

# Microleakage of cervical cavities prepared by an Er:YAG laser or a high-speed handpiece, after restoration using resin composite

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**Objectives** The purpose of this *in vitro* study was to evaluate the microleakage of cervical cavities prepared by Er:YAG laser or high-speed hand piece and bur.

**Methods** This *in vitro* experimental study was performed on 40 sound permanent third molar teeth randomly assigned into two equal groups ( $n = 20$ ). In the first group, high-speed hand piece and bur and in the second group Er:YAG laser was used to prepare class V cavities on the buccal or lingual surfaces. Filtek Z250 composite resin was used as the restorative material. The teeth were thermocycled for 1000 cycles, placed in 2% methylene blue solution for 24 hours, sectioned at the center of restoration and evaluated under a stereomicroscope at x40 magnification for microleakage. Data were analyzed using Mann-Whitney U test at 0.05 level of significance.

**Results** There was no significant difference between the occlusal or gingival margin microleakage of cavities prepared with Er:YAG laser and high-speed hand piece ( $P = 0.445$  and  $P = 0.758$ , respectively). However, the difference in the occlusal and gingival margins was significant within the high-speed hand piece ( $P = 0.042$ ) and Er:YAG laser ( $P = 0.002$ ) groups.

**Conclusion** Cavity preparation by Er:YAG laser and high speed hand piece and bur is not significantly different in terms of microleakage.

**Keywords** lasers, solid-state, dental high-speed technique, dental leakage, composite resins

## Introduction

Patient anxiety is a major factor affecting the outcome of dental treatments. Usually disadvantages of Standard treatment for caries removal and cavity preparation entail an injection for local anesthesia, also noise and vibration that accompanies with mechanical hand piece. Cavity preparation by rotary instruments is associated with friction, heat generation, and even cracks formation.<sup>1</sup> It has been suggested that application of laser can solve these problems, resulting in a more comfortable treatment procedure for the patient.<sup>2</sup>

In the recent years, there has been growing interest in the use of lasers for routine cavity preparation and for conditioning of enamel and dentine surfaces as an alternative to conventional acid etch methods.<sup>3</sup> Early attempts for the use of laser for hard tissue removal was started in the 1960s.<sup>4</sup> Various problems have been named for hard tissue ablation by laser. Primary lasers had low ablation efficiency and their thermal effects including melting of mineralized tissues, carbonization of organic structures and necrosis of the pulp were among other disadvantages of these lasers.<sup>5</sup> Other types of lasers such as CO<sub>2</sub> and Nd:YAG, have been considered to be inappropriate for cavity preparation because of their heat generation and the resultant pulp damage as well as the formation of carbonization layer and cracks in teeth.<sup>5</sup> The advent of Er:YAG laser in 1975 was in response to search for a more effective method of tooth ablation. This type of laser was less invasive for the surrounding tissues because its wavelengths selectively absorb water in tissues and tissue destruction occurs by the explosive power at the time of water vaporization.<sup>3,5</sup> Also, it has been proven that this type of laser can effectively cut enamel and dentin,<sup>4</sup> and remove certain restorative materials at rates comparable to those of dental high-speed hand piece, without the side effects on tooth structure as the primary lasers.<sup>3</sup> The ability of lasers to alter the

surface of enamel and dentine has been comprehensively studied for many years. Studies on surface alterations of enamel and dentine after Er:YAG laser irradiation demonstrate micro-irregularities and lack of a smear layer. Such alterations cause both macro- and micro-roughness. Laser-induced changes in the surface texture of enamel and dentine could potentially affect microleakage of adhesive restorative materials.<sup>6</sup> In fact, given the increasing use of composite resin materials in restorative dentistry, the quality of the margins of composite restorations in terms of leakage is an important issue for clinicians when considering the use of laser for hard tissue preparation.

The aim of the present study was to examine the quality of the margins of composite restorations of cavities prepared with Er:YAG laser by means of well-established dye penetration test, and to compare it with high-speed hand piece and bur.

## Methods

After approval of the ethics committee at Shahid Sadoughi University of Medical Sciences (No: 94407), 40 patients who were candidates for third molar extraction by surgery agreed to participate in this study and signed informed consent forms. Sample size was calculated to be 40 assuming alpha = 0.05 and beta = 0.2.

This *in vitro* experimental study was performed on 40 sound freshly extracted third molar teeth. The teeth were cleaned and stored in distilled water at 4°C. The teeth were placed in 0.5% chloramine solution for one week at 4°C before the experiment.<sup>7</sup> The apices of the roots were sealed with composite resin in order to prevent subsequent penetration of dye into the pulp chamber during testing. The teeth were randomly allocated into two groups of 20 each. A standard class V cavity (4 mm wide, 3 mm high and 1.5 mm deep) was

prepared on the buccal or lingual surfaces of the teeth while the cervical cavosurface margin of the cavities was placed 1 mm below the cemento-enamel junction. Preparation depth was determined with a periodontal probe, while an electronic caliper (Mitutoyo, Tokyo, Japan) was used to verify the width and height.

The samples were prepared as follows:

Group 1: The cavities were prepared in buccal or lingual surfaces using a diamond cylinder bur (852.FG.010; Jota, Bern, Switzerland) in a high-speed hand piece.

Group 2: The cavities were prepared by Er:YAG laser (DEKA M.E.L.A. s.r.l., Florence, Italy) with 2.94  $\mu\text{m}$  wavelength. The output power and repetition rate were 200 mJ/pulse and 20 Hz, respectively. The energy density (fluence) was 25.71 J/cm<sup>2</sup>. The beam diameter was 0.5 mm, and the distance of laser tip from the surface was 7 mm. The irradiation distance was standardized by using a custom designed apparatus consisting of two parts: a holder to fix the laser hand piece in such a way that the laser beam was delivered perpendicular to the specimen surface, at a constant working distance from the target site; and a semi-adjustable base, on which the Plexiglas plate, with the fragment attached, was firmly fixed with wax. The surface was first wetted to avoid cracking and fusion and was cooled with water spray at a rate of 5 mL/minute during irradiation. After washing for 30 seconds, all cavities were etched with 37% phosphoric acid etchant gel (3M ESPE, St. Paul, MN, USA) and then bonded with a resin-based adhesive system according to the manufacturer's instructions. The adhesive used was Adper Single Bond (3M ESPE, St. Paul, MN, USA), which is a fifth generation one-bottle light-activated bonding agent, which was light cured for 20 seconds. The cavities were then restored with Filtek Z250 composite resin (3M ESPE, St. Paul, MN, USA), and irradiated with Blue-phase Style M8 LED light curing light (Ivoclar Vivadent, Schaan, Liechtenstein) with 800 mW/cm<sup>2</sup> light intensity for 40 seconds. This polywave LED light has optimal broadband spectrum of 385–515 nm, similar to the spectrum of halogen lights. All specimens were then stored in distilled water at room temperature for 24 hours and then, the surfaces of the restorations were polished using coarse, medium and fine grit flexible Sof-Lex polishing disks (3M ESPE, St. Paul, MN, USA) respectively.

The teeth were then subjected to thermal cycling for 1000 cycles, between 5°C and 55°C with 30 seconds of dwell time. Then, the teeth were mounted in self-cure acrylic resin (Flash Acrylic, Yates Motloid, Chicago, IL, USA) to a level 1 mm below the cemento-enamel junction, while the exposed crown and root structure were covered with two coats of nail varnish, leaving a 1 mm window around the cavity margins. The samples were then immersed in 2% methylene blue solution for 24 hours.<sup>6</sup> Any surface-adhered dye was carefully rinsed with tap water. To measure the

microleakage, the teeth were sectioned buccolingually<sup>4</sup> through the center of the restoration using diamond discs (Blade XL 12235) at a 250 rpm speed in a Lab cut Machine under constant water irrigation. Dye penetration along the occlusal (enamel) and cervical (dentin) margins was evaluated under a microscope (Mbc-10 Russian stereomicroscope) By Matabog Bucharest, Romania at x40 magnification. The degree of microleakage was scored using a five-point qualitative scale (Table 1).

### Statistical Analysis

The results were analyzed using Mann-Whitney U test. The level of significance was set at 5%.

### Results

Microleakage and the mean dye penetration scores for each group at the occlusal and gingival margins are shown in Table 2.

The Mann Whitney U test revealed significant differences in microleakage between the occlusal and gingival margins in high-speed hand piece and bur group ( $P = 0.042$ ). Also, there were significant differences in microleakage between the occlusal and gingival margins in the Er:YAG laser group ( $P = 0.002$ , Table 3). However, no statistically significant difference was seen in microleakage of the occlusal margin between high speed hand piece and laser groups ( $P = 0.445$ ). Also, there was no significant difference in microleakage at the gingival margin between high speed hand piece and Er:YAG laser groups ( $P = 0.758$ ).

### Discussion

In this study, marginal leakage of class V cavities prepared by high-speed hand piece and Er:YAG laser restored with composite was compared by the dye penetration method. Marginal leakage is a major challenge in restorative dentistry and occurs in case of presence of gap between the tooth structure and restorative material.<sup>8</sup>

Table 1. Qualitative scale for dye penetration

0	No dye penetration
1	Dye penetration through the cavity margin reaching less than 1/3 the depth of cavity wall
2	Dye penetration through the cavity margin reaching 1/3–2/3 the depth of cavity wall
3	Dye penetration through the cavity margin reaching more than 2/3 the depth of cavity wall
4	Dye penetration through the cavity margin reaching the axial wall of cavity

Table 2. Frequency and mean value of microleakage scores at occlusal and gingival margins

Cavity margin	Type of cavity preparation	Microleakage scores					P value
		0	1	2	3	4	
Occlusal	Er:YAG lased	7	9	2	2	0	0.445
	Bur cut	6	7	4	1	2	
Gingival	Er:YAG lased	1	6	6	5	2	0.758
	Bur cut	2	6	3	4	5	

Table 3. Comparison of microleakage score in occlusal and gingival margins by two methods of cavity preparation

Margins	Methods	Bur cut	Er:YAG lased
		Median	Median
Gingival		2	2
Occlusal		1	1
Total		1	1
P value		0.042	0.002

In the recent years, alternative methods for dental hard tissue preparation and surface roughening such as laser irradiation have been increasingly studied.<sup>9</sup> There has been a growing debate on the use of lasers for various applications in dentistry including cavity preparation considering efficient removal of dentin and enamel.<sup>10</sup> A number of studies have focused on the efficiency of Er:YAG laser for potential dental applications, such as removal of carious tooth structure, cavity preparation, sealing of pits and fissures, surface treatment, periodontal procedures, root canal sealing, endodontic surgery and soft tissue applications.<sup>10-14</sup> The interaction of bonding agents and dentin or enamel prepared by Er:YAG laser, and the effects of laser irradiation on the morphology of dental substrates, have not yet been well determined. But the results have been controversial in different studies.<sup>12,15</sup> In this respect, some studies reported that Er:YAG laser irradiation leaves a topographical characteristic on hard dental substrates that includes absence of smear layer, and no melting or carbonization.<sup>15,16</sup> In addition, the micro-ablative effect of Er:YAG laser causes vaporization of water and dental organic components, promoting a micro crater-like appearance in lased surfaces, which has been described to be favorable for adhesion of composite restorations.<sup>9</sup> Some studies have reported that the morphological alterations created on the tooth surface are not sufficient to bond composite effectively to the dental surface, which makes the cavities prepared by laser less receptive to adhesive procedures compared to conventional bur- prepared cavities.<sup>17,18</sup> In contrast, some other researchers reported that the prerequisites for conditioning of the hard dental substrate are best met by pulsed erbium lasers due to their thermomechanical ablation process that produces a rough dental surface similar to the etching process. Consequently, the primary indication for these systems is cavity preparation for composite restorations.<sup>3-6, 8,10,19</sup> Experimental studies and clinical trials have demonstrated the ability of Er:YAG laser to effectively ablate hard dental substrate with minimal injury to the pulp and the surrounding structures. Er:YAG laser has 2.94  $\mu\text{m}$  wavelength, which coincides with the main absorption peak of water and hydroxyapatite; thus, resulting in good absorption of erbium laser into all biological tissues, including enamel and dentin.<sup>5,20,21</sup> Despite the great diversity of dental materials, restoration of cervical lesions such as abrasion, erosion or abfraction still create a major challenge for professionals and researchers.<sup>5</sup> The margins of such restorations are generally located in dentin/cementum; thereby creating an additional difficulty for restorative materials that rely on chemical and/or mechanical bond to provide retention on tooth structure.

In cavity preparation, bonding of resin to enamel is achieved via micromechanical retention on the roughened surface; whereas, retention to dentin is based mainly on hybrid

layer formation and, to a lesser degree, on the micromechanical retention created by resin tags in dentin.<sup>22</sup> Therefore, formation of a hybrid layer and resin tags is essential for the establishment of a strong bond at the dentin level.<sup>1</sup> One way of achieving such a strong bond is complete dissolution of the smear layer and demineralization of intertubular and peritubular dentin by means of acid etching, resulting in an exposed collagen matrix that is infiltrated by resin, which is polymerized in situ. Some studies have assessed the ability of different settings of erbium lasers to improve marginal seal and bond strength, reporting a wide range of results.<sup>19</sup> Laser irradiation of enamel surfaces produces surface fissures and causes union or blending of distinctive etching pattern normally seen in acid-etched enamel. This blending effect probably prevents the penetration of resin into the enamel, resulting in lower enamel bond strength values.<sup>23</sup>

In this study, thermocycling was also used for aging of the restoration material to consider the difference in the coefficient of thermal expansion.<sup>24</sup>

Despite the difference in the cavity preparation technique in our study, the results showed that laser or bur treatments did not affect dye penetration along the composite-tooth interface. These results are in agreement with the findings of Arami et al.,<sup>8</sup> Subramaniam and Pandey<sup>25</sup> and Fumes et al.<sup>26</sup> But in the study by Subramaniam and Pandey,<sup>25</sup> Er, Cr:YSGG laser was used. Fumes et al.,<sup>26</sup> postulated that the acid-etching procedure is essential after laser ablation. The subsequent addition of acid etching to laser-prepared enamel produced a delicate etched pattern that assumed to be more retentive than that created by laser etching alone.<sup>27</sup> Daneshkazemi et al.,<sup>28</sup> showed that cavities prepared by Er:YAG laser had less microtensile bond strength than high speed hand piece.

While bonding to enamel has been reported with consistently predictable results, histological features of dentin. Composite resin should be bonded to wet dentin and dry enamel. This may not be easily achievable, because these two textures are in the vicinity.<sup>29</sup>

Regardless of some controversial results reported in the literature, there exists a certain consensus among researchers that resin-based adhesives bond less effectively to laser-irradiated than to bur-prepared dentin.<sup>27,30-32</sup> On the other hand, it remains unclear how adhesion is actually achieved on laser-irradiated dentin.<sup>33</sup>

When considering bonding to irradiated dentin surfaces, the odontoblastic tubules are opened by the erbium family of lasers, and therefore, laser prepared dentin reveals surface scaling that may lead to flaking and peritubular cuffing. This unusual appearance of laser-irradiated dentin can be understood by gaining insight into the ablation process.<sup>34</sup>

Franzen et al.,<sup>34</sup> proposed that the ablation of dentin fuses collagen fibrils together, resulting in a lack of interfibrillar space that restricts resin diffusion into the subsurface of intertubular dentin. A cross-sectional observation of resin bonded to laser-ablated dentin revealed a lack of penetration of resin and even peeling off of the resin layer from the ablated dentin surface, which supports the theory of resin restriction. However, acid etching procedures improve micromechanical bonding by completely removing nonorganic materials and exposing collagen fibers.<sup>19,35</sup> The findings of our study disclosed that the use of Er:YAG laser for cavity preparation may interfere with the enamel and/or dentin margin sealing. In addition, the degree of microleakage in

the laser prepared cavities was slightly less than that of bur prepared cavities in gingival margins. These findings may be the result of phosphoric acid etching of enamel/dentin surfaces prior to the application of adhesive bonding system. Korkmaz et al.,<sup>21</sup> used all-in-one self-etch adhesive systems in their study and did not use additional etching with phosphoric acid. They reported that microleakage in occlusal margins was significantly lower in bur compared to Er:YAG laser group. According to the results of our study, it seems that phosphoric acid etching of enamel margins could enhance the bond between the tooth and adhesive resin after Er:YAG laser application in enamel margins and resulted in non-significant difference in microleakage scores between the two methods of tooth preparation in occlusal margins.

In addition, similar to the results of Korkmaz et al.,<sup>21</sup> in our study, it was observed that microleakage at the cervical margin was greater than that at the occlusal margins for the two groups of laser or bur prepared cavities. These findings could be the result of different nature of dentin and enamel. Resin adhesion to dentin involves the formation of a 'hybrid zone' where micromechanical porosities are formed by the demineralization of dentin surface (intertubular and peritubular dentin), and opening of the dentinal tubules by acid etchants, which is followed by the introduction of hydrophilic primers and subsequent adhesion of monomer tags.<sup>31</sup> Furthermore, a shear bond strength study showed that Er:YAG laser created a laser-modified layer that adversely affected adhesion to dentin.<sup>36</sup> Alaghemand et al.,<sup>36</sup> observed that cavities prepared by laser appeared less receptive to adhesive procedures than cavities prepared by the conventional bur particularly in deep dentin. Korkmaz et al.,<sup>21</sup> stated that after acid-etching and laser conditioning of dentin, the effectiveness of hybridization is compromised because of the selective ablation of organic tissue, leading to less collagen left to be exposed and consequently to be hybridized. Korkmaz et al.<sup>21</sup> reported that when the cervical margins were compared, those in bur prepared group exhibited significantly less microleakage than those in Er:YAG laser group. They stated that the probable explanation for this result is that the cavosurface margins produced by Er:YAG laser irradiation are quite rough in comparison with the margins produced by bur preparation. Therefore, this marginal contouring could result in increased micro-spacing and greater leakage.<sup>20</sup>

In accordance with the results of our study, Moosavi et al.,<sup>37</sup> and Alaghemand et al.<sup>36</sup> reported that Er:YAG laser

can be used for cavity preparation in dentin. Sanhadji et al.<sup>38</sup> used Er:YAG laser for cavity preparation in the enamel, without adversely affecting the marginal integrity of restoration. However, they also emphasize that care must be taken when choosing the energy density. It has been demonstrated that an increase in pulse energy results in a deeper crater pattern in the tooth surface, which may influence the adaptation of the restorative material to the cavity walls. Contente et al.<sup>39</sup> evaluated thermal alterations taking place during Er:YAG laser cavity preparation in the enamel with different energy density and pulse repetition rates of laser. Temperature in cavity preparation by laser was measured and laser parameters included 250 and 300 mJ energy and 3,4,6,10 and 15 Hz. The results showed that elevation of temperature was related to laser pulse rates and there was no correlation between the temperature rise and energy density of laser. In this study, dye penetration was used to evaluate marginal leakage of prepared cavities. Since this method is reliable and reproducible, it has been used for assessment of marginal microleakage in many studies such as those by Savadi Oskoei et al.,<sup>2</sup> Arami et al.,<sup>6,8</sup> Korkmaz et al.,<sup>21</sup> Bahrololoomi and Heydari<sup>24</sup> and Sanhadji et al.<sup>38</sup>

It is possible that other adhesives yield different results, and future studies should explore the interaction of different adhesives with Er:YAG laser-irradiated teeth in an attempt to clarify the applicability and safety of this promising alternative for dental cavity preparation.

## Conclusion

Within the limitations of this *in vitro* study, there was no significant difference in marginal leakage between the two methods of cavity preparation.

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## Conflict of Interest

None. ■

## References

- Ercoli C, Rotella M, Funkenbushch PD, Russel S. *In vitro* comparison of the cutting efficiency and temperature production of ten different rotary cutting instruments. Part II. Electric handpiece and comparison with turbine. *J Prosthet Dent*. 2009;101:319–331.
- Savadi Oskoei S, Alizadeh Oskoei P, Jafari Navimipour E, Ajami AA, Pournaghi Azar F, Sahand Rikhtegaran S, et al. Comparison of the effect of Nd:YAG and diode lasers and photodynamic therapy on microleakage of class V composite resin restorations. *J Dent Res Dent Clin Dent Prospects*. 2013;7:74–80.
- Arbabzadeh Zavareh F, Samimi P, Birang R, Eskini M, Bouraima SA. Assessment of microleakage of class V composite resin restoration following erbium-doped yttrium aluminum garnet (Er:YAG) laser conditioning and acid etching with two different bonding systems. *J Lasers Med Sci*. 2013;4:39–47.
- Davari AR, Sadeghi M, Bakhshi H. Shear bond strength of an etch-and-rinse adhesive to Er:YAG laser- and/or phosphoric acid-treated dentin. *J Dent Res Dent Clin Dent Prospects*. 2013;7:62–67.
- Davoudi A, Sanei M, Badrian H. Application of laser irradiation for restorative treatments. *Open Dent J*. 2016;10:636–642.
- Arami S, Shahabi S, Tabatabaie M, Chiniforush N, Morshedi E, Torabi S. Assessing microleakage of composite restorations in class V cavities prepared by Er:YAG laser irradiation or diamond bur. *J Conserv Dent*. 2014;17:216–219.
- Andrade AM, Garcia E, Moura SK, Reis A, Loguercio A, Silva LM, et al. Do the microshear test variables affect the bond strength values? *Int J Dent*. 2012; 2012:618960.
- Sadeghi M, Davari AR, Christopher DL. The effect of re-bonding using surface sealant or adhesive system on microleakage of class V resin composite restorations. *Dent Res J*. 2013;10:596–601.

9. Chaves FO, Farias NC, Medeiros LM, Alonso RC, DI Hipólito V, D'Alpino PH. Mechanical properties of composites as functions of the syringe storage temperature and energy dose. *J Appl Oral Sci.* 2015;23:120–128.
10. De Moor RJ, Delmé KI. Laser-assisted cavity preparation and adhesion to erbium-lased tooth structure: part 1. Laser-assisted cavity preparation. *J Adhes Dent.* 2009;11:427–438.
11. Olivi G, Genovese MD, Caprioglio C. Evidence-based dentistry on laser paediatric dentistry: review and outlook. *Eur J Paediatr Dent.* 2009;10:29–40.
12. Esteves-Oliveira M, de Guglielmi CA, Ramalho KM, Arana-Chavez VE, de Eduardo CP. Comparison of dentin root canal permeability and morphology after irradiation with Nd:YAG, Er:YAG, and diode lasers. *Lasers Med Sci.* 2010;25:755–760.
13. Pozza DH, Fregapani PW, Xavier CB, Weber JB, Oliveira MG. CO<sub>2</sub> Er:YAG and Nd:YAG lasers in endodontic surgery. *J Appl Oral Sci.* 2009;17:596–599.
14. Souza-Gabriel AE, Chinelatti MA, Borsatto MC, Pecora JD, Palma-Dibb RG, Corona SA. SEM analysis of enamel surface treated by Er:YAG laser: influence of irradiation distance. *Microsc Res Tech.* 2008;71:536–541.
15. Moosavi H, Ghorbanzadeh S, Ahrari F. Structural and morphological changes in human dentin after ablative and subablative Er:YAG laser irradiation. *J Lasers Med Sci.* 2016;7:86–91.
16. Li Z, Fang C. Bactericidal effects and smear layer removal of Er:YAG-laser radiation against *Enterococcus faecalis* in root canals. *Zhong Nan Da Xue Xue Bao Yi Xue Ban.* 2017;42:328–333.
17. Kolinotou-Koumpia E, Kouros P, Zafiriadis L, Koumpia E, Dionysopoulos P, Karagiannis V. Bonding of adhesives to Er:YAG laser-treated dentin. *Eur J Dent.* 2012;6:16–23.
18. Delfino CS, Souza-Zaroni WC, Corona SA, Palma-Dibb RG. Microtensile bond strength of composite resin to human enamel prepared using erbium: Yttrium aluminum garnet laser. *J Biomed Mater Res A.* 2007;80:475–479.
19. Jaber Ansari Z, Fekrazad R, Feizi S, Younessian F, Kalhori KA, Gutknecht N. The effect of an Er,Cr:YSGG laser on the micro-shear bond strength of composite to the enamel and dentin of human permanent teeth. *Lasers Med Sci.* 2012;27:761–765.
20. Ozel E, Korkmaz Y, Attar N. Influence of location of the gingival margin on the microleakage and internal voids of nanocomposites. *J Contemp Dent Pract.* 2008;9:65–72.
21. Korkmaz Y, Ozel E, Attar N, Bicer CO, Firatli E. Microleakage and scanning electron microscopy evaluation of all-in-one self-etch adhesives and their respective nanocomposites prepared by erbium: yttrium-aluminum-garnet laser and bur. *Lasers Med Sci.* 2010;25:493–502.
22. Farmakis E, Kozyrakis K, Kontakiotis E, Kouvelas N. Effect of Er, Cr: YSGG laser on human dentin collagen: a preliminary study. *J Laser Dent.* 2008;16:15–20.
23. de Jesus Tavares RR, Lima Bezerra G, de Souza Penha KJ, Torres CR, Firoozmand LM. Er:YAG pre-treatment for bonding of orthodontic bracket: 1 year of in vitro treatment. *Clin Cosmet Investig Dent.* 2017;9:19–25.
24. Bahrololoomi Z, Heydari E. Assessment of tooth preparation via Er:YAG laser and bur on microleakage of dentin adhesives. *J Dent (Tehran).* 2014;11:172–178.
25. Subramaniam P, Pandey A. Assessment of microleakage of a composite resin restoration in primary teeth following class III cavity preparation using Er,Cr:YSGG laser: an in vitro study. *J Lasers Med Sci.* 2016;7:172–176.
26. Fumes AC, Longo DL, De Rossi A, Fidalgo TKDS, de Paula E Silva FWG, Borsatto MC, et al. Microleakage of sealants after phosphoric acid, Er:YAG laser and air abrasion enamel conditioning: systematic review and meta-analysis. *J Clin Pediatr Dent.* 2017;41:167–172.
27. Cardoso MV, De Munck J, Coutinho E, Ermis RB, Van Landuyt K, de Carvalho RC, et al. Influence of Er, Cr:YSGG laser treatment on microtensile bond strength of adhesives to enamel. *Oper Dent.* 2008;33:448–455.
28. Daneshkazemi AR, Modabber M, Davari AR, Ravaii S, Javadi ZS, Daneshkazemi P. Comparative study on microtensile bond strength of silorane-based composite in dentin cavity prepared with erbium: yttrium aluminum garnet laser versus bur-cut. *J Int Oral Health.* 2016;8:843–849.
29. Usha C, Ramarao S, John BM, Rajesh P, Swatha S. Evaluation of the shear bond strength of composite resin to wet and dry enamel using dentin bonding agents containing various solvents. *J Clin Diagn Res.* 2017;11:ZC41-ZC44.
30. Cardoso MV, Coutinho E, Ermis RB, et al. Influence of dentin cavity surface finishing on micro-tensile bond strength of adhesives. *Dent Mater.* 2008;24:492–501.
31. Davari AR, Ataei E, Assarzadeh H. Literature review dentin hypersensitivity: etiology, diagnosis and treatment; a literature review. *J Dent Shiraz Univ Med Science.* 2013;14:136–145.
32. He Z, Otsuki M, Sadr A, Tagami J. Acid resistance of dentin after erbium: yttrium-aluminum-garnet laser irradiation. *Lasers Med Sci.* 2009;24:507–513.
33. Jafari A, Shahabi S, Chiniforush N, Shariat A. Comparison of the shear bond strength of resin modified glass ionomer to enamel in bur-prepared or lased teeth (Er:YAG). *J Dent (Tehran).* 2013;10:119–123.
34. Franzen R, Kianimanesh N, Marx R, Ahmed A, Gutknecht N. Fracture forces of dentin after surface treatment with high speed drill compared to Er:YAG and Er, Cr:YSGG laser irradiation. *Anal Cell Pathol (Amst).* 2016;2016:8517947.
35. Lee BS, Lin PY, Chen MH, Hsieh TT, Lin CP, Lai JY, et al. Tensile bond strength of Er, Cr:YSGG laser-irradiated human dentin and analysis of dentin-resin interface. *Dent Mater.* 2007;23:570–578.
36. Alaghehmand H, Nezhad Nasrollah F, Nokhbatolfoghahaei H, Fekrazad R. An *in vitro* comparison of the bond strength of composite to superficial and deep dentin, treated with Er:YAG laser irradiation or acid-etching. *J Lasers Med Sci.* 2016;7:167–171.
37. Moosavi H, Ghorbanzadeh S, Ahrari F. Structural and morphological changes in human dentin after ablative and subablative Er:YAG laser irradiation. *J Lasers Med Sci.* 2016;7:86–91.
38. Sanhadji El Haddar Y, Cetik S, Bahrami B, Atash R. A comparative study of microleakage on dental surfaces bonded with three self-etch adhesive systems treated with the Er:YAG laser and bur. *Biomed Res Int.* 2016;2016:2509757.
39. Contente MM, de Lima FA, Galo R, Pécora JD, Bachmann L, Palma-Dibb RG, et al. Temperature rise during Er:YAG cavity preparation of primary enamel. *Lasers Med Sci.* 2012;27:1–5.

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