Academy of Laser Dentistry
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STUDENT SCHOLARSHIP

Shear Bond Strength and SEM Study of Composite Material to Enamel and Dentin Prepared by Er,Cr:YSGG Laser: Application of Various Etching Time

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Aim of the Study

The purpose of this study was to evaluate if longer etching time can influence the bond strength of composite to enamel and dentin.

Material and Methods

Sixty freshly extracted caries- and restoration-free permanent human molars were selected after scaling to remove residual tissues and calculus, embedded in an acrylic resin, and ground to obtain a standardized and flat enamel or dentin surface.

An Er,Cr:YSGG laser (Waterlase®, Biolase Technology, Irvine, Calif., USA) (wavelength 2,780 nm, free-running, pulse length 140 microseconds, fiber delivered, repetition rate 20 Hz, fiber diameter 600 micrometer) was used with the power of 4 W (200 mJ/pulse) for enamel specimens and 3 W (150 mJ/pulse) for dentin specimens. The tip was bathed in an adjustable air-water spray during the treatment (60% air, 70% water for dentin, and 80% water for enamel). Samples were lased at a 90-degree angle to the previously flattened surface in noncontact mode with a fixed distance of 1 mm away from the laser tip for 10 seconds in a sweeping fashion to achieve an even coverage of the surface by overlapping the laser impacts. Surface areas of approximately 4 × 3 mm were prepared in this manner. To ensure consistent energy density, spot size, distance, and handpiece angle, the laser handpiece was attached to a modified surveyor.

Thirty-six enamel samples and 24 dentin samples were randomly selected for testing the different etching time (12 samples in each group): E1: 20, E2: 40, and E3: 60 seconds for enamel, and D1: 15 and D2: 30 seconds for dentin by 37% phosphoric acid.

Two to three consecutive coats of an adhesive system (Adper™ Single Bond Plus, 3M-ESPE, St. Paul, Minn.) were immediately applied to the exposed etched surface for 15 seconds with gentle agitation, strictly following the manufacturer's recommendations.

A transparent plastic tube of 1.5-mm inner diameter was filled with 3-4 mm of composite (Filtek™ Supreme Plus, 3M-ESPE) and placed on the treated surface, light-cured for 40 seconds, then after 24 hours the samples were subject to a shear bond test in a universal testing machine using a knife edge loading head at a cross-head speed of 1 mm/min.

To evaluate the mode and visualize the failure surface, the composite cylinders were studied under a scanning electron microscope (SEM). The failure mode was classified as Cohesive, Adhesive, or Mixed. Means and standard deviations of shear bond strength (SBS) were calculated and differences between groups were analyzed using One-Way Analysis of Variances (ANOVA) with a 5% level of significance ($p < 0.05$).

Results

The mean SBS for E1 (Enamel 20 s etched) was 16.97 ±7.77 MPa, for group E2 (Enamel 40 s etched) was 21.34 ±3.55 MPa, and for E3 (Enamel 60 s etched) was 14.08 ±4.77 MPa; for group D1 (Dentin 15 s etched) was 13.62 ±7.28 MPa and 13.15 ±6.25 MPa for group D2 (Dentin 30 s etched).

ANOVA showed statistically significant differences between the above-mentioned tested groups ($p = 0.024$). Data were submitted to further analysis for multiple comparison by post-hoc test using the Bonferroni method which indicated mean shear bond strength for E2 was significantly higher than E3 ($p = 0.022$), but it was not the case between E1 and E2 ($p > 0.237$) and between E1 and E3 ($p > 0.755$).

Also ANOVA did not show any significant difference between dentin groups ($p > 0.881$).

SEM evaluation showed enamel and dentin samples tend to fail more cohesively. 50% in group E1, 37% in group E2, 80% in group E3 had total cohesive failure in enamel. It was almost the same for dentin samples also. All the other samples had a mixture of adhesive and cohesive failure in which cohesive failure was predominant.

Conclusion

Within the limits of this *in vitro* study, it can be concluded that etching time can significantly influence the bonding of composite resin to enamel but if increased too much (up to 60 seconds) its positive effect on shear bond strength of composite resin to enamel may be eliminated.

In case of dentin there is no difference observed on shear bond strength between 15 seconds or 30 seconds of etching time.

SEM study revealed subsurface cracks, fissures, and deformities which resulted from the predominantly cohesive failure mode in both enamel and dentin.

Biography: *Dr. Ali Obeidi earned his DDS degree in 2000 from Beheshti University in Tehran, Iran and has been involved in laser dentistry since then. He is a country representative member in the World Federation for Laser Dentistry (WFLD) and founder of the United Arab Emirates (UAE) Laser Dentistry Society. He was recently awarded a master's degree in laser dentistry from Aachen University in Germany, and is currently studying as a postdoctoral resident and working as an adjunct instructor in the University of Alabama at Birmingham, Alabama.*

Disclosure: *Dr. Obeidi is a postdoctoral resident and employee of the University of Alabama at Birmingham (UAB).*

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