

# Microshear Bond Strength of Glass Ionomer to Primary Dentin following Surface Treatment by Bur and Er,Cr:YSGG Laser

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## Abstract

**Background and Aim:** Er,Cr:YSGG laser irradiation has been suggested as an effective method of cavity preparation and surface treatment to enhance the bond strength. The aim of this study was to assess the microshear bond strength of Fuji II LC glass ionomer (GI) cement to primary dentin following bur preparation and Er,Cr:YSGG irradiation.

**Materials and Methods:** This in vitro, experimental study was conducted on 20 extracted primary canine teeth. After debris removal, the teeth were sectioned buccolingually and divided into two groups. In group 1, the exposed dentin surface was prepared by fissure bur; while in group 2, the dentin surface was subjected to Er,Cr:YSGG laser irradiation with 2 W power and 80% air and 50% water. Fuji II LC GI cement was applied. After 24 h of storage, the samples were subjected to microshear bond strength test in a microtensile tester. The bond strength values in the two groups were compared using Student t-test.

**Results:** The mean ( $\pm$  standard deviation) microshear bond strength of GI to dentin was  $15.36 \pm 2.98$  MPa in the laser and  $4.86 \pm 1.36$  MPa in the bur group. The mean microshear bond strength in the laser group was significantly higher than that in the bur group ( $P < 0.0001$ ).

**Conclusion:** Irradiation of Er,Cr:YSGG laser with 2 W power increases the microshear bond strength of Fuji II LC GI to primary dentin, and is superior to bur preparation for this purpose.

**Key Words:** Dentin; Glass Ionomer Cements, Lasers, Tooth, Deciduous, Shear Strength, Tooth Preparation

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## Introduction

The optimal efficacy of glass ionomer (GI) cements for remineralization of tooth structure has been documented, and is attributed to the release of fluoride, aluminum and calcium ions and their buffering capacity, neutralizing the

lactic acid. GI cement can increase the pH from 4.5 to 5.5 in less than 30 s and cease the progression of dental caries (1). GI cements chemically bond to the tooth structure and release fluoride in long-term. Thus, they have been suggested for restoration of carious

primary teeth. However, GI cements have lower bond strength to teeth (2-6 MPa) in comparison with composite resins (18-35 MPa). Thus, it is imperative to use an adjunct method to enhance their bond strength (2).

By advances in technology, use of laser has been suggested in dentistry for cavity preparation and surface treatment. Cavity preparation with laser has less pain in comparison with cavity preparation by bur and therefore, it is more popular and better accepted by children. It has also been used for pulpotomy, caries removal, and etching and preparation of enamel. Due to lower level of pain, the need for anesthesia is also reduced and thus, the anxiety and fear of patients decrease (3, 4). On the other hand, laser is used for soft tissue surgery, tooth bleaching, sealing and sterilization of root end, and enamel and dentin preparation to increase resistance to caries and enhance the bond to composite resins (5).

Various lasers have been introduced for application on hard and soft tissues. Hard tissue lasers are used as an alternative to mechanical cutting and drilling systems, and are used for sound and carious dental substrate removal. The erbium family of lasers are among the hard tissue lasers and are divided into two groups of Er:YAG (2940 nm) and Er,Cr:YSGG lasers (2780 nm) (6). Er,Cr:YSGG laser is well absorbed by water and minerals of hydroxyapatite crystals. Due to numerous advantages, this laser has been suggested for enamel and dentin surface treatment to enhance the bond strength (7).

Considering the numerous advantages of application of Er,Cr:YSGG laser in pediatric dentistry such as optimal acceptance by children and parents due to its minimal invasiveness and higher cooperation of pediatric patients during restorative treatments with laser (3), the low bond strength of GI to tooth surface, lack of sufficient studies regarding the efficacy of Er,Cr:YSGG laser for dentin surface preparation, and the controversial results of previous studies (8, 9), this study was designed to assess the microshear bond strength of GI to primary dentin following surface preparation by bur in comparison with Er,Cr:YSGG laser irradiation.

## Materials and Methods

This in vitro experimental study was conducted on 20 primary canine teeth extracted for orthodontic reasons. The study protocol was approved by the ethic committee of Shahid Beheshti University of Medical Sciences (310141). Sample size was calculated to be 20 teeth considering type one error of 5% and type two error of 20% ( $n=10$  in each group) using Power and Sample Size Calculation Software version 2.1.31. The teeth were selected using convenience sampling and were randomly assigned to bur and laser groups.

The teeth were disinfected in 0.5% chloramine T solution for 72 h. All debris and soft tissue residues were removed using a Universal scaler. The teeth were stored in distilled water during the study to remain hydrated. After cleaning the teeth with a brush and pumice paste, the mesial and distal tooth surfaces were polished using 600-grit silicon carbide paper under running water to reach the outer layer of dentin. The teeth were randomly divided into two groups ( $n=10$ ) using a table of random numbers. In group 1, dentin surfaces were prepared with a long fissure bur (D & Z, Germany) with one or two movements with no alteration in surface anatomy. In group 2, dentin surface was prepared by Er,Cr:YSGG laser (Waterlase, Biolase technology, San Clemente, CA, USA) irradiation with 2 W power, 80% air, 50% water, 2780 nm wavelength, and 15 Hz frequency. Laser was irradiated from 1 mm distance in non-contact mode for 30 s. The Tygon tubes (Tygon Norton Performance Plastic Co., Cleveland, OH, USA) with an internal diameter of 0.7 mm and height of 1 mm were used for the application of GI on dentin surfaces. Fuji II LC glass ionomer powder and liquid (GC Corp., Tokyo, Japan) were mixed according to the manufacturer's instructions, and packed into the tubes. The Tygon tubes containing GI were then placed on prepared dentin surfaces and light-cured for 20 s according to the manufacturer's instructions using a QTH light curing unit (Bonart, south korea) with a light intensity of 740 mW/cm<sup>2</sup>. The Tygon tubes were then removed using a scalpel. The samples were immersed in distilled water at 37°C for 24

h. The teeth were then subjected to microshear bond strength test in a microtensile tester (Bisco, USA). The Load was applied at a crosshead speed of 1 mm/min, and the maximum load at failure was recorded as the microshear bond strength value. To report this value in megapascals (MPa), load in Newtons was divided by the surface area in square-millimeters.

Data were analyzed using SPSS version 20 (SPSS Inc., IL, USA). The mean, standard deviation, and standard error of microshear bond strength were reported for the laser and bur groups. Distribution of data was assessed using the Kolmogorov-Simonov test. Since the data had normal distribution ( $P=0.23$ ), the results of the two groups were compared using parametric Student t-test. Level of significance was set at 0.05.

## Results

The mean microshear bond strength of GI to dentin was  $15.36 \pm 2.98$  MPa in the laser group and  $4.86 \pm 1.36$  MPa in the bur group. The mean microshear bond strength of laser group was significantly higher than that of bur group ( $P < 0.0001$ ).

## Discussion

The present study assessed the microshear bond strength of Fuji II LC GI cement to primary dentin following bur preparation in comparison with Er,Cr:YSGG surface treatment. The results showed that the mean microshear bond strength of GI in the laser group was significantly higher than that in the bur preparation group ( $P < 0.0001$ ).

The microshear bond strength test was used in this study. One of the advantages of microshear bond strength test in comparison with microtensile test is that in this test, the samples are only subjected to stress when removing the mold (10, 11). However, flexural loads and unequal load distribution occur in microshear test due to the use of fine cylinders. Thus, the stress values are higher than those in macro-shear test (10). Nevertheless, this problem was minimized in this study due to the use of GI and absence of adhesive layer.

This study showed higher value of microshear bond strength of GI to dentin following irradiation of Er,Cr:YSGG laser, as the organic and mineral contents of the surface change following laser irradiation. The percentage of calcium and phosphorus increases while the organic content decreases. Chemical bonds are formed between the carboxyl groups of polyalkenoic acid present in GI and calcium in the tooth structure (12, 13). Thus, the increase in the amounts of calcium and phosphorus after laser irradiation can enhance the reactions and the bond strength of GI to dentin surface. Moreover, elimination of the smear layer opens the dentinal tubules, and the irregular surface created by Er,Cr:YSGG laser may increase the micromechanical bond between the glass ionomer and dentin. Laser irradiated surfaces can provide a strong bond to restorative materials due to having numerous porosities and absence of smear layer (14). Moreover, wide dentinal tubules enhance the formation of hybrid layer because the primer and adhesive can better penetrate into the porosities (14, 15). Erbium lasers have numerous applications for dental hard tissue preparation. One of the advantages of these lasers is their absorption by water and dental substrate. Since dentin has high water content, the heat generated during tooth preparation by laser decreases. The manufacturers of Er,Cr:YSGG lasers recommend using 2.25 to 2.5 W power for surface preparation and etching. However, 2 to 3 W powers have also been used for this purpose (16). In the present study, 2 W Er,Cr:YSGG laser was used.

The limitations of the present study included assessment of one type and power of laser and one type of GI, as well as the in vitro design of the study, which may jeopardize the interpretation of results for clinical application. Clinical setting cannot be ideally simulated in vitro. Thus, the results cannot be directly generalized to the clinical setting. In the oral environment, a combination of shear, tensile and torsional forces are applied to restorations, which is different from pure shear test used in this study. Moreover, thermal alterations, humidity, acidity, and presence of microbial

plaque in vivo affect the results. However, despite these shortcomings, in vitro studies provide useful information regarding the behavior of dental materials. Future studies are required to compare the efficacy of different types and parameters of lasers by use of different tests.

## Conclusion

Irradiation of Er,Cr:YSGG laser with 2 W power increases the microshear bond strength of Fuji II LC GI to primary dentin, and is superior to bur preparation for this purpose.

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