

Comparison of the Shear Bond Strength of Resin Modified Glass Ionomer to Enamel in Bur-Prepared or Lased Teeth (Er:YAG)

Ahmad Jafari¹, Sima Shahabi², Nasim Chiniforush^{3✉}, Ali Shariat⁴

¹Associate Professor, Pedodontic Department, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

²Associate Professor, research center for science and technology in medicine, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

³Laser Research Center of Dentistry (LRCD), School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran

⁴Dentist

Abstract

Objective: The purpose of this study was to evaluate the effect of Er:YAG laser on the shear bond strength of resin modified glass ionomer (RMGI) to enamel.

Materials and Methods: Twenty extracted caries-free human premolars were selected. The teeth were embedded in acrylic resin. The buccal surfaces of each sample were ground to plane enamel with carbonated disc. The teeth were randomly divided in two groups. In the first group, the surfaces were treated by Er:YAG laser (350mJ/10Hz). The second group was prepared by carbide bur. Fuji IX RMGI was adhered to surfaces of the samples in both groups in rod shape. The shear bond strength of samples was measured by a universal testing machine. The results of the two groups were analyzed by T- test.

Results: The means and standard deviations of shear bond strength of the laser-treated group and the bur-treated group were 6.75 ± 1.99 and 4.41 ± 1.62 Mpa, respectively. There is significant difference in the shear bond strength of RMGI between the two groups (P-value=0.01).

Conclusion: The laser group showed better results. Er:YAG laser can be an alternative technology in restorative dentistry.

Key Words: Er:YAG Lasers; Glass ionomer; Shear Strength; Dental Bonding

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✉ Corresponding author:
N. Chiniforush, Laser Research
Center of Dentistry (LRCD),
School of Dentistry, Tehran
University of Medical Sciences,
Tehran, Iran

n-chiniforush@farabi.tums.ac.ir

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INTRODUCTION

Since the production of restorative materials has rapidly developed, mechanical tests have played an important role in evaluating the

bond strength of different materials to dental substrates. Developing new techniques to increase bond strength in resin restoration is necessary to reduce marginal microleakage

and discoloration due to failure in marginal integrity [1,2]. So, measuring the enamel and dentin bond strength is important in the evaluation of mechanical fracture and therefore the prognosis of dental treatment [3].

The application of alternative methods such as laser irradiation has been increased in restorative dentistry.

Among different lasers, the Er:YAG laser was approved by FDA in 1997 for caries removal, cavity preparation and conditioning of the enamel or dentin. This laser with a wavelength of 2940 nm and its high coefficient of absorption in water and hydroxyapatite is more effective than the other lasers for preparing hard tissue [4,5].

It produces minimal thermal effect on the tooth structures and surrounding tissues in comparison with other dental lasers especially when water spray is applied. This laser produces an irregular pattern on the surface of the enamel that can improve retention for bonding of restorative material [6].

Advantages such as biocompatibility, adhesion to tooth structure, fluoride release, reduced microleakage and lower polymerization shrinkage have led to wide use of glass-ionomer materials in restorative dentistry [7].

Different parameters and methodologies have guided to controversial results about the effect of Er:YAG laser on the shear bond strength of dental materials to enamel.

Souza-Gabriel et al. in assessing the shear bond strength of resin-modified glass-ionomer to Er:YAG laser treated surfaces concluded that conventional bur-prepared samples provided better adhesion than samples prepared by Er:YAG laser [1].

On the other hand, Visuri et al. found higher values of bond strength in the irradiated surface by Er:YAG laser compared to those that were bur-treated [8]. The aim of this study was to evaluate the shear bond strength of resin modified glass ionomer to enamel in Er:YAG laser-treated surfaces in comparison with bur-treated surfaces.

MATERIALS AND METHODS

Ten caries-free human extracted premolars were selected for this study. All teeth were stored in distilled water with 0.4% thymol for 1 month to reduce the formation of microbial plaque. The teeth were embedded in clear acryl (Repair Material, Dentsply International Inc., Milford, DE) 2 mm under the enamel-cementum junction (CEJ). The buccal surfaces were flattened on the enamel level by carbon disc with 3 mm thickness and 12.5 mm diameter. The samples were randomly divided into two groups. The first group was irradiated by Er:YAG laser (US2940D, Deka, Italy). This laser operates at a wavelength of 2940 nm accompanied by water and air spray. The laser irradiation was done with an average output power of 3.5 W, energy of 350 mJ and frequency of 10 Hz with a pulse duration of 230 μ s in a sweeping motion about 4 mm above the surface. The distance from the enamel surface was controlled by fixing an endodontic file to the laser handpiece. The spot size of laser was 1 mm.

The second group was prepared by carbide bur (6 flutes and spiral angle of 30°) under water spray in sweeping motion for 5 seconds. The dimension of the area, which was conditioned by two methods, was approximately 2 mm \times 2 mm. After surface treatment of the two groups, the conditioner (40% polyacrylic acid) was applied for 30s.

The samples were washed and dried with absorbing paper. Then, self cure resin modified glass ionomer (Fuji IX GC corporation, Tokyo, Japan) was placed on the surface in a 2.8 mm diameter and 3mm height cylindrical mold. All the samples were placed in 37°C distilled water for 24 h to provide the final setting of the restorative material.

The samples were subjected to universal testing machine (Zwick, Germany) in order to measure the shear bond strength at a speed of 0.5mm/min and a 50 kgf load until fracture. The results of the two groups were analyzed by T-test at 0.05 confidence level.

RESULT

The mean and standard deviation of carbide group and Er:YAG laser group were 4.41 ± 1.62 MPa and 6.75 ± 1.99 MPa, respectively. The raw data of two groups was shown in Table.1. There was significant difference between the shear bond strength of the lased and the bur group (P-value=0.01).

DISCUSSION

According to the microretentive pattern obtained by Er:YAG laser irradiation, which is suitable for adhesion, in this study the shear bond strength of an RMGI to lased enamel surfaces in comparison with bur-treated surfaces was assessed. Bond strength testing as a laboratory methodology has been proposed to evaluate the adhesion capacity of dental materials. The shear bond strength test is a simple procedure for experimental evaluation and also a screening mechanism for predicting clinical performance [9, 10]. Laser technology has been presented as an alternative option to replace the conventional high speed turbine. This technology offers the patient comfort by reducing the pressure, heat, vibration and noise produced by a rotary instrument [11,12]. Using laser for etching enamel was preferred because of the disadvantages of acid etching. Application of phosphoric acid for etching the enamel makes the surface more susceptible to caries because of demineralization of the superficial layer. The physiochemical changes by laser etching reduced the acid attack and the risk of caries.

accompanied by the reduction of water and organic component [13-15].

Er:YAG laser acts on the dental substrate by thermo-mechanical ablation and vaporization of the water content which causes expansion followed by microexplosion that produces the ejection of both organic and inorganic tissue particles [16-18].

Therefore, it blocks the intra- and interprismatic spaces and restricts material interdiffusion into the enamel surface [19, 20]. The micromorphology of laser treated surface shows less regular and homogeneous aspects with some fissures occurred in subsurface resulting from heat generated during irradiation [21]. Resin modified glass ionomer has many advantages and has been employed in dental clinic because of the physiochemical adhesion to the enamel and dentin. For a long period, it can release fluoride ions in adjacent enamel and may absorb fluoride from other sources like toothpastes.

It also presents good adhesion, marginal seal and reasonable esthetics [22, 23]. So, RMGI was used in this study. Most of the studies that evaluated the shear bond strength of laser treated surfaces in comparison with bur-prepared enamel showed higher bond strength in the bur-prepared group [1,24]. Svizero et al. measured the shear bond strength of resin composite to enamel treated by different energy intensities and frequencies of Er:YAG laser compared to phosphoric acid and concluded that acid conditioning of the enamel showed higher bond strength than laser [24].

Table 1. Raw Data of Laser and Bur Group

Shear Bond Strength	Groups									
Laser	6.91	5.24	3.85	8.81	5.06	4.34	8.51	7.98	9.39	7.42
Bur	5.00	2.06	4.00	4.23	3.99	4.04	3.26	5.79	3.60	8.08

Korkmaz et al. investigated the shear bond strength between light-curing nano-ionomer restorative and enamel or dentin after acid etching, after Er:YAG laser etching or after combined treatment. They concluded that etching with acid phosphoric increased the shear bond strength, but the laser group showed a lower bond strength [22] that was in contrast with the results of the present study. When Er:YAG laser was used for surface treatment, compared to bur preparation it produced no smear layer leading to increased surface wettability and producing tag formation [25]. This can explain the higher value obtained in the laser group. On the other hand, Turkmen et al. showed that Er,Cr:YSGG laser etches the enamel surface more effectively than phosphoric acid that is in agreement with our results [25]. The higher values that were achieved from the laser group may be contributed to micro irregularities produced on the surface [26]. There is need for more studies which evaluate the interaction of laser prepared surfaces with new generation of glass ionomers like light-curing nano-ionomer restoratives.

CONCLUSION

Based on the results of the present study, Er:YAG laser can be an alternative device for enamel preparation in restorative dentistry.

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