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Effect of Self-Cured and Self-Etch Adhesive Systems on Shear Bond Strength After Photodynamic Therapy and Disinfection with Different Types of Lasers

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Research Article

History

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ABSTRACT

Objectives: The aim of this study was to investigate the strength of shear bonding of self-cured and self-etch adhesive systems to dentin after surface disinfection with Photodynamic Therapy (PDT), Er:YAG, Nd:YAG, and KTP laser.

Materials and Methods: In the study, 6 main-groups were formed as Control, Er:YAG Laser, Nd: YAG Laser, KTP Laser, KTP Laser activated PDT and Diode Laser activated PDT. Each group was divided into two subgroups; Self-cured (Tokuyama Universal) and self-etch (Scotchbond Universal) adhesive system(n=10). 120 molar teeth were prepared to expose dentin surfaces. After disinfection and adhesive application, nanohybrid composite resin with a diameter of 3 mm and a height of 2 mm was applied to the dentin surface with the help of transparent molds. All samples were thermally cycled 5.000 times at 5°C and 55°C. Shear bond strength (SBS) test was applied to the samples in a universal test device.

Results: The differences between the Er:YAG laser group and the control, KTP and Nd:YAG laser groups of the self-cured adhesive samples were statistically significant. While the differences between the Nd:YAG laser group and the PDT groups were statistically significant, the differences between all other groups were no significant. In the samples applied with self-etch adhesive, while the differences between the KTP and Nd:YAG laser groups and all other groups were statistically significant, the difference between them was not statistically significant. Self-etch adhesive applied samples showed higher bond strength values in all disinfection applications.

Conclusions: Er:YAG laser and PDT for surface disinfection applications increased the bond strength to dentin while Er:YAG laser showed the highest shear bond strenght value. The application of Nd:YAG and KTP lasers adversely affected the bond strength. In cases of using surface disinfection applications with laser for self-curing adhesive systems the Er:YAG laser or laser-activated PDT procedures are recommended.

Keywords: Photodynamic therapy, self-cured adhesive, laser disinfection, bond strength.

Fotodinamik Tedavi ve Farklı Tip Lazerler ile Dezenfeksiyon Sonrası Self-Cured ve Self-Etch Sistemlerin Makaslama Bağlanma Dayanımına Etkisi

Süreç

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ÖZ

Amaç: Bu çalışmanın amacı Fotodinamik Tedavi (FDT), Er:YAG, Nd:YAG, ve KTP lazer ile yüzey dezenfeksiyonu uygulanması sonrası self-cured ve self-etch adeziv sistemlerin dentine makaslama bağlanma dayanımını araştırmaktır.

Gereç ve Yöntemler: Çalışmada Kontrol, Er:YAG Lazer, Nd:YAG Lazer, KTP Lazer, KTP Lazer aktivasyonlu FDT ve Diyot Lazer aktivasyonlu FDT olmak üzere 6 ana-grup oluşturuldu. Her grup iki alt gruba ayrıldı; Self-cured (Tokuyama Universal) ve self-etch (Scotchbond Universal)(n=10). 120 adet molar diş dentin yüzeyleri açığa çıkacak şekilde prepare edildi. Dezenfeksiyon ve adeziv uygulamasını takiben şeffaf kalıplar yardımıyla 3 mm çapında 2 mm yüksekliğinde nanohibrit kompozit rezin dentin yüzeyine uygulandı. Tüm örneklere 5°C ve 55°C'de 5.000 kez ısıl döngü işlemi uygulandı. Örnekler universal test cihazında makaslama bağlanma dayanımı testine tabi tutuldu.

Bulgular: Self-cured adeziv uygulanan örneklerden Er:YAG lazer grubu ile kontrol, KTP ve Nd:YAG lazer grubu arasındaki farklar istatistiksel olarak önemli bulunmuştur ($p<0,05$). Nd:YAG lazer grubu ile FDT grupları arasındaki farklar istatistiksel olarak önemli iken ($p<0,05$), diğer tüm gruplar arasındaki farklar önemsiz bulunmuştur ($p>0,05$). Self-etch adeziv uygulanan örneklerde, KTP ve Nd:YAG lazer grupları ile diğer tüm gruplar arasındaki farklar istatistiksel olarak anlamlı bulunurken ($p<0,05$), kendi aralarındaki fark istatistiksel olarak önemsiz bulunmuştur ($p>0,05$). Self-etch adeziv uygulanan örnekler, tüm dezenfeksiyon uygulamalarında daha yüksek bağlanma dayanım değeri göstermiştir.

Sonuçlar: Yüzey dezenfeksiyon amacı ile Er:YAG lazer ve FDT uygulamaları dentine bağlanma dayanımını değerini arttırırken, Er:YAG lazer en iyi makaslama bağlanma dayanımı değerini göstermiştir. Nd:YAG ve KTP lazer uygulanması ise bağlanma dayanımını olumsuz etkilemiştir. Lazerler ile yüzey dezenfeksiyonu uygulamalarında self-cured adeziv sistemler kullanılması durumunda Er:YAG lazer ya da lazer aktivasyonlu FDT prosedürlerinin tercih edilmesi önerilmektedir.

Anahtar Kelimeler: Fotodinamik tedavi, self-cured adeziv, lazer dezenfeksiyon, bağlanma.

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Introduction

Generally, removal of bacteria after cavity preparation and prior to placement of the restoration is one of the most important factors influencing the success of the restoration.[1] The use of cavity disinfectants is recommended to eliminate bacteria and longevity of the restoration.[2] Chlorhexidine digluconate (CHX), sodium hypochlorite (NaOCl), hydrogen peroxide, potassium iodine, benzalkonium chloride, alcohol, propolis, ozone and laser are used for cavity disinfection.[3] In addition, photodynamic therapy (PDT), which has come to the fore with the development of resistance to antibiotics in recent years, can be used as an alternative disinfection method.[4]

Erbium lasers used in dentistry show the bactericidal effect by ablating the tissue by increasing the temperature of the water in the cell to 100°C. It is used in cavity disinfection and root canal disinfection by utilizing the bactericidal effects of the laser beam.[5] In addition, Erbium laser beams have advantages such as roughening the enamel and dentin surface, increasing the amount of Ca and P on the tooth surface, creating a more resistant structure against acid attacks.[6] Nd:YAG lasers can be used in many clinical procedures such as reduction of dentin hypersensitivity, remineralization of initial caries, disinfection of cavity and root canals, gingivectomy, gingivoplasty, frenectomy, crown lengthening.[7-8] The KTP laser is a type of Nd:YAG laser with a wavelength cut in half. KTP laser can be used both in the areas of use of Nd:YAG laser and in teeth whitening applications.[9] Recently, Diode lasers have been used in root canal and cavity disinfection to take advantage of their antibacterial effects.[10]

Photodynamic therapy is based on the principle that target cells, microorganisms or molecules are stained with a photosensitizer and then activated by light of a specific wavelength.[11] PDT is used in periodontitis, periimplantitis[12], root canal disinfection and cavity disinfection.[13,14] The PDT method is applied to deep dentin caries using light sensitive agents (toludine bluee, methylene blue, azure dyes, crystal violet, hematoporphyrins, aluminum disulfonated phthacyanine, chlorins). Takasaki *et al.*[15], the photosensitive agents used in the studies were investigated and it was determined that the most commonly used photosensitive agents were methylene blue and toludine blue.

In recent years, single-stage adhesive systems, also known as universal or multi-mode systems, have been introduced to the market. Universal adhesives have advantages such as ease of application for clinicians, wide usage areas, and being able to be used in etch-and-rinse, self-etch and selective-etch modes.[16] Dimethacrylate monomers have been replaced by 10-methacryloloxydecyl dihydrogen phosphate (MDP) monomers in universal adhesive systems. The 10-MDP monomer plays an important role in establishing a chemical bond between enamel and dentin, and in obtaining a stable and durable interface.[17] One of the universal adhesive systems is a two-component, one-stage, self-curing adhesive system with its own polymerization initiator, which does not require light-curing.[18] It has been stated that the 3D-SR (three dimensional self-reinforcing) monomer in the adhesive can organize alone and the phosphate group it contains can interact with calcium to form ionic bonds.[19]

There are many studies investigating the bonding of adhesive systems after the application of laser cavity disinfection methods. While some of these studies, disinfection of the cavity adversely affected the bond strength[20,21], Kaptan *et al*.[22] stated that it increased the bond strength.

The aim of this study is to investigate the shear bond strength of self-cured and self-etch adhesive systems to dentin after surface disinfection with Photodynamic Therapy, Er:YAG, Nd:YAG, and KTP laser and to examine the reasons for failure in SEM.

Materials and Methods

Teeth Samples

Ethics Committee approval dated 17.11.2021 and numbered 2021-11/23 was obtained by Sivas Cumhuriyet University Non-Interventional Clinical Research Ethics Committee to start the study. In the study, 120 permanent human molars were used and these teeth were procured from the teeth extracted for orthodontic or periodontal reasons in the last 6 months in Sivas Cumhuriyet University Faculty of Dentistry, Department of Oral and Maxillofacial Surgery. No tooth extraction was performed for the study. Organic residues on the tooth surface were cleaned. During the storage of teeth, the teeth were kept in distilled water at room temperature and the storage fluid was renewed every week.

Preparation of Specimens

Before starting the test, 120 human molars were molded using self-curing acrylic to be subjected to shear bond strength testing. The teeth were sectioned to expose superficial dentin with a low- speed diamond saw (Isomet, Buehler Ltd., Lake Bluff IL, USA) under water coolant. Then 600-800-1200 grit silicon carbide papers were applied to the surfaces to obtain a standard smear layer.

Experimental Groups

Teeth were randomly divided into 6 main groups with different disinfection treatments (n=20).

Control Group: No disinfection treatment was applied to the dentin surface.

Er:YAG laser Group: Er:YAG (Smarty 2940D, DEKA M.E.L.A. SRL, Italy) laser systems' parameters used were 100 mJ, 15 Hz, 1.5 W and was held up to 1 mm distance from the dentine surface. Er:YAG lazer was held up to 1 mm distance from the dentin surface and irradiate for 30 seconds.

Nd:YAG laser Group: Nd:YAG (Smarty A10, DEKA M.E.L.A. SRL, Italy) laser systems' parameters used were 100 mJ, 15 Hz, and 1.5 W with repeated pulse mode. A 300 µm fiber optic energy delivery system was started with spiral movements applied for 30 seconds irradiation.

KTP laser Group: KTP (SmartLite D, DEKA M.E.L.A. SRL, Italy) laser systems' parameters used were 100 mJ, 15 Hz, and 1.5 W with repeated pulse mode. A 300 µm fiber optic energy delivery system was started with spiral movements applied for 30 seconds irradiation.

KTP laser activated PDT Group: 0.1% methylene blue (Noratex) was applied to the tooth surface and the teeth were kept in the dark for 5 minutes. KTP laser systems' parameters used were 100 mJ, 15 Hz, and 1.5 W with repeated pulse mode. A 300 µm fiber optic energy delivery system was started with spiral movements applied for 30s irradiation. Then the dentin surface was washed with distilled water followed by drying for 5 s.

Diode laser activated PDT Group: 0.1% methylene blue (Noratex) was applied to the tooth surface and the teeth were kept in the dark for 5 minutes. Then the samples were exposed to a diode laser (BİOLASE Technology Inc, Irvine, CA, USA) for 30 s keeping at a 1 mm distance. Diode laser system was used 1.5W repeated pulse mode. The dentin surface was washed with distilled water followed by drying for 5 s.

The main groups that underwent different disinfection procedures were randomly divided into 2 subgroups according to the adhesive systems used (n=10). In our study, the materials tested and their composition information are given in Table 1.

Subgroup 1; Self-cured adhesive system: The self-cured Universal Bond (Tokuyama Dental Corp, Tsukuba, Japonya) A and B were mixed, the application was completed within 60 s and no light application was performed.

Subgroup 2; Self-etch adhesive system*:* Scotchbond Universal (3M ESPE, St. Paul MN, ABD) was applied to the surface using applicator, After waiting for 10 s, it was air dried and polymerized using a 10 s LED light device (Valo Cordless, Ultradent, USA).

After adhesive applications, composites (Filtek Z550, 3M ESPE, St. Paul MN, ABD) were placed using 3 mm diameter, 2 mm high transparent cylindrical mold and polymerized using a 20 s LED light device.

Thermal Aging of Samples

All prepared samples were stored in distilled water at 37°C for 24 hours. For termal ageing, the specimens underwent 5000 cycles in distilled water baths at 55°C and 5°C with transfer time of 5 s and waiting time of 60 s in a thermocycler (Gökçeler Machinery Trade. and Ind. Co. Ltd. Sivas/Turkiye).

Shear Bond Strength Test

The samples were subjected to shear bond strength test using the universal test machine (LLOYD Instruments, Ametek Inc. England). The crushing apparatus was placed at an angle of 90° with the dentin-composite interface. A shear force was applied at a head speed of 1.0 mm/min until failure occurred. SBS was expressed in MPa.

Failure mode Analysis

After shear bond strength test, the fractured dentin surfaces were examined under SEM to determine the mode of failure at magnification of X25. Modes of falilure were reported as adhesive, cohesive and admixed.

SEM Analysis

After all samples were examined by stereomicroscope, SEM analyzes were performed to evaluate the fracture surfaces in detail. The samples were analyzed with SEM device.

Statistical analysis

Variation data of were analyzed using the SPSS statistical software program (22.0 version, SPSS Inc., Chicago, USA). The data were subjected to statistical analysis with using one-way analysis of variance and Tukey's post hoc test to examine pairwise difference. P<0.05 was accepted significant.

Results

The results, described in Table 2, show the mean bond values, standard deviations and statistical evaluation of the adhesive groups applied after disinfection. The differences between the Er:YAG laser group and the control, KTP and Nd:YAG laser groups of the self-cured adhesive samples were statistically significant. While the differences between the Nd:YAG laser group and the PDT groups were statistically significant ($p<0.05$), the differences between all other groups were not significant. In the samples applied with self-etch adhesive, while the differences between the KTP and Nd:YAG laser groups and all other groups were statistically significant ($p<0.05$), the difference between them was not statistically significant ($p>0.05$). When adhesive systems are compared; while the differences in the control and PDT groups were statistically significant ($p<0.05$), the differences between all other groups were not statistically significant ($p>0.05$). The highest SBS values was exhibited in the disinfection group with Er:YAG laser. The lowest SBS values was exhibited in the disinfection group with Nd:YAG laser. The predominant failure type in dentine disinfected with Er:YAG laser, Nd:YAG laser, KTP laser and PDT was adhesive (Table 3). SEM images of the groups are given in Figure 1-6.

Table 1: Materials tested and their composition

Material	Composition
Universal Bond (Tokuyama Dental Corp, Tsukuba, Japonya)	Phosphoric acid monomer (3D-SR monomer) MTU-6 HEMA Bis-GEMA, TEGDMA, Acetoneγ-MPTES Borate Peroxide Acetone, Isopropyl alcohol, water
Scotchbond Universal Adhesive (3M ESPE, St. Paul MN, ABD)	Dimethacrylate resin, MDP phosphate monomer, Vitrebond, HEMA, fillers, copolymer, silane
Filtek Z550 Nanohybrid Universal Restorative (3M ESPE, St. Paul MN, ABD)	Silanize seramik, silanize silika, BIGMA, UDMA, bisfenol polietilen, glikol dieter dimetakrilat, TEGDMA
Metilen blue (Norateks)	0.1% methylene blue, distilled water

Table 2: The mean bond values, standard deviations and statistical evaluation of the adhesive groups applied after disinfection in the study

Main Groups	Self-cure adhesive		Self-etch adhesive	
	Mean	SD	Mean	SD
Control	$7.64^{A,a}$	1.78	$12.84^{A,f,g}$	2.58
Er:YAG laser	$11.39^{a,b,c}$	1.69	$13.94^{h,ı}$	2.33
Nd:YAG laser	$6.27^{b,d,e}$	1.48	$7.48^{f,h,j,k}$	1.04
KTP laser	7.17^{c}	1.51	$8.93^{g,ı,l,m}$	0.91
KTP laser activated PDT	$9.61^{B,d}$	2.53	$13.37^{B,j,l}$	2.85
Diyot laser activated PDT	$9.99^{C,e}$	2.31	$13.75^{C,k,m}$	2.58

F=9,809 P=0.000 p<0.05

A,B,C There is a statistical difference between the groups shown with the same uppercase letters in the rows

a,b,c,d,e,f,g,h,ı,j,k,l,m There is a statistical difference between the groups shown with the same lowercase letters in the columns

Table 3: Number of modes of failure in each group

	Failure mode					
	Self-cure adhesive			Self-etch adhesive		
Main Groups	**Adhesive**	**Cohesive**	**Mix**	**Adhesive**	**Cohesive**	**Mix**
Control	10	0	0	9	0	1
Er:YAG laser	9	1	0	10	0	0
Nd:YAG laser	10	0	0	10	0	0
KTP laser	10	0	0	10	0	0
KTP laser activated PDT	9	1	0	9	1	0
Diyot laser activated PDT	10	0	0	9	1	0

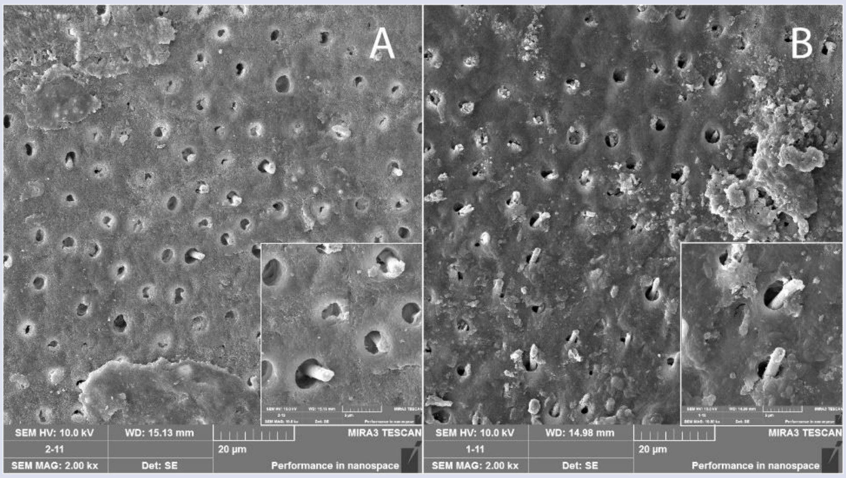

Figure 1. *SEM image of control groups, A) Self-cured adhesive B) Self-etch adhesive.*

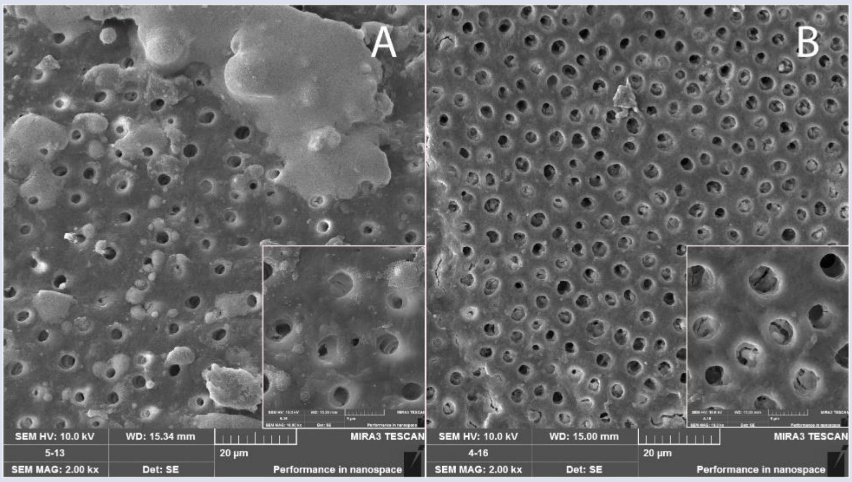

Figure 2. *SEM image of dentin disinfected with Er:YAG laser groups A) Self-cured adhesive B) Self-etch adhesive*

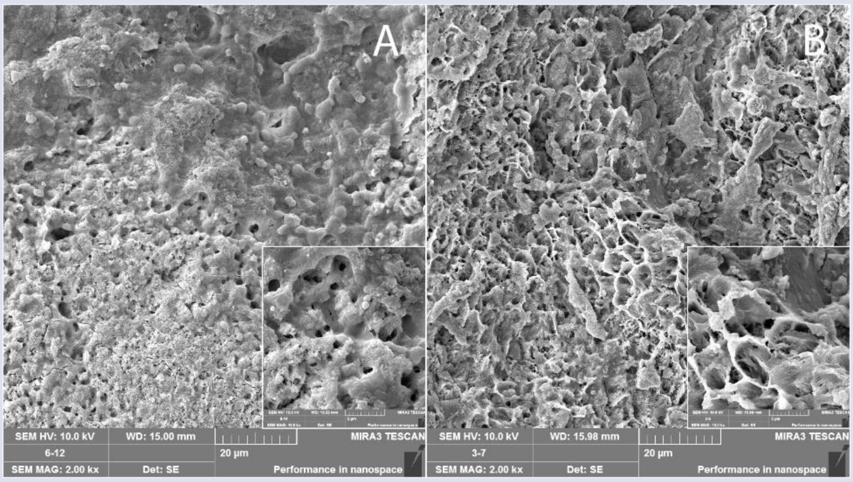

Figure 3. *SEM image of dentin disinfected with Nd:YAG laser groups A) Self-cured adhesive B) Self-etch adhesive.*

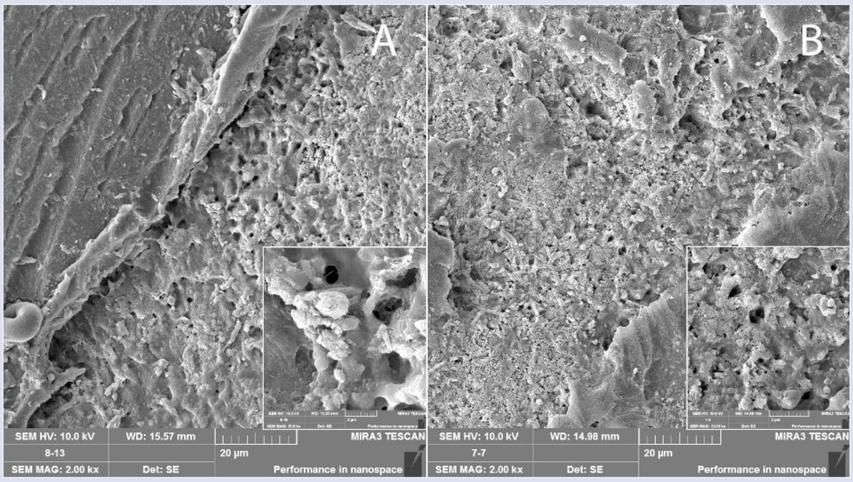

Figure 4. *SEM image of dentin disinfected with KTP laser groups A) Self-cured adhesive B) Self-etch adhesive.*

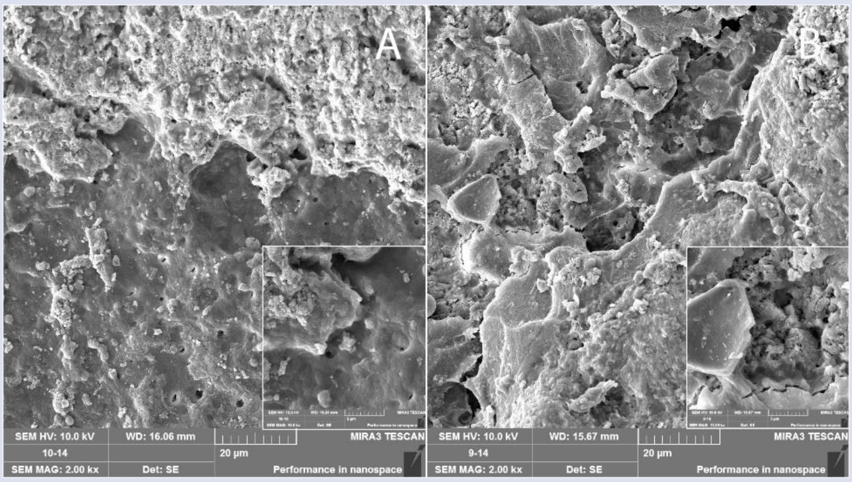

Figure 5. *SEM image of dentin disinfected with KTP laser activated PDT groups A) Self-cured adhesive B) Self-etch adhesive.*

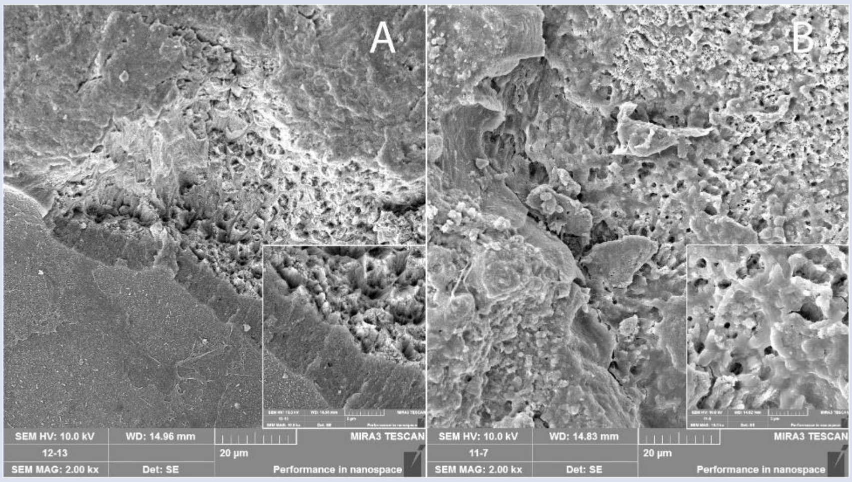

Figure 6. *SEM image of dentin disinfected with Diode laser activated PDT groups A) Self-cured adhesive B) Self-etch adhesive.*

Discussion

Resin-containing restorative materials have started to be preferred more and thus, adhesive system technology has gained importance with the development of minimally invasive dentistry.[23] Although the bonding of resin-containing materials to the tooth has shown successful results with the development of adhesive systems, there are still some failures. The reasons for failure include bacteria remaining in the cavity after preparation, secondary caries formation, pulp inflammations and postoperative sensitivity.[24]

Residual bacteria remaining in the cavity during cavity preparation can multiply within the smear layer, even when the cavity margins of the restoration are isolated from the oral cavity.[1] The use of cavity disinfectants is recommended to eliminate bacteria and increase the longevity of the restoration.[2] There are different studies on the effect of disinfection procedures on bonding. Tulunoglu *et al.*[4] reported that the effects of disinfectant solutions on bonding are related to the adhesive system used. There is no definite information in the literature about the effect of cavity disinfection methods on bond strength. Therefore, in this study were investigated the effects of Er:YAG laser, Nd:YAG laser, KTP laser and photodynamic therapy and disinfection methods on the shear bond strength of two different adhesive systems (self-cured, self-etch).

Celik *et al.*[25] evaluated the effect of chlorhexidine gluconate-based cavity disinfectant and Er,Cr:YSGG laser irradiation on bond strength of etch-and-rinse and self-etch adhesive systems. In self-etch adhesives, Er,Cr:YSGG laser increased the bond strength, while CHX-based cavity disinfection solution decreased the bond strength. Kaptan *et al.*[22] investigated the effects of Er:YAG and Er,Cr:YSGG laser irradiation and adhesive systems on the microtensile bond strength of self-adhering composite. They reported that both adhesives used in combination with Er:YAG and Er,Cr:YSSG laser applications increased the bond strength. Yazici *et al.*[26] in their study examining the effect of Er:YAG laser on the bond strength of conventional and self-adhesive flowable composite to dentin, they stated that Er:YAG laser application increased the bond strength of both flowable composites. However, in the study of Ramos *et al.*[21] in which they examined the effect of Er:YAG laser application on the bond strength of three different adhesive systems to dentin, they reported that laser application reduced the bond strength of adhesives. It has been stated that the reason for this negative effect may be related to the formation of subsurface cracks in the dentin. In this study, the highest bond strength value was observed in the Er:YAG laser group in both adhesive system applications. Celik *et al.*[25], Kaptan *et al.*[22] and Yazici *et al.*[26] in their study on hard tissue lasers, this study supports our results in terms of obtaining high bonding values. Contrary to this study results, Ramos *et al.*[21] reported that Er:YAG laser application reduces the bond strength to dentin. The reason for this difference may be due to the different adhesive systems, laser devices and application parameters used in the studies. In this study, when the SEM images of the Er:YAG laser applied samples are examined, it is seen that the smear layer is completely removed, the dentinal tubules are opened and there is a high rate of adhesive infiltration into these opened tubules (SEM).

Nisar *et al.*[27] investigated the effects of KTP laser, Er:YAG laser, ozonated water, CHX, and Rose Bengal on the bond strength of the adhesive applied in self-etch mode to the caries-affected dentine. They emphasized that high shear bond strength was demonstrated in ozonated water followed by Er:YAG laser and KTP laser. Gurgan *et al.*[28] evaluated the effect of self-etch adhesive systems on the shear bond strength of dentin after Nd:YAG laser and ozone application. Although the difference between the Nd:YAG laser and the control group was no statistically significant, it was stated that both adhesive systems reduced the shear bond strength value. Tarcin *et al.*[20] evaluated the effects of Nd:YAG laser, Er,Cr:YSGG laser and 37% orthophosphoric acid gel on the tensile bond strength of two different adhesive systems to dentin. While Nd:YAG laser application showed the lowest bond strength values statistically, acid gel application showed the highest bond strength. Castro *et al.*[29] investigated the effect of Nd:YAG laser application in different parameters and the etch and rinse adhesive system on the microtensile bond strength to dentin. It was stated that the application of Nd:YAG laser on the non-acid applied dentin surface increased the bond strength value in both parameters. Kobayashi *et al.*[30] investigated the effect of applying Nd:YAG laser in different parameters on shear bond strength of glass ionomer luting cement to dentin surface. The reason why the laser application process increased the bond strength value was attributed to the increase in calcium in dentin and the strengthening of the bonds between the carboxyl group of polyalkenoic acid and calcium.

In this study among the disinfection procedures, the lowest bond strenght values were observed in the Nd:YAG laser group, followed by the KTP laser group. Tarcin *et al.*[20] Gurgan *et al.*[28] and Nisar *et al.*[27] 's laser application results show parallelism with the results of this study. In contrast to this study, Castro *et al.*[29] and Kobayashi *et al.*[30] They reported that Nd:YAG laser application increased the bond strength to dentin. The reason for this difference may be shown the different laser devices, parameters and application times. In this study, when the SEM images of the Nd:YAG and KTP laser applied samples were examined, it was observed that the surface properties changed due to the rapid melting and freezing of the dentin surface. The decrease in bond strength in Nd:YAG and KTP laser applied samples may be due to the reduction of the adhesion surface as a result of occlusion or narrowing of the dentinal tubules.

Alonaizan *et al.*[31] investigated the effects of PDT, Er,Cr:YSGG laser and conventional disinfection application on the pushing bond strength of fiber post to root dentin. While PDT showed the highest bond strength value, they stated that there was no significant difference between PDT and Er,Cr:YSGG laser. Keskin *et al.*[32] evaluated the effect of PDT, Er,Cr:YSGG laser, CHX and NaOCl on the microtensile bond strength of caries-affected dentin. Although Er,Cr:YSGG laser showed higher bond strength value than PDT, it was stated that the difference between them was no significant. Vellappally *et al.*[33] investigated the effects of Er,Cr:YSGG laser, PDT, CHX and NaOCI self-etch adhesive on the microtensile bond strength of caries-affected dentin. Although Er,Cr:YSGG laser and PDT showed higher bonding values compared to other disinfection methods, they reported that the difference between them was no significant.

In this study, the differences between the PDT groups (Diode laser and KTP laser activated PDT) and the Er:YAG laser group were statistically no significant. When the sem images are examined, the formation of recessed, irregular and gapless areas in PDT may have affected the bond strength positively by increasing the micromechanical locking between dentin and adhesive. Vellappally *et al.*[33], Alonaizan *et al.*[31], Keskin *et al.*[32] supports this study in terms of obtaining high bonding values in PDT.

Saito *et al.*[34] investigated the effects of universal adhesives applied in different modes and times (immediate time, prolonged time) on shear bond strength to dentine. Scotchbond Universal demonstrated the highest bond strength when prolonged application time and applied according to the manufacturer's instructions. Karadas *et al.*[35] evaluated the effect of universal adhesives applied in different modes on microshear bond strength to enamel after 2 years of immersion in water. Although Scotchbond Universal Adhesive showed the highest bond strength to enamel in self-etch mode, they reported that the difference with Tokuyama Universal Bond was no significant. Madrigal *et al.*[36] investigated the effects of two different universal adhesives (Scotchbond Universal Adhesive, Tokuyama Universal Bond) and two luting cements on the tensile bond strength to enamel, dentin and different restorative materials. Although the bond strength of Scotchbond Universal to dentine was higher than that of Tokuyama Universal Bond, the difference between them was no significant.

In this study, the Scotchbond Universal Adhesive system showed higher shear bond strength than the Tokuyama Universal adhesive system. This study supports the evidence from the above studies.[34-36]

Scotchbond Universal contains 10-methacryloxy generation dihydrogen phosphate monomer (10-MDP). This monomer exhibits acidic characteristic and has an abrasive effect on the dentin surface. In addition, the 10-MDP monomer bonds the nanolayers and prevents hydrolytic degradation of the hybrid layer, thanks to its strong hydrophobic characteristic.[23,37] Scotchbond Universal contains a polyalkenoic acid copolymer (Vitrebond copolymer) chemically bonding to calcium in hydroxyapatite.[38] More than 50% of the carboxyl groups in the polyalkenoic acid copolymer can be connected to hydroxyapatite. Carboxylic groups form ionic bonds with calcium, replacing the phosphate ions on the substrate.[39] Polyalkenoic acid copolymer provides high bond stability between dentine and adhesive during 6 months of aging. The polyalkenoic acid copolymer supports the bonding of Scotchbond Universal to dentine.[40] Moreover, Scotchbond Universal contains silica fillers (5-15%) containing silane, which can increase the mechanical properties of the adhesive layer and reduce water absorption.[41] The irregular structure and residual solvents at the adhesive interface can affect the bond strength with time.[42] Due to the high HEMA (10-30%) and acetone (30-60%) content of Tokuyama Universal Bond, it causes thinning of the adhesive layer. The high HEMA content of the adhesive results in increased water absorption and therefore a decrease in bond strength.[43] Hubbezoglu *et al*.[44] reported that when the fracture surface of Tokuyama Universal adhesive was examined in SEM, a 0.5-1 µm line-shaped space was observed along the hybrid layer, which negatively affected the bonding.

Conclusions

For the purpose of surface disinfection, Er:YAG laser and Photodynamic treatment applications increased the bond strength to dentine while Nd:YAG and KTP laser applications negatively affected the shear bond strength to dentine. KTP laser activated Photodynamic therapy application showed higher bond strength than KTP laser application alone. Self-etch adhesive system showed higher bonding value than self-cured adhesive system in all disinfection applications. In cases of using surface disinfection applications with laser for self-curing adhesive systems the Er:YAG laser or laser-activated PDT procedures are recommended.

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Conflıct of Interest

None.

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