

Comparison of Micro-Leakage from Resin-Modified Glass Ionomer Restorations in Cavities Prepared by Er:YAG (Erbium-Doped Yttrium Aluminum Garnet) Laser and Conventional Method in Primary Teeth

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Abstract:

Introduction: In recent years, significant developments have been taking place in caries removal and cavity preparation using laser in dentistry. As laser use is considered for cavity preparation, it is necessary to determine the quality of restoration margins. Glass ionomer cements have great applications for conservative restoration in the pediatric field. The purpose of this in vitro study was to compare resin-modified glass ionomer restorations micro-leakage in cavities prepared by Er:YAG (Erbium-Doped Yttrium Aluminum Garnet) laser irradiation and conventional method in primary teeth.

Methods: This was an in vitro experimental study. Forty primary canine teeth were divided into 2 groups: group 1 represented cavities prepared by the no. 008 diamond bur, group 2 represented cavities prepared by Er:YAG laser. After cavity preparation, samples were restored by resin-modified glass ionomer. The teeth were thermocycled for 700 cycles, placed in 2% methylene blue for 24h and sectioned in the buccolingual direction. The degree of dye penetration was scored by 3 examiners. Data was analyzed using Mann-Whitney Test.

Results: There was no statistical difference in micro-leakage between the two modes of cavity preparation ($P=0.862$)

Conclusion: Since preparing conservative cavities is very important in pediatric dentistry, it is possible to use Er:YAG laser because of its novel and portable technology. However, further investigations of other restorative materials and other laser powers are required.

Keywords: Er:YAG lasers; dental leakages; primary tooth

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Introduction

In recent years, significant developments have been taking place in caries removal and cavity preparation using laser in dentistry; and infrared laser is being substituted for conventional methods for this purpose¹. Different types of lasers i.e. Er:YAG (Erbium: Yttrium,

aluminum, garnet), CO₂ (Carbon Dioxide Laser), Nd:YAG (Neodymium-Doped Yttrium Aluminium Garnet), and argon are extensively used in dentistry due to their unique properties^{2,3,4}. In 1997 Food and Drug Administration (FDA) approved the use of Er:YAG laser for hard tissues and its use in pediatric dentistry ensued⁵. Er:YAG laser produces minimal vibration and

noise during cavity preparation and doesn't need local anesthesia, so it is a proper method for children⁶. Some studies have shown the efficacy of Er:YAG laser for caries removal^{7,8}. Er:YAG laser causes less thermal effect than other types of laser while preparing cavities and removes tissues selectively⁸.

Glass ionomer cement due to properties such as adhesion to tooth structure, fluoride release, low shrinkage, low secondary caries, and low micro-leakage has gained an extensive use in pediatric dentistry^{9,10}. Two kinds of glass ionomeres, conventional and resin-modified, with different properties are used in dentistry^{11,12}.

Incomplete adhesion of dental materials to teeth may lead to the leakage of some chemicals, substances, food debris and so on into the tooth which is called micro-leakage, a dynamic process alongside the interface between tooth and restoration. The less micro-leakage the more successful restoration¹³.

Studies on the efficacy of laser in micro-leakage reduction are controversial. Some studies have shown a better outcome after laser irradiation^{6,14,15}, and some have shown a worse outcome¹⁶⁻¹⁹, and some have not found a significant difference between cavity preparation by laser and conventional methods²⁰⁻²³.

Salama et al. showed that pre-treatment of enamel and dentin by Nd:YAG laser increased microleakage¹⁶. But Yamada et al. showed a lower leakage after irradiation of teeth by Er:YAG laser, although this finding was not statistically significant²⁰. Que et al. couldn't find a significantly lower micro-leakage after cavity preparation by Er:YAG laser in comparison to hand piece, although they obtained a better outcome by resin-modified glass ionomeres than conventional ones²¹. The study of Kohara et al. showed a lower micro-leakage by Er:YAG laser¹⁴. Corona et al. and Chinellati et al. showed a higher micro-leakage after irradiation by Er:YAG laser^{17,18}.

Most studies have shown a lower microleakage by resin-modified glass ionomeres than conventional ionomeres^{6,21}.

This study was designed to compare the amount of micro-leakage between the restorations of class V ionomere glass in the cavities prepared by Er:YAG laser and conventional methods in primary teeth.

Methods

This was an in vitro experimental study on 40 primary canine teeth. The teeth were extracted during orthodontic procedures and entered the study after considering exclusion criteria (presence of caries, cracks, fractures

and previous restorations).

Samples were divided into 2 groups. In both groups a class V cavity was prepared in all teeth (4 mm mesiodistally and 3 mm occlusogingivally with 1.5 mm depth). The margin of all cavities lied in the enamel and the cervical margin was 1 mm apart from cement-enamel junction (CEJ).

In group 1, cavities were prepared by the no. 008 diamond bur (Tizkavan, Iran). New burs were used after every five preparations. In the second group, cavities were prepared by an Er:YAG laser (Smart 2940 plus, Deka, Italy) with output energy of 350 mj for enamel, 250 mj for dentin, frequency of 10Hz, power of 3.5 w, wave length of 2.94 μ m and short pulse mode of 230 μ s and cooling system. A 700 μ m – diameter tip perpendicular to the surface and 5mm away from the target area was used.

After cavity preparation, samples were restored with resin-modified glass ionomer (Fuji II LC, Japan), and then irradiated by a light cure device for 40 S (Arialux, Apadana tak, Iran) with the intensity of 500 mW/cm². Samples were put in distilled water for 24 hours and then the prepared surfaces were polished by composite polishing disk (KENDA, Liechtenstein). The teeth were then thermocycled for 700 cycles, placed in 2% methylene blue (Merck KGa A-C.I.52015) for 24h in room temperature and sectioned in the buccolingual direction. The degree of dye penetration and micro-leakage was scored by 3 examiners separately using a stereomicroscope (ZTX-3E, China) at X20 magnification. The highest score of two parts of the section was recorded. The scoring of micro-leakage was as following:

- score 0: without dye penetration
- score 1: dye penetration to 1/3 of cavity depth
- score 2: dye penetration to 2/3 of cavity depth
- score 3: dye penetration to the depth of the cavity but not alongside the axial wall
- score 4: dye penetration alongside the axial wall

Data was analyzed by SPSS (ver. 16) using Mann-Whitney test.

Results

In this study 40 primary canine teeth were evaluated. Table 1 shows the scoring of micro-leakage in the two study groups.

Micro-leakage rate was higher in the first group (diamond bur) than the second group (laser) but the difference was not statistically significant (P=0.862)

Table 1. Micro-leakage scoring in both groups.

Study group	Micro-leakage score, number (percent)				
	0	1	2	3	4
Diamond bur	0 (0%)	0 (0%)	1 (5%)	7 (35%)	12 (60%)
Laser	0 (0%)	1 (5%)	3 (15%)	2 (10%)	14 (70%)
Total	0 (0%)	1 (2.5%)	4 (10%)	9 (22.5%)	26 (65%)

Discussion

The use of laser in pediatric dentistry introduces a lot of advantages such as lower noise and vibration, lower local anesthetic requirement, lower tissue contact, and lower trauma. These advantages make the treatment more comfortable for children by facilitating control of child's behavior⁶.

In this study, micro-leakage of resin-modified glass ionomer restorations of class V cavities was assessed in primary teeth by Er:YAG laser and diamond bur using the dye penetration method.

Selection of the restoration material is very important to maintain tooth structure. In this study, resin-modified glass ionomer was used. Glass ionomers have got some useful characteristics such as adhesion to tooth structure, biocompatibility, fluoride release, and antimicrobial property^{9,10}. Some studies have shown that resin-modified glass ionomer causes a lower micro-leakage than conventional ones; so it can be used as a restorative material in class V cavities prepared by laser in pediatric dentistry^{10,24-26}.

Different thermal expansion coefficients of tooth tissue and restoration material may lead to micro-leakage between restoration and cavity wall²⁷. Liquid materials and bacteria may be transferred through the micro-leakage and cause pulp irritation and secondary caries²⁸⁻²⁹.

This study which did not show a significant micro-leakage difference between cavities prepared by diamond bur and laser in primary teeth was consistent with the study of Rossi et al.⁶ and Yamada et al.²⁰.

Results of the studies performed by Que et al.²¹, Navarro et al.²³, Aranha et al.³⁰, Niu et al.³¹, and Wright et al.³² were in a good agreement with those of this study, although they used composite for restoration of permanent teeth.

Some studies have shown more leakage in cavities prepared by laser in comparison to diamond bur^{17,18,33,34}. Corona et al.¹⁷ believe that laser causes more irregular margins and creates micro-spacing which leads to micro-leakage. Kohara et al.¹⁴ found a lower micro-leakage by laser.

Baghalian et al.³⁵ reported that Er:YAG laser irradiation

resulted in a significantly higher degree of micro-leakage only at the gingival margins for primary teeth restored with GI or RMGI where gingival margin was on cement-enamel junction.

In the current study, like in the study of Niu et al.³¹, all margins of the restored class V cavities were located in enamel. The study of Quo et al.²¹, in which gingival margin was located in dentine showed more micro-leakage from gingival margins.

Different factors can affect the amount of micro-leakage. Some of these factors are the type of prepared cavity, the cavity size, the type and energy level of laser, the restoration material, the method of micro-leakage evaluation, the type of dye used for micro-leakage measurement, the study design (clinical or experimental), and the person who prepares the cavities.

The amount of energy delivered to the target tissue is dependent on the density and fluency of the laser used. Other parameters that affect the results of the laser-tissue interaction are air/water flow and pressure of the integrated spray, the pulse length, and the beam profile. Operator factors such as laser angulation, focus mode, hand speed movement if incorrect can also influence the laser energy absorption³⁶.

Although the laser technology is a non-contact procedure, it requires specific knowledge and a refined performance technique³⁶. Also, the cost of laser equipment is very high compared to the conventional methods and a dentist should be trained properly to set the laser parameters and to use the laser machine.

Conclusion

According to the findings of this study Er:YAG laser can be used for cavity preparation in pediatric dentistry in which conservative cavity preparation is critical. More studies are required using other materials for restoration and lasers with different energy levels.

References

1. Gutknecht N, Apel C, Schafer C, Lampert F. Microleakage of composite filling in Er,Cr:YSGG laser-prepared class II

- cavities. *Lasers Surg Med* 2001; 28(4): 371-4.
2. Maiman TH. Stimulated optical radiation in ruby. *Nature* 1960; 187: 493-4.
 3. Harris DM, R Pick. *Laser Physics*. in: *Lasers In Dentistry*. 1st ed. L.J. Miserendino and R.M. Pick (eds.), Chicago: Quintessence 1995. 27-38.
 4. George R. Laser in dentistry-Review. *Int J Dent Clin* 2009; 1(1): 13-9.
 5. Kotlow LA. Lasers in pediatric dentistry. *Dent Clin North Am* 2004; 48(4): 889-922.
 6. 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; 75(2): 151-7.
 7. Pelagalli J, Gimbel CB. Investigational study of the use of Er:YAG laser versus dental drill for caries removal and cavity preparation - phase I. *J Clin Laser Med Surg* 1997; 15(3): 109-15.
 8. Cozean C, Arcoria CJ. Dentistry for the 21st century Er:YAG laser for teeth. *J Am Dent Assoc* 1997; 128(8): 1080-7.
 9. Donovan TE, Daftary F. Clinical use of glass ionomer restorative materials. *Compend Contin Educ Dent* 1987; 8(3): 180.
 10. Cooley RL, Robbins JW. Glass ionomer microleakage in Class V restorations. *Gen Dent* 1988; 36(2): 113-5.
 11. Mount G, Hume W. Preservation and restoration of tooth structure. St. Louis; Mosby 2006; 220-50.
 12. Powers John M, Sakaguchi Ronald L. *Craig's restorative dental materials*. St. Louis; Mosby 2006; 216-217, 486.
 13. Cortes O, Carcia C. Marginal microleakage around enamel and cementum surfaces of two compomers. *J Clin Pediatr* 1998; 28(4): 307-15.
 14. 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 primary teeth. *J Clin Laser Med Surg* 2002; 20(3): 141-7.
 15. Delme KI, Deman PJ, Nammour S, De Moor RJ. Microleakage of class V glass ionomer restorations after conventional and Er:YAG laser preparation. *Photomed Laser Surg* 2006; 24(6): 715-22.
 16. Salama FS. Effect of laser pretreated enamel and dentin of primary teeth on microleakage of different restorative materials. *J Clin Pediatr Dent* 1998; 22(4): 285-91.
 17. Corona SA, Borsatto MC, Pecora JD, De SA Rocha RA, Ramos TS, Palma-Dibb RG. Assessing microleakage of different class V restorations after Er:YAG laser and bur preparation. *J Oral Rehabil* 2003; 30(10): 1008-14.
 18. Chinelatti MA, Ramos RP, Chimello DT, Borsatto MC, Pécora JD, Palma-Dibb RG. Influence of the use of Er:YAG laser for cavity preparation and surface treatment in microleakage of resin-modified glass ionomer restorations. *Oper Dent* 2004; 29(4): 430-6.
 19. Yaman BC, Guray BE, Dorter C, Gomeç Y, Yazıcıoğlu O, Erdilek D. Effect of the erbium:yttrium-aluminum-garnet laser or diamond bur cavity preparation on the marginal microleakage of class V cavities restored with different adhesives and composite systems. *Lasers Med Sci* 2011; 16.
 20. 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; 3(1): 39-45.
 21. 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; 30(4): 141-6.
 22. Oda M, Araujo RM, Oliviera DC. Microleakage in vitro study comparative of class V cavity preparations by high speed and Er:YAG laser restored with aesthetic materials. *Rev inst scienc saude* 2005; 23(1): 47-52.
 23. Navarro RS, Gouw-Soares S, Cassoni A, Haypek P, Zezell DM, de Paula Eduardo C. The influence of erbium:yttrium-aluminum-garnet laser ablation with variable pulse width on morphology and microleakage of composite restorations. *Lasers Med Sci* 2010; 25(6): 881-9.
 24. Hallett KB, Garcia-Godoy F. Microleakage of resin modified glass ionomer cement restoration: An in vitro study. *Dent Mater* 1993; 9(5): 306-11.
 25. Castro A, Feigal RF. Microleakage of a new improved glass ionomer restorative material in primary and permanent teeth. *Pediatr Dent* 2002; 24(1): 23-8.
 26. Reis LS, Chinelatti MA, Corona SA, Palma-Dibb RG, Borsatto MC. Influence of air abrasion preparation on microleakage in glass ionomer cement restorations. *J Mater Sci Mater Med* 2004; 15(11): 1213-6.
 27. Tolidis K, Nobecourt A, Randall RC. Effect of a resin-modified glass ionomer liner on volumetric polymerization shrinkage of various composites. *Dent Mater* 1998; 14(6): 417-23.
 28. Leinfelder KF, Freedman G, Pakroo JS. Postoperative sensitivity: bonded cavity liners revisited. *Dent Today* 2001; 20(11): 82-7.
 29. Perdigo J, Geraldini S, Hodges JS. Total-etch versus self-etch adhesive: effect on postoperative sensitivity. *J Am Dent Assoc* 2003; 134(12): 1621-9.
 30. Aranha ACC, Turbino ML, Powell GL, Eduardo CP. Assessing microleakage of class V resin composite restorations after Er:YAG laser and bur preparation. *Lasers Surg Med* 2005; 37(2): 172-7.
 31. Niu W, Eto JN, Kimura Y, Takeda FH, Matsumoto K. A study on microleakage after resin filling of Class V cavities prepared by Er:YAG laser. *J Clin Laser Med Surg* 1998; 16(4): 227-31.
 32. Wright GZ, Mcconnell RJ, Keller U. Microleakage of class V composite restorations prepared conventionally with those prepared with an Er:YAG laser: a pilot study. *Pediatr Dent* 1993; 15(6): 425-6.
 33. 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; 73(2): 122-6.
 34. Palma Dibb R.G, Corona SAM, Borsatto MC, Ferreira KC,

- Pecora JD, Ramos RP. Assessing microleakage on class V composite resin restorations after Er:YAG laser preparation varying the adhesive systems. *J Clin Laser Med Surg* 2002; 20(3): 129-33.
35. Baghalian A, Nakhjavani YB, Hooshmand T, Motahary P, Bahramian H. Microleakage of Er:YAG laser and dental bur prepared cavities in primary teeth restored with different adhesive restorative materials. *Lasers Med Sci* 2013; 28(6):1453-60.
36. Olivi G, Genovese MD. Laser restorative dentistry in children and adolescents. *Eur Arch Paediatr Dent* 2011 Apr;12(2):68-78.