10.21608/adjc.2023.234098.1393 Advanced Dental Journal
Volume 6 (2024) | Issue 3| Pages 431 - 444

Original Article

Comparison of Microleakage around Resin Composite Restorations bonded to Er, Cr:YSGG Laser Treated Enamel and Dentin Surfaces versus Conventional Acid Etching: An In-Vitro Study

Lobna Hamed Taha Saad[1], Inas Mohsen El-Zayat[2], Olfat ElSayed Hassanein[3]

[1]Master's degree candidate at the Conservative Dentistry Department, Faculty of Oral and Dental Medicine, Misr International University, Cairo, Egypt.

[2] Associate Professor at Conservative Dentistry, Operative division, Faculty of Oral and Dental Medicine, Misr International University.

[3] Head of Conservative Dentistry Department, Faculty of Dentistry, Cairo University.

Email: lobnahamed88@gmail.com

Submitted: 26-9-2023
Accepted: 20-10-2023

Abstract

Aim: The aim of the current study was to determine the effect of Er, Cr:YSGG laser surface treatment on enamel and dentin compared to conventional acid etching on the marginal integrity of resin composite.

Subjects and methods: Sixty-four sound human permanent molars were used in this study. Teeth were randomly divided into 4 groups, 16 each, according to the type of surface treatment used. Group (A) Universal Adhesive on enamel and dentin (etch & rinse strategy), group (B) Laser surface treatment on enamel & dentin, group (C) Laser surface treatment and etching on enamel and dentin and group (D) selective etch on enamel and Laser on dentin. In all groups the cavities were then restored with resin composite. All groups were further divided into two subgroups; the specimens of the first subgroup for immediate evaluation after 24 hours and second subgroup were subjected to 10000 thermal cycles between 5-55°C proposed to represent approximately 1 year in-vivo. Teeth were sectioned longitudinally in a buccolingual direction and observed under a stereomicroscope to determine microleakage.

Results: The results showed that there was no statistical significance obtained in both immediate groups (p-value =0.78) and thermocycle groups (p-value =0.24). Multiple comparisons cannot be performed because the overall test does not show significant difference across samples.

Conclusion: No significant difference in the effect of Er,Cr:YSGG laser surface treatment on enamel & dentin compared to conventional acid etching on marginal integrity of resin composite.

Keywords: Bonding, ER CR:YSSG laser, Etch-and-rinse, Marginal integrity, Microleakage.

I. INTRODUCTION

Great advances have recently been accomplished in the field of esthetic dentistry, with resin composite restorations being the most commonly used. Nevertheless, their main drawback is polymerization shrinkage, which leads to marginal deterioration due to microleakage at the tooth restoration interface. This limitation is the main weakness that affects the longevity of resin composite restorations. (1,2)

Integrating laser technology has proven to be significantly effective in the dental field. Lasers could be used for various procedures such as tooth surface treatment, cavity preparations, prevention of caries, and bleaching. Several researchers studied the effect of Erbium Chromium: Yittrium Scandium Gallium Garnet (Er,Cr:YSGG) laser irradiation on the surface of enamel and dentin versus the etch and rinse. (3,4,5)

Cavities prepared by Erbium lasers showed a rough surface similar to an acid etched surface with open dentinal tubules and stripped surfaces. Erbium lasers also denature the organic content and reduce the solubility of hydroxyapatite. Several articles have explored the possibility that the micro-retentive pattern resulting from laser irradiation could be favorable to bonding procedures. Parameter factors and wavelength specifically relate to the degree of change that can be induced in enamel. Varying pulse width, pulse mode, and spot size can produce significant changes in enamel and dentin surface morphology. (6,7)

Although numerous studies have assessed microleakage around resin composite restorations, the effect of laser systems in this era is still limited. Additional investigations and evaluations are needed to detect the effect of combining laser with adhesives to enhance the marginal integrity and assess the effect of laser surface treatment on dentine to save the adhesive junction in the long term from the deteriorating effect of the MMPs compared to conventional acid etching. Thus, the aim of the current study was to determine the effect of Er, Cr: YSGG laser surface treatment on enamel and dentin compared to conventional acid etching on the marginal integrity of resin composite restoration.

II. SUBJECTS AND METHODS

Study Settings and Study Design

This in vitro study was conducted at the Dental Laser Center at the Faculty of Oral and Dental Medicine at Misr International University in Egypt. The microleakage values were measured at the Oral and Histopathology laboratory of the Faculty of Dentistry at Cairo University in Egypt.

Sample Size Calculation

The power analysis used microleakage scores as the primary outcome. Based upon the results of Rezaei-Soufi et al. (8) the effect size (f) for comparison between the four groups was 0.486. Using alpha (α) level of (5%) and Beta (β) level of (20%) i.e. power = 80%; the minimum estimated sample size was a total of 52 teeth. Sample size will be increased by 15% to compensate for the use of non-parametric tests, so the minimum estimated sample size will be a total of 64 teeth. Sample size calculation was performed using G*Power.

Samples Collection

Sixty-four sound extracted permanent human first and second molars, upper or lower, obtained from patients with an age range of 25-40 years were selected for the study. The teeth were obtained from the National Institute of Diabetes and Endocrinology in Egypt, following their regulations and patient consents. Deciduous teeth, teeth with previous restorations, carious teeth, or teeth with cracked enamel were excluded to guarantee the presence of sufficient amount of surface area for etching and bonding procedure followed by microleakage assessment.

Samples Preparation

Teeth were cleaned from hard and soft debris using ultrasonic scaler (Woodpecker, Guilin Woodpecker Medical Instrument Co., China). Teeth were immersed in saline solution for one week, at room temperature, for disinfection. After rinsing using tap water, teeth were then stored in saline at room temperature and the solution was changed daily until the beginning of the study.

Class V cavities were prepared on the buccal and lingual surfaces measured 1.5 mm in depth, 3 mm in mesiodistal width and 3 mm in occluso-gingival height using a high speed contra (Sirona T3 Racer high speed 4 jet spray, Dentsply Sirona, Germany) and a 330 fissure bur (Dentsply Sirona, Germany). A pre-marked periodontal probe (Dentsply Sirona, Germany) was used as a guide for measuring the cavity dimensions. The entire external surface of each tooth was coated with water-resistant nail varnish (Yolo, Yolo Cosmetics Co., France) leaving a 1mm wide margin around the cavity margins. A modeling wax (Cavex, Netherlands) was used to seal the root surfaces and root apices.

Samples Grouping

Teeth were randomly divided into four groups of 16 teeth each (n=16). The first group (Group A = control group) was acid etched followed by the application of a universal adhesive resin on both enamel and dentin. Group B was only prepared using laser application on both enamel and dentin. Group C were treated by laser then the universal adhesive was applied on both structures. Finally, Group D was subjected to selective etching where enamel was etched with acid while the dentin was treated by laser then the universal adhesive was applied to both surfaces. Each group specimen was restored with composite resin restoration then specimens were subdivided into two subdivisions (n=8) according to the time of assessment either immediate or after thermocycling.

Interventions

A. Acid-etched group

The enamel surface was etched with 37% phosphoric acid gel (Meta, BioMed Co, USA) for 15 seconds then rinsed with air water spray for 10 seconds and blot dried with cotton pellet. For all teeth that were acid etched, the frosty white appearance of etched enamel was noticed.

B. Laser-etched group

Laser surface treatment was done using Er,Cr:YSGG dental laser (BIOLASE WATERLASE IPLUS®). This hard and soft tissue laser creates laser-energized, atomized water droplets that act as cutting particles. Laser energy is delivered through a fiberoptic system to a sapphire tip terminal 600 mm in diameter. The power settings were 4.5 Watt in a 20 hertz was administered on both enamel and dentine for 40 seconds 55% H2O, 65% air at 13.4 J/cm^2.

C. Laser etching + Acid etching

Laser surface treatment was applied on both enamel and dentine (with the aforementioned parameters in Group B) followed by the application of the acid etch procedure (same as group A). The surface was washed with air/water spray, the excess dentin moisture was removed by blotting with cotton pellets.

D. Selective etching on enamel + Laser etch on dentin

Selective etching was applied with application of 37% phosphoric acid gel on enamel for 15 seconds then the Laser was applied on dentin structure only prior to applying the adhesive resin.

Adhesion Procedures

The adhesive (3M Scotchbond™ Universal Adhesive) was applied with disposable brush for 20 seconds in two coats followed by gentle air spray for 5 seconds, then light cured for 20 seconds using light curing units with an output power of 1000mW/cm^2 (Woodpecker, Guilin Woodpecker Medical Instrument Co., China). All cavities were then restored by incremental packing with resin composite (3M Z350, 3MTM, ESPETM, USA).

All groups were further divided into two subgroups 8 each. The specimens of the first subgroup were used for immediate evaluation after (24 hours) and the second subgroup was subjected to 10,000 thermal cycles using a thermocycling machine (The SD Mechatronic thermocycler, GERMANY) between 5-55°C with 20 seconds of dwell time. It is proposed that 10,000 cycles represent an approximate 1 year in vivo aging.

Outcome Assessment

The samples were immersed in 2% buffered methylene blue at 37°C for 24 hours and after rinsing, they were sectioned using Isomet sectioning machine (BUHLER, USA) from the occlusal surface parallel to the longitudinal axis of the tooth. Microleakage was evaluated under a

stereomicroscope (Leica S8APO Stereo Microscope, Germany) at 20X magnification. Each specimen was blindly and randomly evaluated by two examiners.

All measurements were taken from the junction of the tooth–restoration interface to the point of termination of the dye, and measurements were recorded in micron. Both sections of each restoration were measured at the occlusal and gingival margins, and the mean microleakage values were recorded for each restoration at each margin. The average amount of microleakage was also calculated for each group. Microleakage in the enamel and dentin margins was scored as illustrated in Table (1).

Table 1: Dye penetration scoring system. [9,10]

Score	Explanation
0	No dye penetration
1	Dye penetration to one-third of the cavity wall
2	Dye penetration to two-thirds of the cavity wall
3	Dye penetration to the axial wall.

Statistical analysis

The Kruskal Wallis test was used to evaluate the differences between microleakage scores across the immediate and thermocycle study groups. Multiple comparisons cannot be performed because the overall test does not show significant difference across samples.

III. RESULTS

Immediate Study Groups

The microleakage score was detected across the immediate study groups (A, B, C, and D) with a median value of 3 and a range of values (min = 1 and max = 3). The Kruskal Wallis test was used to evaluate the differences between microleakage scores across the four immediate study groups as seen in table (2). The test revealed a non statistically significant difference between immediate groups with a p-value of 0.78. Multiple comparisons cannot be performed because the overall test does not show a significant difference across samples. A graphical presentation of the data is shown in Figure (1).

Table 2: The P-value calculated across the immediate study groups from Kruskal Wallis test.

Hypothesis Test Summary		
Null Hypothesis	**Test**	**Decision**
The distribution of dye score is the same across categories of Immediate study groups.	Independent-Samples Kruskal-Wallis Test	Sig.=0.776 Retain the null hypothesis.
Asymptotic significance is displayed. The significance level is 0.050		

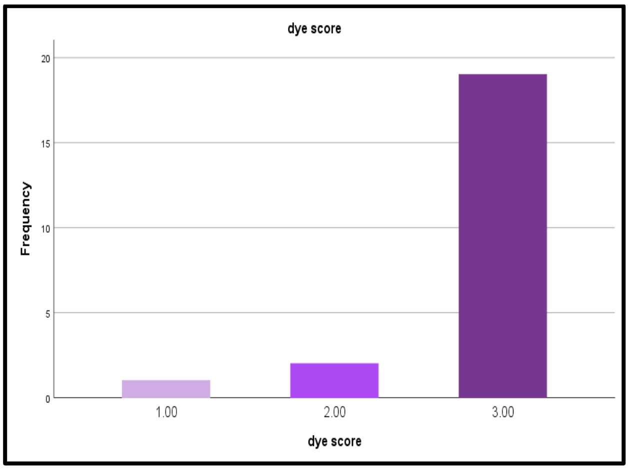

Figure 1: Bar chart showing the frequency of score (1, 2 and 3) across the immediate study groups

Thermocycle Study Groups

The microleakage score was detected across the thermocycle study groups (A, B, C, and D), with a median value of 3 and a range of values (min = 1 and max = 3). The Kruskal Wallis test was used to evaluate the differences between microleakage scores across the four thermocycle study groups, as seen in tables (3). The test revealed a non

Table 3: The P-value calculated from Kruskal Wallis test among the thermocycle study groups

Hypothesis Test Summary		
Null Hypothesis	**Test**	**Decision**
The distribution of dye score is the same across categories of thermocycle study groups.	Independent-Samples Kruskal-Wallis Test	Sig.= 0.236 Retain the null hypothesis.
Asymptotic significance is displayed. The significance level is 0.050		

statistically significant difference between thermocycle groups with a p-value of 0.24. Multiple comparisons cannot be performed because the overall test does not show a significant difference across samples. A graphical presentation of data is shown in figures (2).

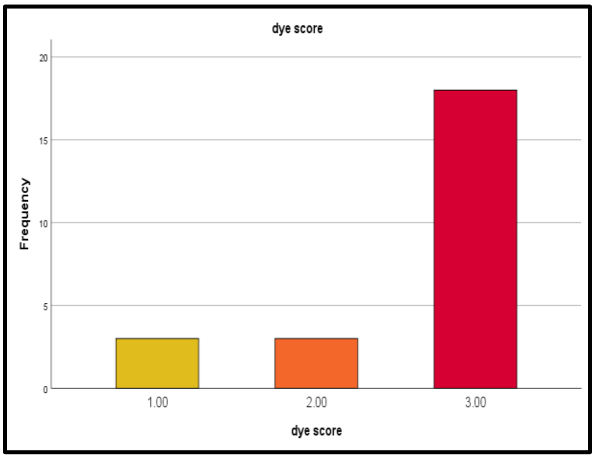

Figure 2: Bar chart showing the frequency of score (1, 2 and 3) across the thermocycle study groups

IV. DISCUSSION

The purpose of our laboratory study was to compare the extent of microleakage that occurs with laser irradiation versus conventional acid etching. The extent of leakage after thermal cycling is relevant to clinical practice since microleakage of saliva, oral fluids, and bacteria at the tooth-restoration interface has been linked causally to a range of problems, including marginal staining, postoperative sensitivity, and secondary caries. (11)

The preparation of dentin with rotary instruments leaves a smear layer on the surface. The smear layer consists primarily of pulverized enamel and dentin, caries debris, and bacteria. The smear layer inhibits impregnation of the enamel and dentin with the adhesive agent, and thus prevents adequate adhesion. (12,13) Acid etching is recommended for conventional cavity preparation to remove the smear layer and demineralize the subsurface. Thereby, the dental tissue is prepared for the creation of a hybrid layer, which is produced by the diffusion of the resin into the demineralized zone. (14) One concern regarding the efficacy of the hybrid layer as a bonding mechanism for adhesive resin to dentin is that the resin monomers would not reach the bottom of the demineralized zone. (15) Strong acids such as phosphoric acid create demineralization deeper than the diffusion capacity of the resin monomers, thus leaving collagen fibers in the deep tissue layers unprotected. This might be a problem and compromise the quality of bonding. (16)

In our study, class V cavities were prepared on the buccal and lingual surfaces away from the CEJ because leakage at this site is known to be of clinical concern when class II and class V cavities are restored with composite resin materials. (17,18) The majority of authors agree with higher leakage values in gingival rather than occlusal aspects of cavities , which can be attributed to the difficulty in establishing a strong bond to dentin rather than enamel. (19) (Thus, cavities were prepared at the center of the buccal and lingual surfaces to ensure that the cavity margins all lie in the enamel, limiting the effect of an additional variable that might affect the microleakage readings obtained from our study.

This study evaluated Class V cavities because they are simple to restore and do not require macro mechanical undercuts during preparation. Consequently, the sealing capability of composite polymers can only be evaluated based on their bonding potential. In this form of cavity, however, both enamel and dentin margins can be evaluated. Restoration of these cervical lesions is difficult because a portion of their margin is enamel and a portion is dentin or cementum. [20] Moreover, the choice of creating class V cavities is considered more suitable for microleakage assessment than their class II counterparts because the laser tip distance with tooth substance is more easily adjustable in class V cavities than in class II. Additionally, the closer distance between the light-curing unit tip and composite surface is more easily achievable in class V cavities, and finally, these cavities present more convenience for the practitioner to apply composite increments that collectively may affect microleakage. [21]

Acid etching and adhesive application were done following the protocol described in the study of Bahrololoomi and Heydari.[22] The enamel surface was etched with a 37% phosphoric acid gel for 15 seconds, then rinsed with air water spray for 10 seconds and blot dried with cotton pellets. The adhesive was then applied with a disposable brush for 20 seconds in two coats, followed by a gentle air spray for 5 seconds, and then light cured for 10 seconds using light curing units with an output power of 1000 mW/cm^2. Laser surface treatment was done using an Er,Cr:YSGG laser at an output of 4.5 watts at 20 hertz was administered on both enamel and dentine for 40 seconds. For the selective etch group, after laser application to dentin, 37% phosphoric acid gel was applied to enamel for 15 seconds, followed by the application of the adhesive material. The cavities were then restored with a resin composite (3M Z250). [23,24]

The external surface of each tooth was coated with water-resistant nail varnish, leaving a 1 mm wide margin around the cavity margins after being restored by composite resin restorations. [25] Sealing the entire roots and root apices using pink wax, additional work was performed to avoid dye penetration through the root dentinal tubules rather than through gap areas of microleakage, thus obscuring the actual effect of leakage. Teeth were then stored in saline at room temperature, which was changed daily to prevent bacterial growth. [26] The groups assigned for thermocycling. [27] were subjected to 10,000 cycles between 5-55°C with 20 seconds of dwell time to imitate the heat and humidity conditions of the oral cavity. [28] Thermocycling was used for the aging of the restoration material to consider the difference in thermal expansion coefficient. [29]

Microleakage is one of the most important challenges in restorative dentistry. This phenomenon occurs when proper adaptation between restorative margins and tooth margins does not exist. [30] Several techniques have been proposed in the literature to evaluate microleakage, among which dye penetration is considered one of the most widely accepted. [31] Thus, in our study, dying the samples was done using buffered methylene blue, which has a low molecular weight and high penetrability. The dye penetration test is the most widely used laboratory method for assessing leakage, a simple and inexpensive method. [32] and for the purposes of this study, a simple grading system was used. [33] Our study utilized 2% methylene blue due to its high penetrability and low molecular weight. [34] Teeth were sectioned from the occlusal surface parallel to the longitudinal axis of the tooth in a buccolingual direction, and dye penetration was assessed using a stereomicroscope.

Er,Cr:YSGG laser was compared to the conventional universal adhesive protocol due to its major advantages, including its adjustable frequency settings, [35] lack of temperature rise effect, which is a factor capable of inducing irreversible damage to the pulp, greater absorbance in water and hydroxyapatite, [36] efficient cutting ability on dentin and enamel, [37] lack of smear layer formation, and finally its ability to create minute surface irregularities. [38]

Yu et al. [39] and Ergucu et al. [40] showed that Er,Cr:YSGG laser-treated enamel and dentin had more surface roughness compared with those cut by diamond burs. They suggested that laser treatment could be a valid alternative to acid etching and was able to increase bond strength between restorative materials and dentin hard tissue. Similarly, Hossain and his colleagues observed that, in addition to the lack of a smear layer and the presence of intact enamel rods as well as exposed dentinal tubular openings in their SEM study, laser prepared surfaces provided better bond abilities with restorative materials, and acid etching could be easily replaced by laser use [41] unlike the use of Er:YAG laser which necessitates the use of an adjunct adhesive protocol. [42]

Previously conducted studies differ in their conclusions in terms of favoring either laser-etching or acid-etching for bur-prepared cavities. In our study, results revealed that there was no statistically significant difference in microleakage scores of cavities when comparing the two conditioning methods between the study groups for both immediate and thermocycled groups. This comes in line with an in vitro study conducted by Yazici and his colleagues, in which the effect of dentin preparation with Er,Cr:YSGG laser or SiC paper used with a universal adhesive system was studied while performing different adhesive strategies and studying their effect on bond strength. [5] In accordance with our results, Sabbah et al. [43] and Atalay et al. [44] also did not find any statistically significant difference between etch-and-rinse mode with laser and etch-and-rinse mode with acid [43,44] despite the fact that Sabbah et al.'s study was performed on primary teeth.

Similarly, a study by Üşümez et al. [45] concluded that enamel conditioning with an Er,Cr:YSGG laser cannot be considered a successful alternative to the conventional methods of increasing bond strengths in enamel. Sungurtekin and Oztas found that Er,Cr:YSGG laser etching does not eliminate the need for acid etching, and they found that when the Er,Cr:YSGG laser and acid etching are combined, Er,Cr:YSGG is as effective as conventional acid etching. [46] Same results were obtained by Islam et al., [47] authors stated that Er,Cr:YSSG laser etching alone is not an alternative therapy to conventional acid etching. But the Er,Cr:YSSG laser and acid etching combination can be a good choice and is comparable to bur invasion. Vohra et al. [7] also found that microleakage scores were more prevalent in groups treated with laser in the usage of either etch and rinse or self-etch bonding agents.

On the other hand, Hossain et al. [48] claimed that laser treatment of the tooth surface showed a significant increase in its surface roughness; thus, resin restorative materials have shown adaptation to laser-treated enamel comparable with acid-etched enamel. Therefore, improved microleakage scores can be attributed to enamel surface roughness and optimum resin adaptation to laser-treated bleached enamel. Shahabi et al. [17] concluded that laser cavity preparation for Class V cavities results in less microleakage than if phosphoric acid was used on laser-cut surfaces or if the same acid was used after cavity preparation with a bur without being lased. The authors justified their results by stating that when middle infrared lasers are used for cavity preparation, sudden evaporation of the water contained in the dental hard tissues causes photomechanical disruption. Loss of particles from the tooth surface gives it a macro- and micro-roughened topography, which can substitute for conditioning with acid. [49] Acid etching following Er,Cr: YSGG laser conditioning was found to help in the reduction of microleakage in class V restorations. [50] However, some researchers have shown a lack of or negative effects of lasers in reducing microleakage, but this might have been due to different laser types used. [51,52]

In an earlier study , when acid etching was compared to laser etching, the latter was found to be less technique sensitive and lead to higher control over the area needed to be etched precisely. [53] Er,Cr:YSGG laser showed comparable adhesive bond outcomes to conventional etch and bond dentin conditioning techniques in the study by Al Rifaiy and Vohra. [54] Microleakage scores for specimens treated with Er,Cr:YSGG laser were even significantly lower compared with bleached and ascorbic acid-treated specimens. [55]

On the contrary, the study by Tzimas et al. [34] stated that microleakage values for Er,Cr:YSGG prepared by laser without additional surface modification were the most discouraging. In the study by Bas et al. , [56] authors claimed that laser etching of the dentin tissues is not as effective as acid etching where the highest shear bond strength values were detected in the "Acid" group followed by the Laser group. Also the study by Al-Habdan et al. [57] concluded that the shear bond strength of composite resin bonded to enamel and dentin etched with phosphoric acid was higher than when conditioned with Er,Cr:YSGG laser. Thus, laser conditioning is not recommended.

ER,CR:YSGG, was also used by Beer et al. [58] where the authors mentioned that Er,Cr:YSGG laser irradiation (2 W, 20 Hz, 55% water/65% air) shows no smear layer, no subsurface demineralization, and open dentin tubules. Irradiation of dentin with an Er,Cr:YSGG laser creates a rough surface with chimney-like formations due to the preferential removal of intertubular dentin.

The erbium laser is mainly absorbed by water and other hydrated organic components of the tissue. The different content of water in peri and intertubular dentin is responsible for the selective ablation of intertubular dentin by this wavelength. [59] Due to the rapid heating of the embedded water, the internal pressure in the tissue increases until explosive removal of the inorganic components of the surface occurs. Since intertubular dentin contains more water and has a lower mineral component than peritubular dentin, it is selectively ablated to a higher extent than peritubular dentin, leaving protruding dentinal tubules with a cuff-like appearance. [60]

A major difference in tooth substance removal during acid etching and laser conditioning is based on structural differences between peri- and intertubular dentin. Acid etching can remove more peritubular than intertubular dentin due to the higher mineral content in peritubular dentin. In contrast, laser energy absorbance is seen more in intertubular dentin and dentinal fluid due to increased collagen and water content, respectively. [61,62]

These highly irregular cavity surfaces without a smear layer are believed to provide suitable surfaces for strong bonding with composite resin materials, and laser irradiation is considered to be an alternative to conventional acid etching. [63] Previous reports have claimed that there are certain advantages to bonding to lased dentin because of the apparently enlarged surface area for adhesion based on the scaly and flaky surface appearance following Er:YAG irradiation. [24,64,65]

Moreover, the concept behind laser surface treatment applied to both enamel and dentine, followed by the application of the universal adhesive with a self etching procedure in one of the tested groups, was to obtain an ideal surface morphology. It is believed that acid application dissolves the intertubular dentin too, thus destroying the chimney-like formations and widening the orifices of the dentinal tubules. [3] However, consecutive acid etching involves the problems of unpredictable depths of the demineralization zone and a deficit in the diffusion depth of resin monomers. This was confirmed by the findings of Beer et al. [58] study, where the best results were achieved when laser preparation was applied without subsequent phosphoric acid etching. The predictability was better than in all non-laser groups; and the most constant results were achieved.

In a study by Atalay et al. [44] when the laser was used in selective-etch application mode, the difference between the two groups was not significant, in spite of obtaining lower microleakage values compared to the self-etch group. This was an unexpected result. It is difficult to explain why the laser had a positive influence only in etch-and-rinse mode and not in selective-etch mode. This result is probably due to the manually controlled irradiation process. In order to simulate clinical conditions, instead of positioning the laser tip in a constant apparatus, the laser was hand-held and samples were irradiated in a sweeping motion. In the etch-and-rinse group, both enamel and dentin tissues were irradiated with a laser. During this total-etching process while irradiating dentin, the enamel tissue may also be exposed more with the laser than the selective etch group due to the handling of the laser tip. Therefore, the laser application time to enamel should be briefly reconsidered. It might be recommended to extend enamel conditioning time with a laser. As it is difficult to interpret these results, more laboratory or even clinical studies should be performed.

However, it can be concluded that multiple factors are reported to influence marginal microleakage, including polymerization shrinkage, coefficient of thermal expansion, bonding agent and liners, polymerization technique, quality of substrate (enamel or dentin), location of margins in the substrate, and the surface topography. (66,29)

Nevertheless, in clinical circumstances, patient-related factors, including caries activity and oral hygiene status, can have an influence on the quality of marginal adaptation and seal. (67) Clinically speaking on the basis of current findings, phototherapy (Er-Cr-YSGG laser) treatment for tooth preparation and bonding of resin composite to dentin has shown considerable potential. However multiple factors including, laser parameters, dentin surface and type of bonding agent influence the bonding outcomes of lased specimens and must be optimized for clinical success. (7) Therefore; long-term clinical studies are warranted to evaluate the clinical outcome of laser-etched cavities versus conventional acid-etching.

V. CONCLUSION

The use of Er,Cr:YSGG laser showed no additive value over the use of conventional acid etching.

Conflict of Interest:

The authors declare no conflict of interest.

Funding:

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors

Ethics:

This study protocol was approved by the ethical committee of the faculty of oral and dental medicine- Misr International University on:14/11/2020, approval number: MIU-IRB-2021-113

VI. REFERENCES

1. Zhou, X., Huang, X., Li, M., Peng, X., Wang, S., Zhou, X. and Cheng, L., 2019. Development and status of resin composite as dental restorative materials. Journal of Applied Polymer Science, 136(44), p.48180.
2. Soares, C. J., RODRIGUES, M. D. P., VILELA, A. B. F., PFEIFER, C. S., TANTBIROJN, D., & VERSLUIS, A. (2017). Polymerization shrinkage stress of composite resins and resin cements–What do we need to know?. Brazilian oral research, 31, e62.
3. Valinhos Piccioni, M. A. R., Girotto, A. C., Saad, J. R. C., & de Campos, E. A. (2019). Influence of different surface protocols on dentin bond strength irradiated with Er, Cr: YSGG laser. Lasers in Dental Science, 3, 43-51.
4. Ayar, M. K., & Erdemir, F. (2017). Bonding performance of universal adhesives to er, cr: YSGG laser-irradiated enamel. Microscopy Research and Technique, 80(4), 387-393.

5. Yazici, A. R., Karaman, E., Tuncer, D., Berk, G., & Ertan, A. (2016). Effect of an Er, Cr: YSGG laser preparation on dentin bond strength of a universal adhesive. Journal of adhesion science and Technology, 30(22), 2477-2484.
6. Hassoon, S. N. (2015). Evaluation of Shear Bond Strength of Composite Resin to Dentin after Etching with Er, Cr: YSGG Laser And Conventional Acid Etch (An In Vitro Study. Tikrit Journal for Dental Sciences, 3(1).
7. Vohra, F., Alghamdi, A., Aldakkan, M., Alharthi, S., Alturaigi, O., Alrabiah, M., ... & Abduljabbar, T. (2018). Influence of Er: Cr: YSGG laser on adhesive strength and microleakage of dentin bonded to resin composite. In-vitro study. Photodiagnosis and Photodynamic Therapy, 23, 342-346.
8. Rezaei-Soufi, L., Fekrazad, R., Vahdatinia, F., Moghimbeigi, A., & Haddad, M. (2018). Evaluation of Diode laser (940 nm) irradiation effect on microleakage in class V composite restoration before and after adhesive application. Journal of Dental Materials & Techniques, 7(1).
9. Sakri, M. R., Koppal, P., Patil, B. C., & Haralur, S. B. (2016). Evaluation of microleakage in hybrid composite restoration with different intermediate layers and curing cycles. Journal of Dental and Allied Sciences, 5(1), 14.
10. Ghavami-Lahiji, M., Firouzmanesh, M., Bagheri, H., Kashi, T. S. J., Razazpour, F., & Behroozibakhsh, M. (2018). The effect of thermocycling on the degree of conversion and mechanical properties of a microhybrid dental resin composite. Restorative dentistry & endodontics, 43(2).
11. Shimazu, K., Karibe, H., Oguchi, R., & Ogata, K. (2020). Influence of artificial saliva contamination on adhesion in class V restorations. Dental materials journal, 39(3), 429-434.
12. Buonocore, M. G. (1955). A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. Journal of dental research, 34(6), 849-853.
13. Sathawane, N. R., Sharma, R., & Wadhwa, R. (2023). Assessment of shear bond strength between composite resin and enamel surface after treating with acid etching and laser etching: a comparative study.
14. Kaptan, A., & Oznurhan, F. (2023). Effects of Er: YAG and Er, Cr: YSGG laser irradiation and adhesive systems on microtensile bond strength of a self-adhering composite. Lasers in Medical Science, 38(1), 41.
15. Tang, C., Ahmed, M. H., Yao, C., Mercelis, B., Yoshihara, K., Peumans, M., & Van Meerbeek, B. (2023). Bonding performance of experimental HEMA-free two-step universal adhesives to low C-factor flat dentin. Dental Materials, 39(6), 603-615.
16. Özcan, M., & Volpato, C. A. M. (2020). Current perspectives on dental adhesion:(3) Adhesion to intraradicular dentin: Concepts and applications. Japanese Dental Science Review, 56(1), 216-223.
17. Shahabi, S., Ebrahimpour, L., & Walsh, L. J. (2008). Microleakage of composite resin restorations in cervical cavities prepared by Er, Cr: YSGG laser radiation. Australian dental journal, 53(2), 172-175.
18. Donmez, N., Siso, S. H., & Usumez, A. (2013). Microleakage of composite resin restorations in class V cavities etched by Er: YAG laser with different pulse modes. J Laser Health Acad, 1, 6-10.
19. Goda, A. A., Sayed, A., & Ezz, D. (2023). Microleakage at Occlusal Margins Versus Cervical Margins of Thermocycled Preheated Class V Resin Composite Restorations. Al-Azhar Assiut Dental Journal, 6(1), 151-159.
20. Sooraparaju, S. G., Kanumuru, P. K., Nujella, S. K., Konda, K. R., Reddy, K., & Penigalapati, S. (2014). A comparative evaluation of microleakage in class v

composite restorations. International journal of dentistry, 2014.

21. Momin,Z.and Maria,R., (2023) To Compare and Evaluate the Microleakage of Four Different Tooth Coloured Restorative Materials in Class V Cavities: A Stereomicroscopic Study. Acta Scientific Dental Sciences 7.2 :61-67
22. Bahrololoomi, Z., & Heydari, E. (2014). Assessment of tooth preparation via Er: YAG laser and bur on microleakage of dentin adhesives. Journal of Dentistry (Tehran, Iran), 11(2), 172.
23. Moldes, V. L., Capp, C. I., Navarro, R. S., Matos, A. B., Youssef, M. N., & Cassoni, A. (2009). In vitro microleakage of composite restorations prepared by Er: YAG/Er, Cr: YSGG lasers and conventional drills associated with two adhesive systems. Journal of Adhesive Dentistry, 11(3).
24. Alaghehmand, H., Nasrollah, F. N., Nokhbatolfoghahaei, H., & Fekrazad, R. (2016). An in vitro comparison of the bond strength of composite to superficial and deep dentin, treated with Er: YAG laser irradiation or acid-etching. Journal of Lasers in Medical Sciences, 7(3), 167.
25. Fattah, T., Kazemi, H., Fekrazad, R., Assadian, H., & Kalhori, K. A. (2013). Er, Cr: YSGG laser influence on microleakage of class V composite resin restorations. Lasers in medical science, 28, 1257-1262.
26. Palesik, B., Šileikytė, K., Griškevičius, J., Stonkus, R., Šidlauskas, A., & Lopatienė, K. (2022). Impact of temperature changes to the adhesion strength of molar tubes: an in vitro study. BMC Oral Health, 22(1), 115.
27. Ali, S. W. A., & Moukarab, D. A. A. (2020). Effect of deep marginal elevation on marginal adaptation and fracture resistance in endodontically treated teeth restored with endocrowns constructed by two different CAD/CAM ceramics: an in-vitro study. Egyptian Dental Journal, 66(1-January (Fixed Prosthodontics, Dental Materials, Conservative Dentistry & Endodontics)), 541-556.
28. Pordel, E., Sabeti, A. K., Rezaei-Soufi, L., & Roshanayi, G. (2022). Comparison of Microleakage of Class V Composite Restorations in Primary Teeth prepared with Er, Cr: YSGG Laser and High Speed Diamond Bur associated with Three adhesive system.
29. Dutra, N. M. S., Baroudi, K., Silva, A. S. F., Laxe, L. A. C., Tribst, J. P. M., & Salvio, L. A. (2023). Effect of the Combination of Restorative Material and the Etching Protocol in Enamel Microleakage in Class II Cavities after Thermocycling. Biomed research international, 2023.
30. Rathi, S. D., Nikhade, P., Chandak, M., Motwani, N., Rathi, C., & Chandak, M. (2020). Microleakage in Composite Resin Restoration- A Review Article. Journal of Evolution of Medical and Dental Sciences, 9(12), 1006–1011.
31. Alqutaibi, A. Y., Alhajj, M. N., Alharthi, A. S., & Alqarni, A. A. (2021). Microleakage of bulk-fill composite restorations using different bonding agents. Journal of International Society of Preventive and Community Dentistry, 11(3), 329-334. doi: 10.4103/jispcd.JISPCD_452_20.
32. GARCÍA, L., Gil, A. C., & Puy, C. L. (2019). In vitro evaluation of microleakage in Class II composite restorations: High-viscosity bulk-fill vs conventional composites. Dental materials journal, 38(5), 721-727.
33. Eltoum, N. A., Bakry, N. S., Talaat, D. M., & Elshabrawy, S. M. (2019). Microleakage evaluation of bulk-fill composite in class II restorations of primary molars. Alexandria Dental Journal, 44(1), 111-116.
34. Tzimas, K., Gerasimou, P., Strakas, D., Tolidis, K., & Tsitrou, E. (2019). Comparative assessment of diamond bur and Er, Cr: YSGG laser irradiation for cavity preparation and tissue

modification: a microleakage study. Lasers in Dental Science, 3, 53-60.
35. Baygin, O., Korkmaz, F. M., Tüzüner, T., & Tanriver, M. (2012). The effect of different enamel surface treatments on the microleakage of fissure sealants. Lasers in medical science, 27, 153-160.
36. Romanos, G. E. (2021). Advanced Laser Surgery in Dentistry. John Wiley & Sons.
37. Shinkai, K., Suzuki, M., & Suzuki, S. (2020). Effects of intensity and frequency of erbium, chromium: yttrium-scandium-gallium-garnet (Er, Cr: YSGG) laser irradiation on tooth ablation. Lasers in Dental Science, 4, 123-129.
38. Alkhudhairy, F., Vohra, F., & Naseem, M. (2020). Influence of Er, Cr: YSGG Laser dentin conditioning on the bond strength of bioactive and conventional bulk-fill dental restorative material. Photobiomodulation, photomedicine, and laser surgery, 38(1), 30-35.
39. Yu, J., Jia, X., & Qiao, L. (2003). A scanning electron microscopy study on morphological changes of Er, Cr: YSGG laser-cutted dental hard tissue. Hua xi kou Qiang yi xue za zhi= Huaxi Kouqiang Yixue Zazhi= West China Journal of Stomatology, 21(5), 356-358.
40. Ergucu, Z., Celik, E. U., & Turkun, M. (2007). Microleakage study of different adhesive systems in Class V cavities prepared by Er, Cr: YSGG laser and bur preparation. General dentistry, 55(1), 27-32.
41. Hossain, M., Nakamura, Y., Yamada, Y., Murakami, Y., & Matsumoto, K. (2002). Microleakage of composite resin restoration in cavities prepared by Er, Cr: YSGG laser irradiation and etched bur cavities in primary teeth. Journal of Clinical Pediatric Dentistry, 26(3), 263-268.
42. Shakya, V. K., Bhattacharjee, A., Singh, R. K., Yadav, R. K., Singh, V. K., & Singhai, A. (2023). Shear bond strengths of bur or Er: YAG laser prepared dentine to composite resin with or without low-level laser conditioning: an in vitro study. Lasers in Medical Science, 38(1), 161.
43. Sabbah, A. A. (2020). Microleakage of Cavity Class V Restored by Glass Ionomer Restorations in Primary Molars Conditioned by Er, Cr: YSGG Laser Versus Conventional method (An in Vitro Study). Egyptian Dental Journal, 66(2-April (Orthodontics, Pediatric & Preventive Dentistry)), 781-788.
44. Atalay, C., Uslu, A., & Yazici, A. R. (2021). Does laser etching have an effect on application mode of a universal adhesive?—A microleakage and scanning electron microscopy evaluation. Microscopy Research and Technique, 84(1), 125-132.
45. Üşümez, S., Orhan, M., & Üşümez, A. (2002). Laser etching of enamel for direct bonding with an Er, Cr: YSGG hydrokinetic laser system. American Journal of Orthodontics and Dentofacial Orthopedics, 122(6), 649-656.
46. Sungurtekin, E., & Öztaş, N. (2010). The effect of erbium, chromium: yttrium–scandium–gallium–garnet laser etching on marginal integrity of a resin-based fissure sealant in primary teeth. Lasers in medical science, 25, 841-847.
47. İslam, A., Kızılelma, Z., & Çetiner, S. (2018). In Vitro Comparative Evaluation of Er, Cr: YSSG Laser and Conventional Etching Methods on the Microleakage and Adaptation of Pit and Fissure Sealants. Cyprus Journal of Medical Science, 3, 85-9.
48. Hossain, M., Yamada, Y., Nakamura, Y., Murakami, Y., Tamaki, Y. and Matsumoto, K., 2003. A study on surface roughness and microleakage test in cavities prepared by Er: YAG laser irradiation and etched bur cavities. Lasers in medical science, 18, pp.25-31.
49. Labunet, A., Tonea, A., Kui, A., & Sava, S. (2022). The use of laser energy for etching enamel surfaces in dentistry—A scoping review. Materials, 15(6), 1988.
50. Zhang, Y., Chen, W., Zhang, J., & Li, Y. (2020). Does Er, Cr: YSGG reduce the

microleakage of restorations when used for cavity preparation? A systematic review and meta-analysis. BMC Oral Health, 20, 1-13.

51. Corona, S. A., Borsatto, M. C., Dibb, R. P., Ramos, R. P., Brugnera, A., & Pécora, J. D. (2001). Microleakage of class V resin composite restorations after bur, air-abrasion or Er: YAG laser preparation. Operative Dentistry, 26(5), 491-497.
52. Setien, V. J., Cobb, D. S., Denehy, G. E., & Vargas, M. A. (2001). Cavity preparation devices: effect on microleakage of Class V resin-based composite restorations. American Journal of Dentistry, 14(3), 157-162.
53. Luong, E., & Shayegan, A. (2018). Assessment of microleakage of class V restored by resin composite and resin-modified glass ionomer and pit and fissure resin-based sealants following Er: YAG laser conditioning and acid etching: in vitro study. Clinical, cosmetic and investigational dentistry, 83-92.
54. Al Rifaiy, M. Q., & Vohra, F. (2019). Effect of phototherapy on dentin bond strength and microleakage when bonded to resin with different conditioning regimes. Photodiagnosis and Photodynamic Therapy, 25, 271-274.
55. Alkhudhairy, F., AlKheraif, A., Bin-Shuwaish, M., Al-Johany, S., Naseem, M., & Vohra, F. (2018). Effect of Er, Cr: YSGG laser and ascorbic acid on the bond strength and microleakage of bleached enamel surface. Photomedicine and Laser Surgery, 36(8), 431-438.
56. Bas, K., & Uslu-Cender, E. (2021). Bond strength evaluation of bulk-fill composites to dentin under different surface treatments. Odovtos International Journal of Dental Sciences, 23(2), 90-103.
57. Al Habdan, A. H., Al Rabiah, R., & Al Busayes, R. (2021). Shear bond strength of acid and laser conditioned enamel and dentine to composite resin restorations: An in vitro study. Clinical and Experimental Dental Research, 7(3), 331-337.
58. Beer, F., Buchmair, A., Körpert, W., Marvastian, L., Wernisch, J., & Moritz, A. (2012). Morphology of resin–dentin interfaces after Er, Cr: YSGG laser and acid etching preparation and application of different bonding systems. Lasers in medical science, 27, 835-841.
59. Vieira, A. A., & Silva, A. C. N. (2021). Effects of erbium laser radiation on the dentin organic matrix. Lasers in Dental Science, 5, 69-78.
60. Elsahn, N. A., El-Damanhoury, H. M., & Elkassas, D. W. (2021). Influence of low-level laser modification and adhesive application mode on the bonding efficiency of universal adhesives to Er: YAG laser-ablated dentin. Journal of lasers in medical sciences, 12.
61. Kharouf, N., Mancino, D., Naji-Amrani, A., Eid, A., Haikel, Y., & Hemmerle, J. (2019). Effectiveness of Etching by Three Acids on the Morphological and Chemical Features of Dentin Tissue. The journal of contemporary dental practice, 20(8).
62. Zakrzewski, W., Dobrzynski, M., Kuropka, P., Matys, J., Malecka, M., Kiryk, J., ... & Wiglusz, R. J. (2020). Removal of composite restoration from the root surface in the cervical region using Er: YAG laser and drill—In vitro study. Materials, 13(13), 3027.
63. Guven, Y., & Aktoren, O. (2015). Shear bond strength and ultrastructural interface analysis of different adhesive systems to Er: YAG laser-prepared dentin. Lasers in medical science, 30, 769-778.
64. Babarasul, D. O., Faraj, B. M., & Kareem, F. A. (2021). Scanning Electron Microscope Image Analysis of Bonding Surfaces following Removal of Composite Resin Restoration Using Er: YAG Laser: In Vitro Study. Scanning, 2021.
65. Souza-Gabriel, A. E., Sousa-Neto, M. D., Scatolin, R. S., & Corona, S. A. M. (2020). Durability of resin on bleached

dentin treated with antioxidant solutions or lasers. Journal of the mechanical behavior of biomedical materials, 104, 103647.

66. Chandrika, R. P. (2019). An In vitro Comparative Evaluation of Marginal Adaptation in Large Class II Cavities using Various Liners in Open Sandwich Technique (Doctoral dissertation, Vivekanandha Dental College for Women, Tiruchengode).
67. Scholz, K.J., Hinderberger, M., Widbiller, M., Federlin, M., Hiller, K.A. and Buchalla, W., 2020. Influence of selective caries excavation on marginal penetration of class II composite restorations in vitro. European Journal of Oral Sciences, 128(5), pp.405-414.