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Effects of Different Er,Cr:YSGG Laser Parameters on Resin-Enamel/Dentin Bond Strength

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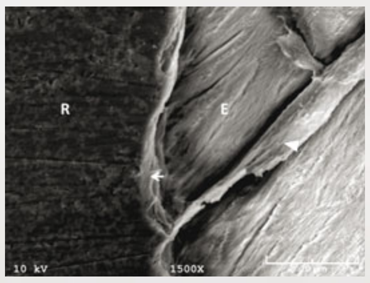
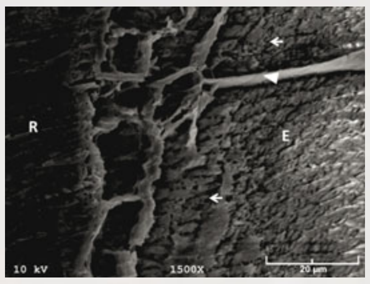
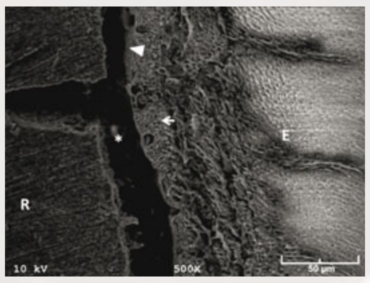
CED IADR October 15-17, 2015 Gloria Golf Resort & Convention Center, Belek - Antalya



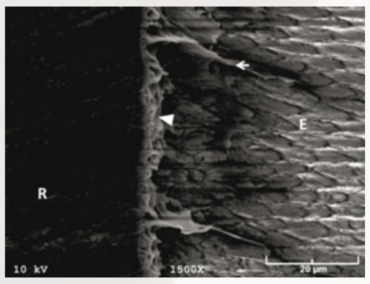
SEM image of acid-etched cross section of resin-enamel interface using acid etching. There was no horizontal crack in the subsurface of enamel. However, a tremendous vertical crack was seen as result of mechanical stress during the high speed abrading mechanism of the diamond bur (arrowhead).



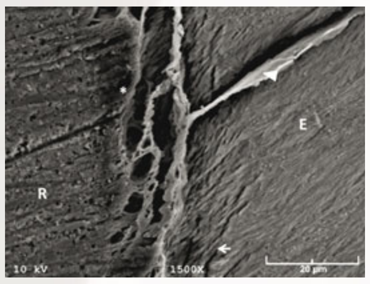
SEM image of acid-etched cross section of resin-enamel interface using laser irradiation with 6W - 20Hz parameters. Large vertical and horizontal resin extensions were evident (arrowhead). Occurrence of widening inter-prismatic rods indicates minor cracks throughout enamel rod interfaces (arrows).



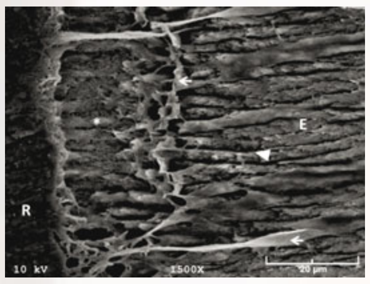
SEM image of acid-etched cross section of resin-enamel interface using laser irradiation with 6W - 20Hz parameters. A huge interface gap due to ineffective bonding to large vitrificated enamel surface was seen (*). Rounded enamel crystals due to vitrification were seen (white arrow).



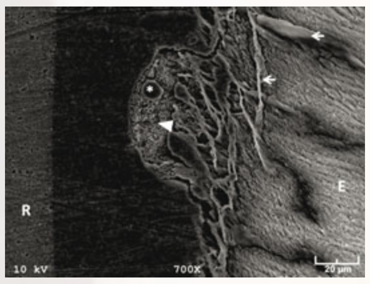
SEM image of acid-etched cross section of resin-enamel interface using laser irradiation with 6W - 35Hz parameters. Resin-enamel interface was intact. However, large resin extensions of approximately 30µm were evident. Despite Group 1, minor cracks throughout enamel rods were not extensive (arrow).



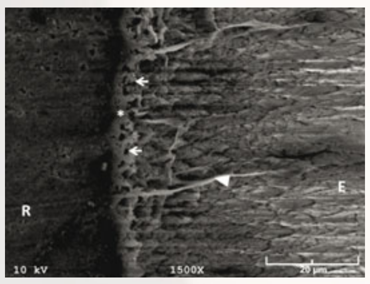
SEM image of acid-etched cross section of resin-enamel interface using laser irradiation with 6W - 50Hz parameters. Resin-enamel interface was intact (*), extensive subsurface fissuring. In addition, large vertical resin extensions were present (arrowhead). Minor cracks among enamel rods were seen (arrows).



SEM image of acid-etched cross section of resin-enamel interface using laser irradiation with 3W - 20Hz parameters. Subsurface cracks resulting in large vertical and horizontal resin extensions were evident (arrows). Widening inter-prismatic areas indicating minor cracks among enamel rods were seen (arrowhead). Cavity at the interface because of defragmented surface enamel fragment is indicated by asterisk.



SEM image of acid-etched cross section of resin-enamel interface using laser irradiation with 3W - 35Hz parameters. An irregular resin-enamel interface due to smaller partially defragmented vitrification area which was encapsulated by adhesive resin was seen (*). Different surface texture indicates vitrification of enamel surface exposed to laser irradiation with 3 W- 35Hz parameters.



SEM image of acid-etched cross section of resin-enamel interface, using laser irradiation with 3W - 50Hz parameters. A resin-enamel interface was intact (*). Although large vertical resin extensions were evident, their widths were smaller than those of other groups (arrowhead). Thinner horizontal resin extensions were positioned at 10µm below interface (arrows). Cracks among enamel rods were absent.

INTRODUCTION / AIM

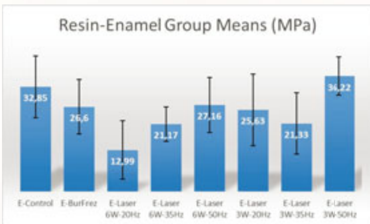
Previous studies have shown the effects of Er,Cr:YSGG laser irradiation on the enamel and dentin bond strengths[1,2]. However, there are few reports that show the significance of the irradiation with different laser parameters (output power and pulse frequency) on enamel and dentin bond strengths and interface morphology. This *in-vitro* study attempted to evaluate the microtensile bond strength (µTBS) and interface morphology of resin-enamel and resin-dentin interfaces, either followed by treatment with Er,Cr:YSGG laser irradiation using different parameters or not.

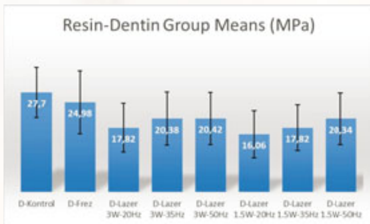
MATERIALS AND METHODS

The flattened enamel and dentin samples of seventy bovine teeth were embedded into acrylic blocks and randomly divided into enamel and dentin groups; dentin specimens were further divided into seven subgroups according to surface treatments using Er,Cr:YSGG lasers with different parameters: **3 W/20 Hz, 3 W/35 Hz, 3 W/50 Hz, 1.5 W/20 Hz, 1.5 W/35 Hz, 1.5 W/50 Hz,** or no laser treatment.

Enamel and dentin specimens were further divided into seven subgroups according to surface treatments using Er,Cr:YSGG lasers with different parameters: **6 W/20 Hz, 6 W/35 Hz, 6 W/50 Hz, 3 W/20 Hz, 3 W/35 Hz, 3 W/50 Hz,** or no laser treatment (n=5). Interface morphology was also assessed under SEM.

RESULTS





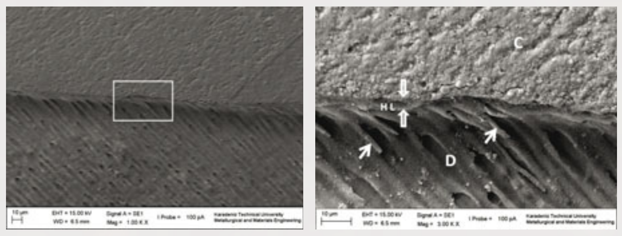
DISCUSSION

The bonding effectiveness of adhesive resin to laser-irradiated enamel was affected by both the output power and pulse frequency of Er,Cr:YSGG laser. However, Er,Cr:YSGG laser treatments yielded significantly reduced dentin bond strengths regardless of different parameters. Although parameters recommended by the manufacturer lowered µTBS, increasing pulse rate may maintain optimum enamel µTBS. Therefore, 3 W-50 Hz parameters might improve resin-enamel bond strength, when Er,Cr:YSGG laser irradiation is used for laser conditioning.

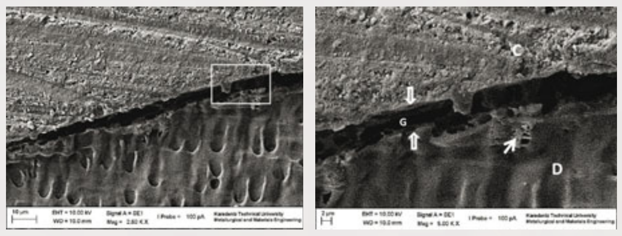
REFERENCES

[1] De Moor, R. J., and K. I. Delme. "Laser-assisted cavity preparation and adhesion to erbium-lased tooth structure: part 2. present-day adhesion to erbium-lased tooth structure in permanent teeth." The journal of adhesive dentistry 12.2 (2010): 91.

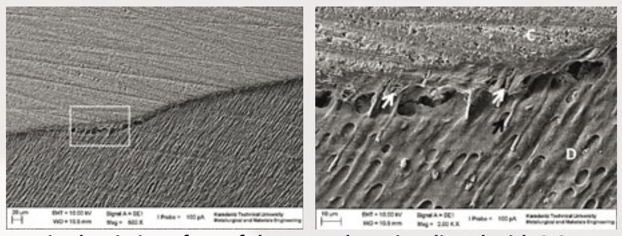
[2] Lopes, Raquel Marianna, et al. "Dental Adhesion to Erbium-Lased Tooth Structure: A Review of the Literature." Photomedicine and laser surgery 33.8 (2015): 393-403.



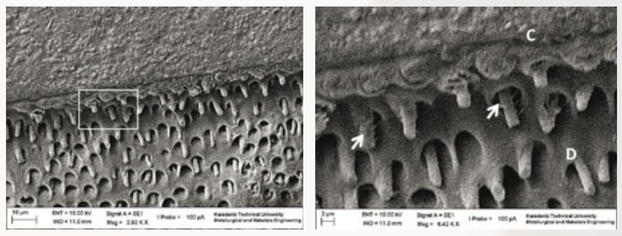
Resin adhesive – dentin interface not irradiated (control group). Magnification: 1500X. Magnification of depicted area within figure: 3000X. A typical hybrid layer with approximately 3.5µm thickness was created.



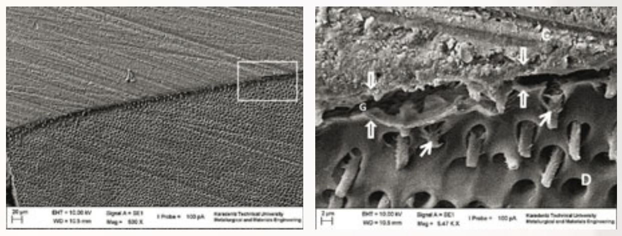
Resin-dentin interface of the group laser irradiated with 3.0W and 20Hz. Magnification of depicted area within figure: 5000X. A gap formation between laser irradiated dentin and adhesive resin can be seen (G between arrows).



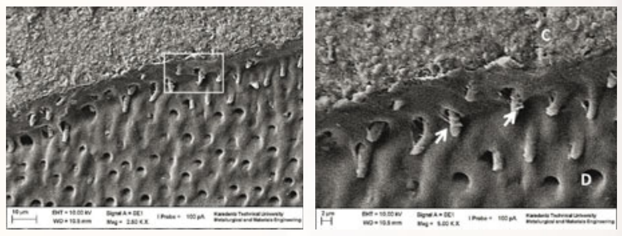
Resin-dentin interface of the group laser irradiated with 3.0W and 35Hz. Magnification of depicted area within figure: 2000X. Resin tags with wings were evident (white arrows). However, deeper regions of resin tags seem regular (black arrow).



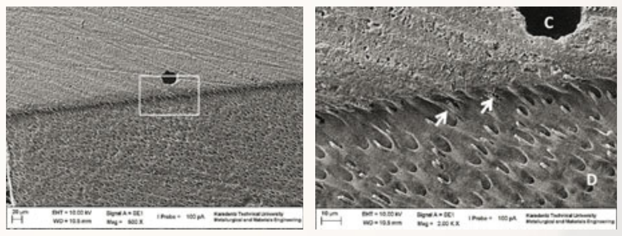
Resin-dentin interface of the group laser irradiated with 3.0W and 50Hz. Magnification of depicted area within figure: 6400X. Resin tags with wings were evident (white arrows).



Resin-dentin interface of the group laser irradiated with 1.5W and 20Hz. Magnification of depicted area within figure: 5400X. A gap formation between laser irradiated dentin and adhesive resin can be seen (G between arrows). Resin tags with wings were evident (white arrows).



Resin-dentin interface of the group laser irradiated with 1.5W and 35Hz. Magnification of depicted area within figure: 5000X. Resin tags with wings were evident (white arrows).



Resin-dentin interface of the group laser irradiated with 1.5W and 50Hz. Magnification of depicted area within figure: 2000X. Resin-dentin interface seems intact. However, resin tags with wings were still evident (white arrows). C: Composite, D: Dentin.