Caspian Journal of Dental Research
e-ISSN: 2322-2395 p-ISSN: 2251-9890
Babol University Of Medical Sciences

Effect of diode laser and light-emitting diode (LED) activated bleaching with 35% hydrogen peroxide on microleakage of class-V composite restorations: An in vitro study

Pouya Abedi [1]✉, Zahra Mohyadin [1]✉, Sara Hosseini [1]✉, Mehdi Abbasi [2*]

1.Dentistry Student, Student Research Committee, Rafsanjan University of Medical Sciences, Rafsanjan, Iran.
2. Assistant Professor, Department of Operative Dentistry, School of Dentistry, Rafsanjan University of Medical Sciences, Rafsanjan, Iran.

Article Type

Research Paper

Received: 11 Oct 2021
Revised: 22 Nov 2021
Accepted: 5 Jan 2022

ABSTRACT

Introduction: Residual oxygen-free radicals of bleaching agents before composite restorations can increase microleakage in enamel and dentin margins, and also various bleaching techniques are being developed using light sources. The present study was conducted to compare the effect of diode laser bleaching and LED activated bleaching on the microleakage of composite restorations.

Materials & Methods: This in-vitro study was conducted on 84 extracted human premolars in three groups: In group one, class-V cavities were prepared and the teeth (n=12) were restored with composite ten days after bleaching with 35% hydrogen peroxide with no activator. In groups two and three (n=36 each), the teeth were bleached with a Diode laser activator and LED, respectively. Thereafter, each group was divided into three subgroups (n=12), cavities were prepared and restored with composite three, five, and ten days after bleaching. Digital photographs were used to assess microleakage in the enamel and dentin margins. Data were analyzed using Friedman and Wilcoxon Signed Ranks tests ($p<0.05$).

Results: The lowest amount of microleakage in the enamel margin pertained to the diode laser ten-day subgroup (0.17±0.38) and the diode laser ten-day subgroup in the dentin margin (0.50±1.03). Also, the highest amount of microleakage in the LED group was in the three-day subgroup of the dentin margin (2.78±0.42). Five-day subgroup of diode laser-activated bleaching had a lower amount of microleakage compared to the control group (P=0.042).

Conclusion: It may be concluded that diode laser-activated bleaching with 35% hydrogen peroxide has a better effect on reducing microleakage with an interval of five to ten days, compared to the control and LED activated bleaching group.

Keywords: Tooth Bleaching, Hydrogen Peroxide, Light, Diode Laser, Dental Leakage

Cite this article: Abedi P, Mohyadin Z, Hosseini S, Abbasi M. Effect of diode laser and light-emitting diode (LED) activated bleaching with 35% hydrogen peroxide on microleakage of class-V composite restorations: An in vitro study. Caspian J Dent Res 2022; 11:8-14.

© The Author(s).
Publisher: Babol University of Medical Sciences

* **Corresponding Author:** Mehdi Abbasi, School of Dentistry, Rafsanjan University of Medical Sciences, Rafsanjan, Iran.
Tel: +983434280013
E-mail: abassi_mehdi@yahoo.com

[Downloaded from cjdr.ir on 2026-11-12]
[DOR: 20.1001.1.22519890.2022.11.1.6.2]
[DOI: 10.22088/cjdr.11.1.8]

[Downloaded from cjdr.ir on 2026-11-12]

[DOR: 20.1001.1.22519890.2022.11.1.6.2]

[DOI: 10.22088/cjdr.11.1.8]

Introduction

Dental bleaching is a conservative, effective, and fairly safe aesthetic treatment for the teeth and one of the most popular dental treatments for dentists and patients.[1] Bleaching techniques are categorized as in-office and home bleaching.[2] However various types of in-office bleaching gels and methods have been generated, bleaching agents for at-home technique contain carbamide peroxide or hydrogen peroxide (H2O2) in low concentrations from 10% to more than 45% for carbamide peroxide and 3% to 14% for H2O2.[3] In-Office bleaching contains high concentrations of both peroxides containing 30-40% H2O2.[4] H2O2 may change the structure of the teeth, including color, roughness, and surface hardness. These changes may decrease bond strength and increase microleakage at the restorative material interface with the tooth tissue.[5]

Despite that, after the bleaching procedure teeth may require treatments like diastema closures or cavity preparations for fillings. An interval of seven to ten days is advised from the time bleaching is over until the bonding procedure is performed, to allow for the removal of the oxygen-free radical residue left inside the tooth structure as a result of the decomposition of the bleaching agents. These radicals can interfere with the process of polymerization of the bonding agents and composites, resulting in increased marginal microleakage.[6] However, this delay time is not possible due to the dentist's lack of time or personal patient issues. Microleakage is defined as the penetration of bacteria, fluids, molecules, or ions into the spaces between the cavity wall and the restorative material, and clinically, is one of the major factors involved in the decomposition of the adhesive bond and the reduced sustainability of composite restorations.[7, 8] According to current studies, bleaching negatively affects the integrity of the restoration margin and there are many studies on the post-bleaching microleakage of composite resin restorations. [9, 10]

Light or laser can be used in surgery to hasten the activation of the bleaching gel.[11] Hydrogen peroxide (30-38%) is used in light-activated bleaching. The source of light can be plasma arc lamps, halogen or xenon lamps, light-emitting diode (LED), or laser.[12] Over the years, studies have investigated the effect of different lasers (including diode lasers) on dental treatments due to their appropriate size, cost-effectiveness, durability, and safety.[13, 14] Diode lasers are low-power lasers that can reverse the adverse effect of bleaching by eliminating free radicals and thus improve bond strength.[15, 16]

Some studies have examined the penetration of dye through restorations and their margins before bleaching,[17-19] but there is still controversy about the effect of bleaching before and after restoration on the microleakage of composite restorations. As some studies showed an increased risk of microleakage in dentin margins soon after bleaching with carbamide peroxide in different consentrations[17, 18, 20] but another study didn't find any effects on the marginal seal.[21] Another study advised postponing the placement of composites for two weeks after bleaching with 37% hydrogen peroxide as it can increase the risk of microleakage.[22]

Despite their increasing popularity, there is a lack of information about the effectiveness of diode lasers with different wavelengths, and it is not yet clear how light-activated bleaching using different light sources and peroxides will affect the composite restoration margin sealing and whether damaged restorations should be replaced or not. The present in-vitro study was therefore designed and conducted to compare the effect of bleaching with 35% hydrogen peroxide with and without LED light activator or diode laser on the microleakage of the enamel and dentin margins of class-V composite restorations three, five, and ten days after the completion of bleaching.

Materials & Methods

The ethical approval was obtained from the Ethics Committee of Rafsanjan University of Medical Sciences (IR.RUMS.REC.1398.058). In this in-vitro study, 84 freshly extracted human permanent premolars were selected. Extractions were due to orthodontic problems and as a part of the treatment plan. They had no caries, restorations, root canal treatments, or fractures were selected and kept in distilled water until it was time to begin the experiments. They were then divided into three groups:

In group one (n=12), the teeth were bleached with an in-office bleaching agent opalescence boost, 35% hydrogen peroxide gel (Ultradent Products Inc, South Jordan, Utah, USA) with no light activator according to the manufacturer's instructions, as follows: A 2-mm-layer of the gel was placed on the entire buccal surface of each tooth and after 20 minutes, it was rinsed for 30 seconds. This process was repeated twice more with an interval of one minute between each repetition.

In group two (n=36), bleached teeth (by the same method as before) were exposed to diode laser (Doctor Smile Dental Laser, Genova, Italy) continuous mode, with 5 W of power, 300 Hz frequency, and 980 nm wavelength at 0.5 mm distance from the buccal surface of the tooth, in a way that the laser light covered the entire buccal surface for 20 seconds. This process was repeated three times.[23]

In group three (n=36), teeth were bleached (by the same method as before) using a Woodpecker LED curing light instrument (Guilin Woodpecker Medical Instrument Co., Beijing, China) at 760 MW/cm^2 intensity and 1-2 mm distance from the buccal surface of the tooth, such that the light from the LED could cover the entire surface of the tooth for 40 seconds. Also, this process was repeated three times.[24]

In group one (control), ten days after the bleaching process, cavity preparation followed by composite restoration of the teeth. Groups two and three were divided into three subgroups each (n=12), and cavity preparation and composite restoration of the teeth were carried out for them three, five, and ten days after the bleaching process. A diamond fissure bur was used to drill a class-V cavity 3 mm mesiodistally, 2 mm occlusogingivally and 1.5 mm in axial depth with 1 mm extension apical to CEJ (the dentin gingival margin) and 1 mm extension occlusal to CEJ (occlusal margin in the enamel) along with a 45-degree enamel margin bevel at the buccal surface of all the teeth. The restoration process was as follows: After 15 seconds of etching using 35% phosphoric acid (3M ESPE, St. Paul MN, USA), the cavities were rinsed for 10 seconds and then air-dried for 10 seconds. Then, Adper^{TM} Single Bond 2 (3M ESPE, St. Paul, Minnesota, USA) was put on the cavity walls and light-cured for 20 seconds using the Woodpecker curing instrument (Guilin Woodpecker Medical Instrument Co., Beijing, China). Next, Z250 composite, shade A2 (3M ESPE, St. Paul, Minnesota, USA) was placed in one increment inside the cavity and cured for 40 seconds by the Woodpecker curing instrument. The samples from all groups were kept in 100% humidity at room temperature for one month after restoration and underwent 1500 thermal cycles (Vafaie Co., Tehran, Iran) at a temperature of 5 to 55 °C.[25]

The apex of all the samples was sealed with sticky wax and the surfaces of all the teeth (except for the restorations and 1 mm from the margins) were covered with two coats of nail varnish. The samples were then submerged in 2% Fuchsin solution and incubated at 37 °C for 24 hours. The surface stain was rinsed with tap water, a rubber cap, and pumice powder. Then, each tooth was bisected longitudinally in a buccolingual direction using a diamond disc cutting machine (Mecatome, T201A, PRESI, France). The microleakage in the occlusal (enamel) and gingival (dentin) margins were examined using digital photographs (Nikon D3200, Bangkok, Thailand) and Photoshop-8 with 20x magnification and an accuracy of 0.1 mm. A standard scoring system was applied as follows:

No microleakage =0

Penetration to 1/3rd of the cavity depth =1

Penetration between 1/3rd and 2/3rd of the cavity depth =2

Penetration to more than 2/3rd of the cavity depth up to the axial wall =3.[26]

The collected data were analyzed using SPSS 22.0. The Shapiro-Wilks test was used to assess the normal distribution of the data. This test showed that the data were not normally distributed ($P<0.05$); therefore, the Friedman and Wilcoxon Signed Ranks tests were used to analyze the data. $P<0.05$ was taken as the level of statistical significance.

Results

Friedman's test showed that the difference between microleakages in the enamel and dentin margins and the control group was significantly different in all groups ($P<0.05$). Table 1 presents a Pairwise comparison of the subgroups with the control group and the mean±standard deviation of microleakage score in all subgroups by enamel and dentin margins.

[Downloaded from cjdr.ir on 2026-11-12]

[DOR: 20.1001.1.22519890.2022.11.1.6.2]

[DOI: 10.22088/cjdr.11.1.8]

Results show that microleakage in group two (diode laser) was significantly lower on day ten compared to the three-day and five-day subgroups (P=0.003 and P=0.001 respectively). Yet, in group three (LED), microleakage was significantly higher on day three than on days five and ten (P=0.009 and P=0.001, respectively).

Table 1. A comparison of microleakage mean±standard deviations of the bleaching subgroups and the control group based on the enamel and dentin margins

Group	Subgroup	Sample Size	Mean ± SD			
			Enamel	P-Value	Dentin	P-Value
Group 1 (control)	---------	12	1.22±1.10	-	1.83±1.40	-
	3-day	12	1.00±1.22[a]	0.99	0.78±1.10[e]	0.002**
	5-day	12	0.83±1.03[a]	0.042**	1.39±1.27[h]	0.050**
	10-day	12	0.17±0.38[b]	<0.001**	0.50±1.03[e]	<0.001**
	3-day	12	1.44±1.48[c]	0.615	2.78±0.42[g]	0.001**
	5-day	12	0.72±1.11[a]	0.196	1.89±1.39[f]	0.936
	10-day	12	0.89±1.12[a]	0.256	1.67±1.39[h]	0.489

*The mean values with the same superscripts are not significantly different in each enamel and dentin margins according to Wilcoxon Signed Ranks Test (P>0.05)

**Different compared to control group was statistical significant according to Wilcoxon Signed Ranks Test

The lowest amount of microleakage in the enamel margin pertained to the diode laser ten-day subgroup (P<0.001) and to the diode laser ten-day subgroup in the dentin margin (P<0.001). Also, the highest amount of microleakage in the LED group was in the three-day subgroup of the dentin margin (P=0.001). In the other subgroups, there was no significant difference compared to the control group.

Discussion

In the present study, diode laser reduced microleakage in both enamel and dentin margins, and LED did not significantly change it. This may be attributed to the power densities, different times of gel application, or the heat each of them produces. Microleakage mean in the five-day subgroup of the diode laser group was statistically lower than the control group which shows the effect of diode laser-activated bleaching with 35% hydrogen peroxide in reducing the time between office bleaching and adhesive restoration. This is consistent with what has been found in a recent study by Cevval Ozkocak et al.[27] which reported that diode laser-assisted bleaching can be used as an alternative method today because it makes the operation time shorter and causes minimal morphological changes on the enamel surface but a waiting time of at least 7 days will increase the bond strength.

This study put together class-V cavities with occlusal enamel margin and gingival dentin margin to assess the effect of pre-restorative bleaching on microleakage on each of them on different days. The pre-restorative bleaching microleakage can be due to the oxygen residue on the tooth surface, which hinders bonding polymerization. Also, the bleached enamel etched with 37% phosphoric acid has an unclear etching pattern and fragile resin tags that make it penetrate less deeply compared to the control group, which can decrease restoration bonding to the enamel leading to increased microleakage.[28]

According to the results, in the diode laser-activated group, microleakage in the dentin margin was significantly lower on all days compared to the control group, and restoration microleakage was lower after ten days compared to the other subgroups. A possible reason could be the elapse of a longer time and the induced laser heat in this subgroup, which could have led to the evaporation of the remaining bleaching agents and the decline in oxygen free radicals in the tooth, and might have reduced microleakage by increasing the composite bond to the tooth.[29]

The results also showed that the lowest amount of microleakage in the enamel margin was in the ten-day subgroup of the diode laser, with similar reasons as above. Other studies have argued that bleaching a vital tooth changes the

[Downloaded from cjdr.ir on 2026-11-12]

[DOR: 20.1001.1.22519890.2022.11.1.6.2]
[DOI: 10.22088/cjdr.11.1.8]

protein and minerals of the enamel surface layers, which may reduce the bond strength.[29] In agreement with this finding, Bulucu et al. [30] showed that there was less microleakage in the enamel margin cavity than the dentin margin. They also found that microleakage was significantly higher in the LED activated group compared to the other groups, which concurs with the present findings. Moreover, Loretto et al. [31] argued that the type of light activator has no effects on the enamel bond strength immediately after bleaching, which disagrees with the present findings, perhaps due to the difference in the time of assessing the microleakage or the difference in bleaching agents used since they used carbamide peroxide 10% in their study which acts as a home bleaching agent.

As discussed above, another effect of bleaching is weakening the enamel structure due to enamel minerals and organics oxidation, which changes its microhardness, and these changes are due to minerals absorption or loss,[32] which can affect the restoration microleakage. Zhang et al. [33] stated that hydrogen peroxide 35% bleaching with diode laser and LED activators did not significantly change the enamel's microhardness. To our knowledge, there are very few studies on light-activated bleaching before composite restorations, making it impossible to compare the present findings with the results of further similar studies. The researchers recommend that other parameters related to restoration bonding, such as bond strength, also be assessed in future studies, so that the effect of a diode laser or LED activated bleaching can be further investigated.

Conclusion

It may be concluded that diode laser-activated bleaching with 35% hydrogen peroxide has a better effect on reducing microleakage with an interval of five to ten days, compared to the control and LED activated bleaching group. Since this study had not stimulated the exact oral conditions, it should be supported by clinical studies.

Acknowledgments

We would like to express our profound gratitude to Rafsanjan University of Medical Sciences for financial support.

Funding

This study was a research project (Grant No: 990080), supported and funded by Rafsanjan University of Medical Sciences.

Conflicts of Interest

The authors certify that they have no conflict of interest.

Authors' Contribution

M. Abbasi helped with study design and data analysis. P. Abedi helped in manuscript writing and editing. Z. Mohiadin and S. Hosseini helped in data collection. All authors read and approved the final manuscript.

References

1.Matis BA, Cochran MA, Eckert G. Review of the effectiveness of various tooth whitening systems. Oper Dent 2009;34:230-5.
2.Joshi SB. An overview of vital teeth bleaching. J Interdiscip Dent 2016; 6:3.
3.Hilton, TJ,Ferracane JL, Broome JC, editors. Summitt's Fundamentals of Operative Dentistry: A Contemporary Approach. 3rd ed. Chicago: Quintessence Pub Co; 2006. p. 437-62.

[Downloaded from cjdr.ir on 2026-11-12]
[DOR: 20.1001.1.22519890.2022.11.1.6.2]
[DOI: 10.22088/cjdr.11.1.8]

4.Sari T, Celik G, Usumez A. Temperature rise in pulp and gel during laser-activated bleaching: in vitro. Lasers Med Sci 2015;30:577-82.
5.Anagnostou M, Chelioti G, Chioti S, Kakaboura A. Effect of tooth-bleaching methods on gloss and color of resin composites. J Dent 2010;38 ((Suppl 2):e129-36.
6.Feiz A, Mosleh H, Nazeri R. Evaluating the effect of antioxidant agents on shear bond strength of tooth-colored restorative materials after bleaching: a systematic review. J Mech Behav Biomed Mater 2017; 71:156-64.
7.Frassetto A, Breschi L, Turco G, Marchesi G, Di Lenarda R, Tay FR, et al. Mechanisms of degradation of the hybrid layer in adhesive dentistry and therapeutic agents to improve bond durability—A literature review. Dent Mater2016;32:41-53.
8.Waldman GL, Vaidyanathan TK, Vaidyanathan J. Microleakage and resin-to-dentin interface morphology of pre-etching versus self-etching adhesive systems. Open Dent J 2008;2:120.
9.Roubickova A, Dudek M, Comba L, Housova D, Bradna P. Effect of postoperative peroxide bleaching on the marginal seal of composite restorations bonded with self-etch adhesives. Oper Dent 2013;38:644-54.
10.White DJ, Duschner H, Pioch T. Effect of bleaching treatments on microleakage of Class I restorations. J Clin Dent 2008;19:33-6.
11.Rocha Gomes Torres C, Caneppele TM, Del Moral de Lazari R, Ribeiro CF, Borges AB. Effect of dental surface treatment with Nd: YAG and Er: YAG lasers on bond strength of resin composite to recently bleached enamel. Lasers Med Sci 2012;27:755-60.
12.Buchalla W, Attin T. External bleaching therapy with activation by heat, light or laser—a systematic review. Dent Mater 2007;23:586-96.
13.Al-Qahtani AS, AlZain SA, AlHamdan EM, Tulbah HI, Al Alsheikh HM, Naseem M, et al. A comparative evaluation of the effect of phototherapy of fiber post on its bond strength to dental composite. Photodiagnosis Photodyn Ther 2018;24:228-31.
14.Gutiérrez-Corrales A, Rizcala-Orlando Y, Montero-Miralles P, Volland G, Gutiérrez-Pérez JL, Torres-Lagares D, et al. Comparison of diode laser–oral tissue interaction to different wavelengths. In vitro study of porcine periodontal pockets and oral mucosa. Med Oral Patol Oral Cir Bucal 2020;25:e224-32.
15.Torres CR, Zanatta RF, Silva TJ, Huhtala MF, Borges AB. Influence of previous acid etching on bond strength of universal adhesives to enamel and dentin. Gen Dent 2017;65:e17-e21.
16.Curylofo FA, Messias DC, Silva-Sousa YT, Souza-Gabriel AE. Bond strength of restorative material to dentin submitted to bleaching and Er: YAG laser post-treatment. Photomed Laser Surg 2014;32:495-9.
17.Shinohara MS, Rodrigues JA, Pimenta LA. In vitro microleakage of composite restorations after nonvital bleaching. Quintessence Int 2001;32:413-7.
18.Deliperi S, Bardwell DN, Wegley C, Congiu MD. In vitro evaluation of giomers microleakage after exposure to 33% hydrogen peroxide: self-etch vs total-etch adhesives. Oper Dent 2006;31:227-32.
19.Mortazavi V, Fathi M, Soltani F. Effect of postoperative bleaching on microleakage of etch-and-rinse and self-etch adhesives. Dent Res J (Isfahan) 2011;8:16-21.
20.Yazici AR, Keleş A, Tuncer D, Başeren M. Effect of Prerestorative Home-bleaching on Microleakage of Self-etch Adhesives. J Esthet Restor Dent2010;22:186-92.
21.Crim GA. Prerestorative bleaching: effect on microleakage of Class V cavities. Quintessence Int 1992;23:823-5.
22.Yassen AA, Haridy MF. Leakage of low shrinkage composite with pre and post-restorative tooth bleaching protocols. Egyptian Dent J 2014;60:3179.
23.Kiomarsi N, Arjmand Y, Kharrazi Fard M J , Chiniforush N. Effects of erbium family laser on shear bond strength of composite to dentin after internal bleaching. J Lasers Med Sci 2018;9:58-62.
24.Yavuz T, Ozyilmaz OY, Ozturk AN, Aykent F. Bond strength of resin composite to light-activated bleached enamel. Niger J Clin Pract 2016;19:766-71.
25.Morresi AL, D'Amario M, Capogreco M, Gatto R, Marzo G, D'Arcangelo C, et al. Thermal cycling for restorative materials: does a standardized protocol exist in laboratory testing? A literature review. J Mech Behav Biomed Mater 2014;29:295-308.

[Downloaded from cjdr.ir on 2026-11-12]
[DOR: 20.1001.1.22519890.2022.11.1.6.2]
[DOI: 10.22088/cjdr.11.1.8]

26.Khoroushi M, Fardashtaki SR. Effect of light-activated bleaching on the microleakage of Class V tooth-colored restorations. Oper Dent 2009;34:565-70.
27.Cevval Ozkocak BB, Aytac Bal F. Effect of diode laser-assisted bleaching on the bond strength of different adhesive systems to enamel: Interfacial SEM analysis. Microsc Res Tech 2021; 84:1542-52.
28.Attin T, Hannig C, Wiegand A, Attin R. Effect of bleaching on restorative materials and restorations—a systematic review. Dent Mater 2004;20:852-61.
29.Alqahtani MQ. Tooth-bleaching procedures and their controversial effects: A literature review. Saudi Dent J 2014;26:33-46.
30.Bulucu B, Ozsezer E, Ertaş E, Yüksel G. The effect of different light sources on microleakage of bleached enamel. Dent Mater 2008;27:598-604.
31.Loretto SC, Braz R, Lyra AM, Lopes LM. Influence of photopolymerization light source on enamel shear bond strength after bleaching. Braz Dent J 2004;15:133-7.
32.Lippert F, Lynch RJ.Comparison of Knoop and Vickers surface microhardness and transverse microradiography for the study of early caries lesion formation in human and bovine enamel. Arch Oral Biol 2014;59:704-10.
33.Zhang C, Wang X, Kinoshita J, Zhao B, Toko T, Kimura Y, et al. Effects of KTP laser irradiation, diode laser, and LED on tooth bleaching: a comparative study. Photomed Laser Surg 2007;25:91-5.

[Downloaded from cjdr.ir on 2026-11-12]
[DOR: 20.1001.1.22519890.2022.11.1.6.2]
[DOI: 10.22088/cjdr.11.1.8]