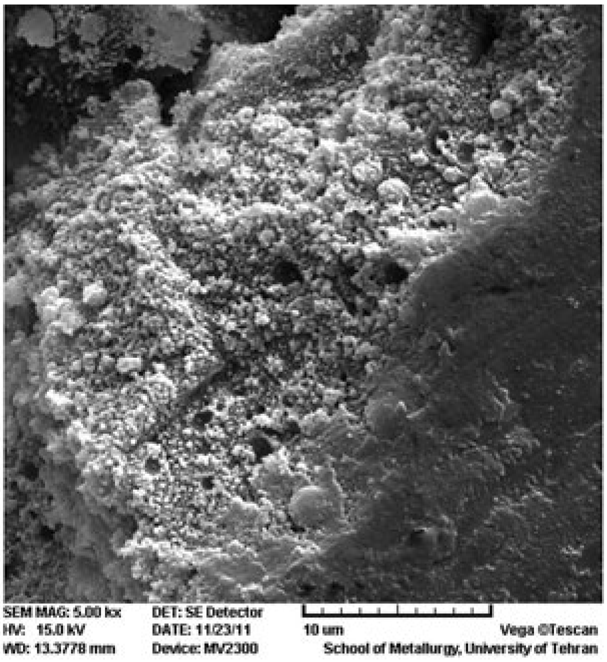

Figure 3. Surface treated by Nd:YAG laser with output power of 0.5 W (Original magnification ×5000, bar=10μm)

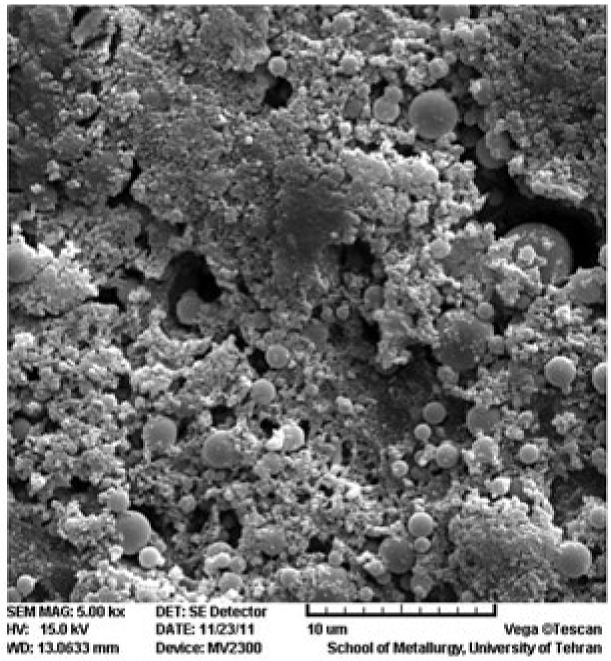

Figure 4. Surface treated by CO_2 laser with output power of 0.5 W and frequency of 10 Hz (Original magnification ×5000, bar=10μm)

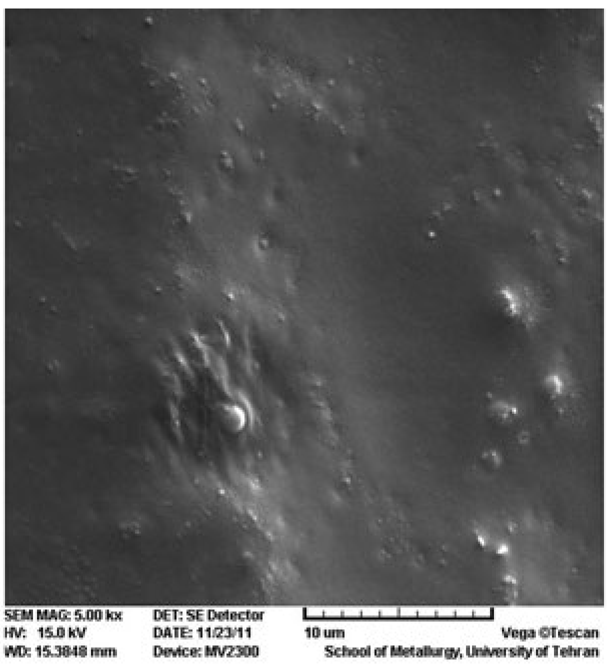

Figure 5. Surface treated by CO_2 laser with output power of 0.5 W and frequency of 5 Hz (Original magnification ×5000, bar=10μm)

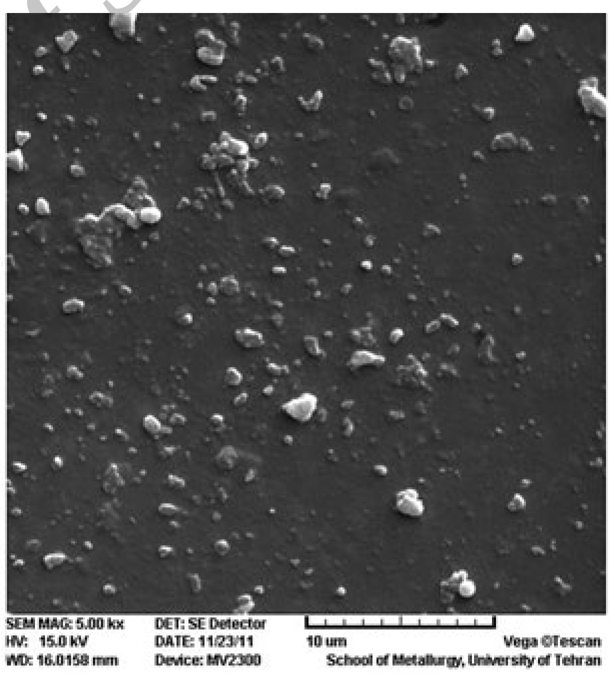

Figure 6. No surface treatment (Control group)

Discussion

An ideal adhesive material should present no shrinkage during polymerization and have physicochemical properties similar to dental hard tissues[14]. Some studies have shown that laboratory Processed composites showed 25-80% decrease in bond strength[15].

To enhance the bond strength, the surface of restorations should become rough enough. Therefore, mechanical retention can be provided and more number of free carbon bonds on surface can be made available[16].

The utilization of Er:YAG laser in dental hard tissues is considered efficient when associated with adhesive procedures[17]. In a few studies like Burnett (2004) in assessing the effect of surface treatment with Er:YAG laser on tensile bond strength, increased bond strength was shown which is mainly due to loss of resin matrix and exposure of filler particles[18].

Moezizadeh in 2012 reported that the surface treatments using sandblast and laser beam of 1W power along with silane are two effective methods to increase the bond strength of composites[19].

In the present study, results of SEM evaluation showed that exposure of composites to laser beams caused irregularities and surface roughness which do not follow particular pattern and by increasing the laser power, these changes also increase.

Conclusion

Among different lasers, Er:YAG laser can be used as an alternative technique for surface treatment of indirect composites. There is still need to do more researches to find the best protocol for achieving to the best bonding.

References

1. D'Arcangelo C, Vanini L. Effect of three surface treatments on the adhesive properties of indirect composite restorations. J Adhes Dent 2007;9:319-26.
2. Saleh RS, Gallab OH, Zaazou MH, Niazi HA. The influence of different surface pretreatments on the shear bond strength of repaired composite. J Am Sci 2011;7(7):705-11.
3. Davidson CL, de Gee AJ, Feilzer A. The competition between the composite-dentin bond strength and the polymerization contraction stress. J Dent Res1984;63:1396-9.
4. Soares CJ, Giannini M, Oliveria MT, Paulillo LA, Martins LR. Effect of surface treatments of laboratory-fabricated composites on the microtensile bond strength to a luting resin cement. J Appl Oral Sci 2004;12(1):45-50.
5. Tanoue N, Matsumura H, Atsuta M. Comparative evaluation of secondary heat treatment and a high intensity light source for the improvement of properties of prosthetic composites. J Oral Rehabil 2000;27:288-93.
6. Yamaga T, Sato Y, Akagawa Y, Taira M, Wakasa K, Yamaki M. Hardness and fracture toughness of four commercial visible light-cured composite resin veneering materials. J Oral Rehabil 1995;22:857-63.
7. Touati B, Aidan N. Second generation laboratory composite resins for indirect restorations. J Esthet Dent 1997;9:108-18.
8. Frankenberger R, Sindel J, Kramer N, Petschelt A. Dentin bond strength and marginal adaptation: direct composite resins vs ceramic inlays. Oper Dent 1999;24:147-55.
9. Mak YF, Lai SC, Cheung GS, Chan AW, Tay FR, Pashley DH. Micro-tensile bond testing of resin cements to dentin and an indirect resin composite. Dent Mater 2002;18:609-21.
10. Soares CJ, Celiberto L, Dechichi P, Fonseca RB, Martins LR. Marginal integrity and microleakage of direct and indirect composite inlays-SEM and stereomicroscope evaluation. Braz Oral Res 2005;19(4):295-301.
11. Hannig M, Friedrichs C. Comparative in vivo and in vitro investigation of interfacial bond variability. Oper Dent 2001;26(1):3-11.
12. Lin CT, Lee SY, Keh ES, Dong DR, Huang HM, Shih YH. Influence of silanization and filler fraction on aged dental composites. J Oral Rehabil 2000;27:919-26.
13. Eduardo Cde P, Bello-Silva MS, Moretto SG, Cesar PF, de Freitas PM. Microtensile bond strength of composite resin to glass-infiltrated alumina composite conditioned with Er,Cr:YSGG laser. Lasers Med Sci 2012;27(1):7-14.
14. Türkmen C, Durkan M, Cimilli H, Öksüz M. Tensile bond strength of indirect composites luted with three new self-adhesive resin cements to dentin. J Appl Oral Sci. 2011;19(4):363-9.
15. Hasani Tabatabaei M, Alizade Y, Taalim S. Effect of various surface treatments on repair strength of composite resin. J Dent Tums 2004; 1:5-11.
16. Barkmeier WW, Shaffer SE, Gwinnett AJ. Effects of 15 vs 60 second enamel acid conditioning on adhesion and morphology. Oper Dent 1986;11:111–6.
17. Shahabi, Chiniforush N, Bahramian H, Monzavi A, Baghalian A, Kharazifard MJ. The effect of ebrium family laser on tensile bond Strengrth of composite to dentin in comparison with conventional method. Lasers Med Sci. 2013;28(1):139-42.
18. Burnett LH, Jr, Shinkai RS, de Paula Eduardo C. Tensile bond strength of a one-bottle adhesive system to indirect composites treated with Er:YAG laser, air abrasion, or fluoridricacid. Photomed Laser Surg 2004;22:351–6.
19. Moezizadeh M, Ansari ZJ, Fard FM. Effect of surface treatment on micro shear bond strength of two indirect composites. J Conserv Dent 2012; 15(3): 228–32.