Original Article

Comparison of Microleakage of Glass Ionomer Restoration in Primary Teeth Prepared by Er: YAG Laser and the Conventional Method

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Abstract

Objective: One of the main criteria in evaluating the restorative materials is the degree of microleakage. The aim of this study was to compare the microleakage of glass ionomer restored cavities prepared by Er:YAG laser or turbine and bur.

Materials and Methods: Twenty extracted caries-free deciduous posterior teeth were selected for this study. The teeth were randomly divided into two groups for cavity preparation. Cavities in group one were prepared by high speed turbine and bur. In the second group, Er:YAG laser with a 3W output power, 300 mJ energy and 10 Hz frequency was used. Cavities were restored with GC Fuji II LC. After thermocycling, the samples were immersed into 0.5% methylene blue solution. They were sectioned for examination under optic microscope.

Results: The Wilcoxon signed ranks test showed no significant difference between microleakage of the laser group and the conventional group (P>0.05).

Conclusion: Er:YAG laser with its advantages in pediatric dentistry may be suggested as an alternative device for cavity preparation.

Key Words: Er:YAG laser, Glass ionomer, Microleakage

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INTRODUCTION

Due to the development of new technologies in dentistry, using laser technology as a new modality has gained special attention [1,2]. The erbium family laser with two different wavelengths including Er:YAG laser (2940 nm) and Er,Cr:YSGG laser (2780 nm) is an effective device for cutting dental hard tissue due to their high absorption in water and hydroxyapatite that makes them suitable for cavity preparation [3,4]. Using laser for cavity preparation has some advantages such as reduced pain and vibration during the procedure and providing patient's comfort which is the key factor in pediatric dentistry [5,6].

Esthetic dentistry increases the demands for resin composite restoration, but these materials have some disadvantages such as polymeriza-

tion shrinkage, change in volume and the gap between the tooth and restoration [7,8].
This gap may lead to microleakage of fluid and bacterial movement which result in hypersensitivity and discomfort for the patients, pulpal irritation and recurrent caries [9,10].
To eliminate these problems and to develop fluoride materials, glass ionomer cements with increased working time, easy handling, increased bond strength, less brittleness and less sensitivity to moisture have been introduced [11].
The aim of this study was to compare the microleakage of glass ionomer restored cavities prepared by Er:YAG laser or turbine and bur.

MATERIALS AND METHODS

Twenty extracted caries-free deciduous posterior teeth were selected for this study. Residual tissues were removed by brush and the teeth were stored in distilled water for 1 month. The root apices were sealed with wax in all teeth in order to prevent dye penetration through the pulp chamber.
The cavities were prepared on the buccal and lingual side of each tooth with 3 mm width, 2 mm height and 1.5 mm depth. The occlusal margin of the cavities were placed in the enamel and the cervical margin was located in the cementum. The depth of the cavities was controlled by a periodontal probe.
The teeth were randomly divided into two groups for cavity preparation.
Cavities in group one were prepared by high speed turbine and bur.
In the second group, Er:YAG laser had 2940 nm wavelength, 3 W output power of 3 W, 300 mJ energy and 10 Hz frequency. The procedure was performed by water and air spray.
The laser was used in non-contact mode with a distance of 2 mm and pulse duration of 140 µs (very short pulse). Cavities were restored with GC Fuji II LC (GC Fuji II LC JAPAN). According to the manufacturer's instruction, the powder and liquid were mixed and after replacement, it was cured for 20 s.
The restorations were finished and polished with Soflex polishing discs (3M dental products, USA).
Then, the samples were thermocycled for 3000 cycles between 5°C and 55°C through water baths with a 20 second dwell time in each.
The samples were coated with two layers of nail varnish up to 1 mm border around the margin of the cavity.
The teeth were immersed into 0.5% methylene blue solution for 12 hours at room temperature. After that, the samples were washed under tap water and embedded in acrylic resin.
They were sectioned longitudinally in a buccolingually direction by low speed air cooled diamond disc.

Table 1. Dye Penetration Scale

Scores	Scale
0	No dye penetration
1	Dye penetration to enamel/cementum margins of the cavity
2	Dye penetration to dentin wall of the cavity
3	Dye penetration up to the floor of the cavity

The sections were examined under optic microscope (Olympus CX 31, Olympus America Inc) at ×30 magnification.

The depth of penetration was recorded according to Table 1.

The data were then analyzed using Wilcoxon signed ranks test and Mann-Whitney statistical tests.

RESULT

The data in the occlusal and gingival part in both groups have been summarized in Tables 2 and 3.

The Mann-Whitney U test showed no significant difference between microleakage of laser group and conventional group (P>0.05).

The Wilcoxon signed ranks test showed a significant difference (P<0.05) between coronal and apical microleakage.

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DISCUSSION

One of the main problems in adhesive restoration is lack of suitable adhesion to the tooth structure and microleakage between the tooth and the filling material.

Longevity and stability of treatment is the most important factor in the success rate [12,13].

Many studies have assessed different methods for reducing microleakage such as beveling of

Many studies have assessed different methods for reducing microleakage such as beveling of
the enamel, application of adhesives, filling the cavity incrementally and recently, using laser irradiation [14,15].

Providing chemical bonding between the filling material and the enamel or dentin tissue is another concern.

Penetration of bacteria from saliva into the interference between the tooth and filling materials results in tooth discoloration, recurrent caries, failure of restoration and sensitivity after treatment and pulp reaction [16,17].

There are limited studies which evaluate laser for cavity preparation in order to assess microleakage in primary teeth.

The aim of this study was to evaluate microleakage of class V cavities restored by glass ionomer following preparation by Er:YAG laser and the conventional method. In recent years, preventive methods, minimally invasive methods, reduction in caries risk and longevity of restorations has gained special attention in pediatric dentistry [18].

Glass ionomer is an alternative material to composite resins for class V cavities due to its low shrinkage, capability of forming strong bond to dental structures, biocompatibility and the remineralization effect through constant fluoride release [19].

Based on the advantages mentioned, we used glass ionomer in this study.

Table 2. Frequency Distribution of Microleakage in the Occlusal Part of Conventional and Laser Groups

	Score 0	Score 1	Score 2	Score 3
Conventional group	35%	15%	35%	35%
Laser group	25%	50%	15%	10%

New technologies such as laser application in pediatric dentistry have some advantages like providing comfort and calm for children [20].

Among different applications of laser in pediatric dentistry, cavity preparation can be performed by Er:YAG laser with less need for anesthesia and more conservative preparation [21].

SEM images of laser prepared cavities showed no smear layer, exposure of enamel rods and open dentinal tubules which is suitable for retention of adhesive materials.

In addition, enamel prisms showed a honeycomb-like appearance resulted from photomechanical ablation of Er:YAG laser [22].

Er:YAG laser ablates the intertubular dentin which is rich in collagen through the photothermal effect which causes degradation and collapsing of collagen fibers and sometimes melting collagen network [23].

There are several methods for measuring microleakage but we use the methylene blue solution most commonly method because it can penetrate better than other solutions due to its size that is smaller than the smallest bacteria. On the other hand, it is inexpensive and easy handling [24].

There are various results obtained from studies that have evaluated the microleakage of class V cavities prepared by erbium family laser and high-speed turbine.

In our study, there was no significant difference in microleakage of cavities prepared by Er:YAG laser or the conventional method.

In agreement with our results, Rossi et al. in the evaluation of microleakage of glass ionomer restored in cavities prepared by Er,Cr:YSGG laser compared to high speed drill, concluded that there were no differences between the cavities prepared by an Er,Cr:YSGG laser and those prepared by air turbine [25].

In contrast, Kohara et al. (2002) assessed microleakage cavities prepared by Er:YAG laser. They showed a lower degree of leakage than those prepared by conventional methods [26]. Borsatto et al. (2006) compared microleakage of three cavity preparation methods (carbide bur, Er:YAG laser and air abrasion) in primary teeth and concluded that microleakage in the Er:YAG laser group was significantly greater than the two other groups [27].

CONCLUSION

There was no significant difference between microleakage of glass ionomer restored cavities in the laser group and the conventional group. So, Er:YAG laser with its advantages in pediatric dentistry may be suggested as an alternative device for cavity preparation.

Further studies are necessary to find the new generation of restorative materials that can best interact with laser prepared surfaces.

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Table 3. Frequency Distribution of Microleakage in the Gingival Part of Conventional and Laser Groups

	Score 0	Score 1	Score 2	Score 3
Conventional group	30%	20%	20%	30%
Laser group	40%	10%	25%	25%

REFERENCES

1- Walsh LJ. The current status of laser applications in dentistry. Aust Dent J. 2003 Sep;48(3):146-55.

2- Hossain M, Yamada Y, Nakamura Y, Murakami Y, Tamaki Y, Matsumoto K. A study on surface roughness and microleakage test in cavities prepared by Er:YAG laser irradiation and etched bur cavities. Lasers Med Sci. 2003 18(1): 25-31.

3- Gutknecht N, Apel C, Schäfer C, Lampert F. Microleakage of composite fillings in Er,Cr:YSGG laser-prepared class II cavities. Lasers Surg Med. 2001;28(4):371-4.

4- Shahabi S, Chiniforush N, Bahramian H, Monzavi A, Baghalain A, Kharazifard MJ. The effect of erbium family laser on tensile bond strength of composite to dentin in comparison with conventional method. Lasers in Medical Science. 2012; DOI: 10.1007/s10103-012-1086-3.

5- Apel C, Schäfer C, Gutknecht N. Demineralization of Er:YAG and Er,Cr:YSGG laser-prepared enamel cavities in vitro. Caries Res. 2003 Jan-Feb;37(1):34-7.

6- Sungurtekin E, Öztaş N. The effect of erbium, chromium:yttrium-scandium-gallium-garnet laser etching on marginal integrity of a resin-based fissure sealant in primary teeth. Lasers Med Sci. 2010 Nov;25(6):841-7.

7- Aranha AC, Turbino ML, Powell GL, Eduardo Cde P. Assessing microleakage of class V resin composite restorations after Er:YAG laser and bur preparation. Lasers Surg Med. 2005 Aug;37(2):172-7.

8- Davidson CL, de Gee AJ, Feilzer A. The competition between the composite-dentin bond strength and the polymerization contraction stress. J Dent Res. 1984 Dec;63(12):1396-9.

9- Bergenholtz G, Cox CF, Loesche WJ, Syed SA. Bacterial leakage around dental restorations: its effect on the dental pulp. J Oral Pathol. 1982 Dec;11(6):439-50.

10- Wang L, D'Alpino PH, Lopes LG, Pereira JC. Mechanical properties of dental restorative materials: relative contribution of laboratory tests. J Appl Oral Sci. 2003 Sep;11(3):162-7.

11- Ashwin R, Arathi R. Comparative evaluation for microleakage between Fuji-VII glass ionomer cement and light-cured unfilled resin: a combined in vivo in vitro study. J Indian Soc Pedod Prev Dent. 2007 Apr-Jun;25(2):86-7.

12- Küçükeşmena C, Sönmez H. Microleakage of class-V composite restorations with different bonding systems on fluorosed teeth. Eur J Dent. 2008 Jan;2(1):48-58.

13- Ozel E, Korkmaz Y, Attar N, Bicer CO, Firatli E. Leakage pathway of different nano-restorative materials in class V cavities prepared by Er:YAG laser and bur preparation. Photomed Laser Surg. 2009 Oct;27(5):783-9.

14- Armengol V, Jean A, Enkel B, Assoumou M, Hamel H. Microleakage of class V composite restorations following Er:YAG and Nd:YAP laser irradiation compared to acid-etch: an in vitro study. Lasers Med Sci. 2002, 17(2):93-100.

15- Yamada Y, Hossain M, Nakamura Y, Murakami Y, Matsumoto K. Microleakage of composite resin restoration in cavities prepared by Er:YAG laser irradiation in primary teeth. Eur J Paediatr Dent. 2002 Mar;3(1):39-45.

16- Ceballos L, Toledano M, Osorio R, García-Godoy F, Flaitz C, Hicks J. ER-YAG laser pretreatment effect on in vitro secondary caries formation around composite restorations. Am J Dent. 2001 Feb;14(1):46-9.

17- Browning WD, Dennison JB. A survey of failure modes in composite resin restorations. Oper Dent. 1996 Jul-Aug;21(4):160-6.

18- Ana PA, Bachmann L, Zezell DM. Lasers effects on enamel for caries prevention. Laser Physics. 2006;16(5):865-75.

19- Quo BC, Drummond JL, Koerber A,

Fadavi S, Punwani I. Glass ionomer microleakage from preparations by an Er:YAG laser or a high-speed handpiece. J Dent. 2002 May;30(4):141-6.

20- Parkins F. Laser in pediatric and adolescent dentistry. Dent Clin North Am. 2000 Oct;44(4):821-30.

21- Kornblit R, Bossù M, Mari D, Rocca JP, Polimeni A. Enamel and dentine of deciduous teeth Er:YAG laser prepared. A SEM study. Eur J Paediatr Dent. 2009 Jun;10(2):75-82.

22- Delme KI, De Moor RJ. Scanning electron microscopic evaluation of enamel and dentin surfaces after Er:YAG laser preparation and laser conditioning. Photomed Laser Surg. 2007 Oct;25(5):393-401.

23- Schien MT, Bocangel JS, Nogueira GE, Schien PA. SEM evaluation of the interaction pattern between dentin and resin after cavity preparation using Er:YAG laser. J Dent. 2003 Feb;31(2):127-35.

24- Alani AH, Toh CG. Detection of microleakage around dental restorations: a review. Oper Dent. 1997 Jul-Aug;22(4):173-85.

25- Rossi RR, Aranha AC, Eduardo Cde P, Ferreira LS, Navarro RS, Zezell DM. Microleakage of glass ionomer restoration in cavities prepared by Er,Cr:YSGG laser irradiation in primary teeth. J Dent Child (Chic). 2008 May-Aug;75(2):151-7.

26- Kohara EK, Hossain M, Kimura Y, Matsumoto K, Inoue M, Sasa R. Morphological and microleakage studies of the cavities prepared by Er:YAG laser irradiation in primary teeth. J Clin Laser Med Surg. 2002 Jun;20(3):141-7.

21- Borsatto MC, Corona SA, Chinelatti MA, Ramos RP, de Sá Rocha RA, Pecora JD et al. Comparison of marginal microleakage of flowable composite restorations in primary molars prepared by high-speed carbide bur, Er:YAG laser, and air abrasion. J Dent Child (Chic). 2006 May-Aug;73(2):122-6.