



# Effect of Nd:YAG Laser on the Shear Bond Strength of Composite to Dentin

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**Purpose:** This study was conducted to investigate the surface effects on dentin following laser “etching” with an Nd:YAG laser, and to determine the shear bond strengths of composite to untreated and laser-treated dentin.

**Materials and Methods:** Dentin surfaces from freshly extracted permanent molars were subjected to laser treatment with an Nd:YAG laser. The results were analyzed using an SPSS/PC multiple range test. The shear bond strengths of laser-treated dentin/composite and untreated dentin/composite by dentin bonding were also determined. These results were also compared using the SPSS/PC multiple range test.

**Results:** Shear bond strength in laser and acid groups were  $6.70 \pm 2.86$  and  $15.24 \pm 8.51$  MPa, respectively. Bond strength in the laser group was significantly lower than in the other group ( $p < 0.01$ ).

**Conclusion:** The Nd:YAG dental laser tested produced weaker shear bond strength than conventional acid etching.

**Keywords:** shear bond, dentin, Nd:YAG laser.

*J Oral Laser Applications 2009; 9: 117-120.*

*Submitted for publication: 18.04.09; accepted for publication: 18.08.09.*

At present, enamel conditioning is usually performed with the acid-etch technique. The great number of investigations into enamel and dentin surface morphology and shear strength carried out in the past 35 years has resulted in a marked reduction in phosphoric acid concentrations and application times with no significant reduction in shear bond strength.<sup>1-3</sup> The disadvantage of conventional enamel conditioning using phosphoric acid gel is damage to the surface of the enamel.<sup>4,5</sup> Moreover, damage to dental hard substance and to local soft tissue may be caused by residual acid.<sup>4</sup>

Laser technology has improved significantly in the past 30 years. Basic investigations on the effects of

laser impacts on teeth were carried out by Goldman and Stern in the 1960s.<sup>5,6</sup> In recent years, there has been growing interest in the use of lasers for conditioning enamel and dentin surfaces, the latter as an alternative to conventional acid-etching methods.<sup>7-9</sup> Today, more than ten different laser types are used in dental research. Investigations have discovered the capacity of different lasers to roughen tooth structure in a manner analogous to the acid-etch technique prior to bonding resin composite material to dentin or enamel.<sup>10-13</sup>

The neodymium:yttrium-aluminium-garnet (Nd:YAG) laser was invented in 1961 by Snitzer and then marketed as an instrument for use on both hard and soft

dental tissues.<sup>14</sup> The earliest reference in the dental literature can be credited to Sognaes, who evaluated laser irradiation of enamel and dentin.<sup>15</sup>

The Nd:YAG laser has been proposed for application to dental hard tissues for a variety of purposes, including dentinal hypersensitivity treatment, etching procedures, caries removal, cavity preparation, and soft tissue procedures.<sup>16-26</sup>

The present study was undertaken to compare the shear bond strength of resin composite placed in dentin conditioned with Nd:YAG laser or conventionally acid etched.

## MATERIALS AND METHODS

Twenty freshly extracted human caries- and restoration-free permanent posterior teeth were cleaned and stored in distilled water at 40°C. Prior to the study, the teeth were placed in 0.5% chloramine solution for one week. The teeth were randomly allocated into two groups of 10 each. The Nd:YAG laser used in the investigation was a Pulse-Master dental laser (Fotona Fidelis Plus II; Ljubljana, Slovenia), a pulsed neodymium-doped yttrium-aluminum-garnet laser. This laser emitted in a frequency range of 10 to 100 Hz with an energy range of 30 to 320 mJ. Laser emission power at the tip of the glass fibers was adjustable from 0.3 to 10 W. Laser power was beamed to the enamel surface by a 300- $\mu$ m fiber optic.

The samples were prepared as follows:

- Group 1: The teeth were conditioned with 37% phosphoric acid (Total Etch, Ultradent products; South Jordan, UT, USA) for 30 s.
- Group 2: The teeth were conditioned using an Nd:YAG laser (Fotona Fidelis Plus II), with no acid-etching step. The manufacturer's recommended settings were used (0.9 W, 15 Hz, 60 mJ per pulse). The laser beam was applied perpendicularly to the material surface for 2 s in a circular pattern.

After washing for 15 s, all surfaces were treated with a resin-based adhesive system in accordance with the manufacturer's instructions. The adhesive used was Adper Single Bond 2 Adhesive (3M ESPE, 6gr-51202; St Paul, MN, USA). This was light cured for 20 s, and then Supreme restorative resin composite (3M ESPE) was applied and light cured for 40 s. All specimens were then stored in distilled water at room temperature for 24 h. After this time, shear bond strength was measured using a universal testing machine (LR50K,

Lloyd Instruments; Fareham, Hants, UK). The bond strengths obtained from the lasered and acid-etched groups were compared using the independent sample t-test. Data were analyzed using SPSS 11.5 software (Chicago, IL, USA), and the p-value was set at 0.05.

## RESULTS

The shear bond strengths in laser and acid groups were  $6.70 \pm 2.86$  and  $15.24 \pm 8.51$  MPa, respectively. The bond strength in the laser group was significantly lower than in the acid-etched group ( $p < 0.01$ ).

## DISCUSSION

A major problem in restorative dentistry is the lack of adhesion of dental restorative materials to mineralized dental tissues. The resulting gap may influence the retention of the restorative material, increase secondary caries, or cause inflammatory reactions in the dental pulp.<sup>27</sup>

Enamel and dentin surface conditioning can be performed with Nd:YAG laser. From the results of this study, it can be concluded that the shear bond strength reduces when using laser. The shear bond strengths for acid-etched and lasered dentin were significantly different. Shaw et al,<sup>27</sup> using Nd:YAG laser on dentin, have shown that the shear bond strength of lasered dentin was not significantly different from untreated dentin. In the present study, the bond strengths were lower in lasered dentin, complementing a study by Munro et al.<sup>28</sup> Using an Nd:YAG laser with the parameter combination  $E=80$  mJ and  $f=10$  Hz, von Fraunhofer et al achieved tensile bond strengths ranging from 2.2 to 12.8 MPa and found enamel surface conditioning superior to laser conditioning in terms of tensile bond strength.<sup>29</sup>

Several studies have shown that the treatment of dentin surfaces with different laser types increased the retention between composite and resin.<sup>30-32</sup> Nd:YAG-laser radiation can be used to seal open dentinal tubules.<sup>33</sup> Parameters of the generated intense laser pulses can vary in broad ranges and this enables us to study the pulse interaction with a dentin surface under conditions not always accessible by special dental lasers. Using a beam with a diameter of 0.6 mm, and an energy of 200 mJ per pulse or higher is required for the modification of a dentin surface assuming onefold irradiation. Using several successive irradiations, even energies around 100 mJ per pulse are sufficient.<sup>34-36</sup>

Several laser wavelengths increase the resistance of enamel and dentin to caries. Therefore, the incidence of recurrent caries around restoration placing using laser etching may be reduced.<sup>37</sup>

Rolla et al<sup>38</sup> investigated the influence of Nd:YAG on microtensile bond strength ( $\mu$ TBS) of different adhesive systems for human dentin. They concluded that the application of Nd:YAG laser to dentin provided an increase in the bond strength values for the Tyrian SPE/One Step Plus and Adper Prompt L-Pop adhesive systems, but did not influence the bond strength values of the Single Bond adhesive system.

Paranhos et al<sup>39</sup> evaluated the microtensile bond strength of 2 adhesive systems (Adper Single Bond Plus [3M ESPE] and Clearfil SE Bond [Kuraray]) to carious or normal dentin, with or without previous treatment with Nd:YAG laser or Nd:YAG laser associated with fluoride. According to their research, after excavating a cavity with caries-affected dentin, the use of Nd:YAG laser followed by a self-etching adhesive system is the best clinical choice when considering bond strength, compared with the etch-and-rinse system and laser.

Another study evaluated the microtensile bond strength of a commercial adhesive system to dentin irradiated with Nd:YAG laser after adhesive application but prior to polymerization. Based on the results of this study, it was possible to conclude that irradiation of dentin with the Nd:YAG laser at low energy densities after application of the adhesive but prior to polymerization might be positive for the adhesive restorative process.<sup>40</sup>

One general disadvantage of using laser devices for conditioning is the increase in pulp temperature. Depending on laser type, exposure time and laser power, various temperature increases towards the pulp are reported.<sup>41</sup> Clinical application of laser devices for dentin conditioning demands more intensive analysis, including the evaluation of other types of laser, with respect to the degree of dentin roughness and potential side effects with an optimum laser setting.

## CONCLUSION

The Nd:YAG dental laser tested produced weaker shear bond strengths than conventional acid etching.

## ACKNOWLEDGMENTS

This research was supported by the Tehran University of Medical Sciences, Health Services grant no.1142. The authors are grateful to the Dental Research Center, Tehran University of Medical Sciences. The authors thank Dr. Siahkollah, Dr Zendedel and Mr. Mehdipour for their assistance in doing experiments.

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