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Original research

The effects of dental adhesives total etch; self-etch and selective etch application procedures on microleakage in class II composite restorations

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Purpose
The aim of this study is to evaluate the amount of microleakage resulting from the application of self-etch, selective etch, etch-and-rinse of adhesive systems in class II cavities.

Materials and Methods
Four adhesive systems with etch-and-rinse, selective etch and self etch methods were used on the extracted teeth. All groups were restored with G-aenial A'CHORD (Nanohybrid) (GC, Tokyo, Japan) A2 composite. After 1000 thermal cycles were applied to the teeth after restoration, the samples were kept in 0.5% basic fuchsin for 24 hours. Microleakage values formed after dye penetration with basic fuchsin were determined quantitatively by scoring method on sections taken from each sample in the mesiodistal direction. One-way Analysis of Variance (ANOVA) and Tukey test were used for statistical analysis of the data ($p<0.05$).

Results
While there was no statistically significant difference between the etch-and-rinse and selective etch applications of adhesive systems (G2-Bond Universal, Clearfil Tri-S Bond Universal Prime&Bond Universal and Tokuyama Bond Force II) ($p>0.05$), there was a statistically significant difference in self-etch application ($p<0.05$). As a result of Prime&Bond Universal's self-etch application, it showed statistically more microleakage than the other three adhesive systems ($p<0.05$).

Conclusion
It has been observed that additional etching of enamel and/or dentin with phosphoric acid reduces the amount of microleakage.

Keywords: *Adhesion, multimodal adhesive systems, etch-and-rinse adhesives, self-etch adhesives, selective etch*

Introduction

Due to advancements in adhesive dentistry (1,2), the principle of "Expand to Protect" has been supplanted with the principle of "Minimally Invasive Treatment". The development and regular use of adhesive materials has started to revolutionize many areas of restorative and preventive dentistry. Preparations for mechanical retention of the cavity, which were once necessary through features such as dovetail, groove, undercut, and sharp interior angles to ensure the retention of the filling, are now eliminated (3). As a result, attitudes towards cavity preparation are changing.

Aesthetic restorative materials that are considered ideal should have a smooth surface, maintain color stability, not cause any toxic reactions in the pulp, adhere well to enamel and dentin, and exhibit no microleakage (4). Insufficient marginal adaptation and loss of retention leading to

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microleakage are among the most commonly reported factors causing the failure of adhesive restorations (5). Therefore, in modern dentistry, where adhesives are critical to the success of restorative aesthetic materials, numerous dental adhesives have been developed to achieve adequate bond strengths in enamel and dentin (6,7).

Dental adhesives currently used can be classified into three-stage etch-and-rinse, two-stage etch-and-rinse, two-stage self-etch, and one-stage self-etch adhesive systems. In etch-and-rinse systems, the smear layer is eliminated using orthophosphoric acid at a concentration of 30-40%, which exposes collagens. Subsequently, the applied resin infiltrates the dentinal tubules and intercalates between the collagen fibers, resulting in the formation of a foundation for the hybrid layer upon polymerization (8). Self-etch adhesives incorporate acidic monomers that can demineralize and penetrate dentin without the need for washing. They also modify the smear layer and incorporate it into the hybrid layer (9). However, the bonding efficacy of self-etch adhesives to enamel is still uncertain (10). Therefore, to resolve this issue, it is recommended to roughen the enamel edges of the cavity with orthophosphoric acid before the application of moderately self-etch adhesives (11). To provide clinical ease of use, adhesives known as 'Universal' or 'Multimod' have been developed, which can be used both as self-etch and etch-and-rinse.

Our study aims to assess the impact of total etch, self-etch, and selective etch application techniques using universal adhesives, which are considered novel materials in dentistry, on microleakage observed in class II composite restorations. The null hypothesis of our study is that the application of universal adhesives using total etch, self-etch, and selective etch techniques will not have any effect on the microleakage observed in class II composite restorations.

Materials and Methods

Ethical approval

This study was initiated with the approval of the ethics committee (2021/117).

Sample size estimation

The sample size required for the study was calculated as β=0.80, α=0.05 with the G*Power 3.1 program, and the effect size was determined as 0.40 based on previously published data. The analysis of variance (ANOVA) test was targeted first and a total of 120 sample (n=10) in each group was considered. An additional 10% for non-parametric tests and 10% for cases that could be excluded from the study were also included.

Sample collection and storage

A total of 60 molars selected from caries and non-restorative extracted teeth were used. Care was taken to avoid cracks, hypoplasia or caries among the selected teeth, and these teeth were not included in the study. Extracted teeth were stored in a 0.1% thymol solution at +4 ^{0}C until they were to be used for the study for a maximum of 3 months.

Sample preparation

The tartar and soft tissues were removed from the teeth with a sharp hand tool. Using a cylindrical diamond bur (FG Diamond Burs ISO 110/018, Ra'anana, Israel) and a high-speed rotating water-cooled rotary tool, 60 teeth were prepared, with each tooth's mesial and distal surfaces prepared at the cementum boundary, and two box cavities in the enamel, for a total of 120 cavities (12). The burs were changed every 10 cavities. The mesiodistal width of each cavity was prepared to be 1/3 of the mesiodistal width of the tooth, while the buccolingual width was prepared to be 1/3 of the intercuspal distance. After the preparations were completed, metal matrix bands (PratiCap Matrix no 01063, İDA Dental Product, Turkey) were placed on the samples to reconstruct the lost proximal walls. The samples were then divided into 12 groups, each consisting of five specimens, with 10 box cavities from each group (n=10) (Table 1). Adhesive systems were applied according to the instructions of their manufacturers, using selective etch,

Table 1. *Names, contents and manufacturers of the adhesive systems used in our study.*

Product Name	Manufacturer	Composition	Lot Numbers
G2-Bond Universal	GC Corp., Tokyo, Japan	Primer: 4-MET, MDP ,MDTP , Dimethacrylates, Water, Acetone, Photoinitiators, Fillers Bonding: Bis-GMA, Dimethacrylates, Fillers Photo starters pH=1,5	2011051
Clearfil Tri-S Bond Universal	Kuraray Noritake, Niigata, Japan	MDP, Bis-GMA, HEMA, Hydrophilic Aliphatic dimethacrylate, Colloidal silica, Silane coupling agent Al-camphorquinone, Ethanol, Water pH=2,3	000058
Prime Bond Universal	Dentsply Sirona Pennsylvania, USA	PENTA, 10-MDP, Bis-GMA, UDMA, TEGDMA, Isopropanol, Acetone, Water pH=2,5	210500422
Tokuyama Bond Force II	Tokuyama Dental, Tokyo, Japan	Phosphoric acid, monomer, (new 3D-SR monomer), HEMA, Bis-GMA, TEGDMA, Alcohol, Camphorquinon e, Water pH=2,8	143E41

self-etch, or etch-and-rinse methods based on the group they belonged to. All cavities were restored with the universal composite G-aenial A'CHORD (color A2) using the oblique layering technique, and each composite layer was polymerized with a light device for 20 s in accordance with the manufacturers' recommendations. The LED light source (Woodpecker Led-E Plus) with a wavelength of 420-480 nm and a light power of 850- 1000mW / cm2 was used for polymerization. Finally, all restorations were polished with the Polishing Kit (Super-Snap Rainbo Technique Kit, Shofu, Japan).

Etch-and-rinse application

Enamel and dentin were treated with 35% orthophosphoric acid for 15 seconds. For 15 seconds, the acid-coated tooth surface was rinsed. Excess water was removed with a damp cotton pellet. Adhesive systems were applied in accordance with the manufacturer's instructions.

Selective etch application

Enamel was treated with 35% orthophosphoric acid for 15 seconds. For 15 seconds, the acid-coated tooth surface was rinsed. Excess water was removed with a damp cotton pellet. Adhesive systems were applied in accordance with the manufacturer's instructions.

Self-etch application

Adhesive systems were applied directly without orthophosphoric acid gel application in accordance with the manufacturer's instructions.

Table 2. *Microleakage scores and levels.*

Score	Microleak Level
0	No dye penetration
1	Less than half of the gingival wall has dye penetration.
2	There is dye penetration along the gingival wall.
3	There is paint penetration along the gingival wall and less than half of the axial wall.
4	There is paint penetration along the gingiva and axial wall.

Microleakage test

The dye penetration test was used to determine the amount of microleakage. Before the test, the samples were kept at a temperature range of 5-55±20C for 15 seconds with a transfer time of 10 seconds. A thermal cycle was applied 1000 times using the SD Mechatronic Thermocycler device. After the thermal cycle process, the apexes of the specimens were covered with boxing wax to prevent the transfer of paint from the areas outside the restoration. In addition, the areas outside the 1 mm area around the restorations were covered with three layers of nail varnish (Flormar, Turkey). The samples were then kept in 0.5% basic fuchsin for 24 hours and rinsed thoroughly with water before being implanted in blocks of polymerized acrylic resin.

After autopolymerization, sections were taken from each sample in the mesiodistal direction using a precision cutting device (IsoMet® 1000 Precision Sectioning Saw) under water cooling and 250 rpm. To evaluate the leakage amounts, photographs were taken from each section at 1/100 magnification using a stereomicroscope (Leica, Wetzlar, Germany) and a camera (D-Lux 3, Leica, Germany) for each sample. The amount of microleakage was then evaluated using a scoring method depicted in Table 2.

Statistical analysis

The dataset was analyzed with SPSS software version 22 (Statistical Package for Social Sciences, IBM SPSS, Armonk, NY, USA). The normality assumptions were checked with Shapiro-Wilk test. As the data distibuted normally, one way-ANOVA test was used for multiple comparisons followed by the post-hoc test Tukey's HSD for pairwise comparisons. The confidence interval was set to 95% and p values less than 0.05 was considered significant.

Results

Table 3 shows the leakage values obtained by using microleakage scoring for a total of 120 cavities prepared in our study. When we examined the findings of our study, we did not find any statistically significant difference between the selective etch, self-etch, and etch-and-rinse applications of G2-Bond Universal, which is one of the adhesive systems. However, we did find a statistically significant difference be-

Table 3. *Comparison of the mean (Average) and standard deviations (SD) of the microleakage amounts of the application methods according to the material used in permanent teeth.*

	Selective Etch	Self-Etch	Etch-And-Rinse	
	Mean ± SD	Mean ± SD	Mean ± SD	p
G2-Bond Universal	1,07 ±0,70^{a,A}	1,13 ±0,92 ^{a,A}	0,80 ±0,76 ^{a,A}	0,332
Clearfil Tri-S Bond Universal	1,60 ±1,06 ^{a,A}	2,13 ±0,64 ^{a,BC}	1,07 ±0,80 ^{b,A}	0,000
Prime&Bond Universal	1,40 ±0,99 ^{a,A}	2,47 ±0,74 ^{b,C}	1,27 ±0,96 ^{a,A}	0,000
Tokuyama Bond Force II	1,07 ±0,70 ^{a,A}	1,40 ±1,24 ^{a,AB}	1,20 ±0,68 ^{a,A}	0,332
P	0,322	0,000	0,332	

** A-C shows comparisons between rows, a-b shows comparisons between columns, p<0.05 was considered statistically significant. Oneway Analysis, posthoc Tukey test.*

tween the selective etch, self-etch, and etch-and-rinse applications of Clearfil Tri-S Bond Universal, which is also one of the adhesive systems (p<0.05). Among the adhesive systems used, there was no statistically significant difference between the selective etch and etch-and-rinse applications of Prime Bond Universal, but the self-etch application showed the most microleakage statistically (p<0.05). Finally, we did not find any statistically significant difference between the selective etch, self-etch, and etch-and-rinse applications of Tokuyama Bond Force II (see Figure 1 for details).

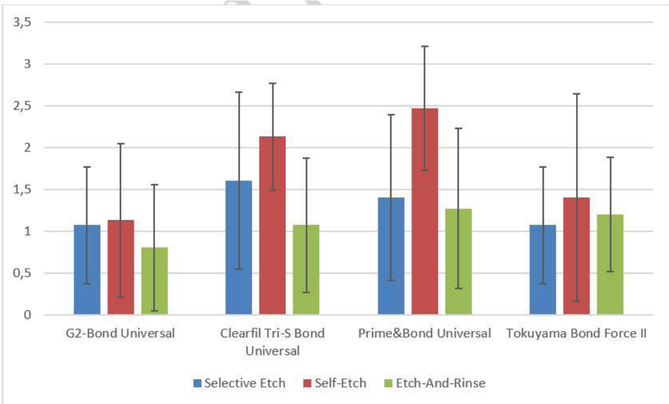

Figure 1. *Microleakage amounts of the application methods of the universal adhesives used are compared in the graphic.*

Discussion

In the identification of microleakage, in vitro investigations are preferred over in vivo research. Although extraoral tests do not completely replicate the oral environment, they are still necessary for the development of restorative materials, as noted by Watanabe *et al.* (13). It has been reported that in vitro studies with good standardization yield results similar to in vivo studies. In this study, we evaluated the microleakage of universal adhesives, which can be considered new among dental materials, on permanent teeth using different application methods (self-etch, selective etch, etch-and-rinse) in vitro.

In a study that examined the depth of polymerization of composite resins with different colors, it was reported that the color and opacity of the composite affected the depth of polymerization (14). Therefore, in our study, all restorations were made with G-aenial A'CHORD brand and A2 color composite.

To minimize the polymerization shrinkage that occurs during the polymerization of composite resins, it has been suggested that the composite layers applied to the cavity should not exceed 2 mm, and the light source should be positioned as close as possible to the surface to be polymerized (15). In our study, we took care to apply the composite layers within 2 mm and to position the light source as close as possible to the samples during polymerization.

Various methods are used in in vitro studies to simulate oral conditions (16). One of these methods is thermal cycling. In dental restoration studies that use thermal cycling, temperatures between 5-55°C are preferred, and a variation of ±5°C is considered normal (17). The holding times in cold and hot water tanks during the thermal cycling procedure can vary between 10, 15, 30, 60, and 120 seconds (18). Although there is no consensus in the literature on the transfer and holding times and the number of cycles used in thermal cycling, it is believed that shorter holding times are more effective in mimicking the intraoral environment (19). While the number of cycles used in microleakage studies varies in the literature, Crim *et al*. and Gale *et al*. reported that the number and duration of cycles did not affect microleakage (20,21). In our study, we applied 1000 cycles of thermal cycling with a waiting time of 15 seconds and a transfer time of 10 seconds at temperatures between 5-55±2 °C.

The dye penetration method is the most frequently used method for detecting microleakage. This method is preferred because it does not damage the dental tissue-restorative material interface, is easy to detect under visible light, provides fast and direct measurement, does not interact with dental hard tissues, is inexpensive, and is non-toxic (22,23). In our study, we used the dye penetration method with 0.5% basic fuchsin solution, which is an easy and widely used method. Although soaking time of the samples in the dye varies between 1 hour and 72 hours, it has been reported that it does not affect microleakage studies. In our study, the samples were kept in the dye solution for 24 hours.

As a result of various studies, it has been reported that at least three sections should be taken from each sample in order to reach true microleakage values (24). In our study, in order to increase the reliability of the measurements, each tooth was examined from 4 surfaces and the average of these measurements was taken to reach the microleakage score for that tooth.

The most frequently used method to evaluate microleakage after the dye penetration method is the scoring method, which is preferred due to its ease of application and low cost (25). However, this method is subjective, and either more than one observer needs to evaluate the samples and calibrate themselves or the same researcher needs to repeat the scoring twice to eliminate any optical illusions (26). In our study, the scores were repeated twice. In our study, stereomicroscopy was used to determine the scores, similar to most of the previous ones (27,28). The cut samples were photographed using a stereomicroscope, and scores were given between 0 and 4 in accordance with the literature (29,30).

A previous study reported that microleakage is more intense at the edges of the samples, and the sections taken from these regions can affect the results of the study (31). Therefore, in our study, the samples were cut in the middle of the mesiodistal direction (27) to avoid this issue. The reason for the different microleakage scores observed in the literature depending on the application of adhesive systems is attributed to the type of monomer and solvent contained in the adhesive system, the way the adhesive system is applied, its sensitivity to dentin moisture, and the pH of the adhesive system (32). Adhesives with a pH exceeding 2.5, also known as "ultra-light self-etch adhesives," do not penetrate the dentin deeply enough. Ultra-light and lightweight self-etch adhesives create minimal porosity on the enamel surface, which may result in the absence of resin tags between the prisms (33). The adhesive systems used in our study were Prime&Bond Universal with a pH of 2.5, Tokuyama Bond Force II with a pH of 2.8, Clearfil Tri-S Bond Universal with a pH of 2.3, and G2-Bond Universal with a pH of 1.5. This may explain why Prime&Bond Universal and Clearfil Tri-S Bond Universal showed more microleakage in self-etch application, while G2-Bond Universal had a moderately acidic primer (pH=1.5) and strong chemical bonding, which led to less microleakage in self-etch application.

In their study comparing the microleakage values of four different adhesive systems (Optibond Solo Plus, Optibond XTR, Optibond All-in-one, Fuji Bond LC), Sadeghi *et al*. (34) reported that the two-stage Optibond XTR applied in self-etch mode had lower microleakage levels than the other single-stage groups. Our study supports these findings, and the reason for G2-Bond Universal showing less microleakage can be attributed to its medium-strong acidic primer (pH=1.5), strong chemical bonding, and two-stage application.

Many universal adhesives contain the monofunctional monomer HEMA to increase wetting of the hydrophilic dentin surface (35) and water to provide self-etch bonding potential (35). Bonding to dentin is more challenging than to enamel because it is a moist tissue. Adhesives are hydrophilic to match moist dentin but become hydrophobic after polymerization (36), and they must maintain a balance between these hydrophilic and hydrophobic characteristics (36). Prime&Bond Universal does not contain HEMA but contains isopropanol as a co-solvent. This chemical ingredient may affect the bond strength of Prime&Bond Universal. The higher bond strength of Prime&Bond Universal may also be related to the fact that it contains isopropanol as an additional solvent, as noted in a previous study (35).

In their 2011 study, Takahashi *et al*. (37) examined the long-term values of water absorption and bond strength of single-stage self-etch adhesive systems with and without HEMA and found that water absorption increased and bond strength decreased over time for HEMA-containing adhesives (37). Our study also supports these findings, and we observed that the microleakage value of Clearfil Tri-S Bond Universal and Tokuyama Bond Force II, HEMA-containing single-stage self-etch adhesive systems, were higher than the HEMA-free two-stage self-etch adhesive G2-Bond Universal.

Takahashi *et al*. (38) evaluated the effectiveness of HEMA and 4-MET co-monomers in MDP-primed adhesive-dentin interfaces in terms of mechanical properties on a submicron scale, while increasing the diffusion of HEMA co-monomer found in MDP-based adhesives into the dentin tissue, reducing inelastic stiffness and adhesiveness. They reported that it reduces the retentive properties of the restorative material with significant viscoelastic deformity at the dentin interface. Additionally, 4-MET produces higher inelastic stiffness compared to HEMA and potential chemical interaction with MDP at the adhesive-dentin interface. Our findings suggest that the use of 4-MET co-monomer is probably a better complement to MDP-based dental adhesives. Therefore, our study supports the above-mentioned findings and explains why G2-Bond Universal contains 4-MET comonomer instead of HEMA and shows less microleakage in self-etch application compared to Clearfil Tri-S Bond Universal, which contains HEMA.

Solvents in adhesives can affect the moisture balance in dentin. Acetone-based systems remain on the surface as a thinner layer after evaporation than ethanol-based systems, resulting in more sensitive joint surfaces. A clinical study reported that after 36 months, an acetone-based adhesive system (One-Step, Bisco) showed lower retention rates than an ethanol-based adhesive system (Single Bond, 3M ESPE) (39). While Clearfil Tri-S Bond Universal used in our study is an ethanol-based adhesive, Prime Bond Universal is an acetone-based adhesive. Therefore, our study supports the above-mentioned findings and explains why Clearfil Tri-S Bond Universal shows less microleakage in self-etch application than Prime Bond Universal.

In their study, Oz *et al.* (40) found that the deterioration of the edge harmony and the edge coloration occurred in the self-etch groups at higher rates compared to the selective etch and etch-and-rinse methods. This is because the bond strength to the enamel with the self-etch application method is lower than that of the selective etch and etch-and-rinse methods (41). However, distortion of edge harmony and edge discoloration is at a level that can be easily removed by polishing, similar to previous studies (42). Lenzi *et al.* (43) restored decidous teeth by using Scotchbond Universal adhesive in self-etch and etch-and-rinse application forms after caries removal and reported that there was no significant difference between the application methods as a result of 18-month clinical follow-up. When the findings of our study are examined, in self-etch application, no statistically significant difference was found in terms of microleakage values in G2-Bond Universal and Tokuyama Bond Force II adhesive systems compared to selective etch and etch-and-rinse applications. However, G2-Bond Universal and Tokuyama Bond Force II showed more microleakage in self-etch application, although there was no statistically significant difference compared to selective etch and etch-and-rinse applications. In the Clearfil Tri-S Bond Universal adhesive system, self-etch application showed statistically significantly more microleakage than the etch-and-rinse application; however, self-etch application did not show a statistically significant difference compared to selective etch application. In Prime&Bond Universal adhesive system, self-etch application showed statistically significantly more microporous than selective etch and etch-and-rinse applications.

In vitro studies have shown that application of phosphoric acid to enamel increases the bond strength of universal adhesives (44). Phosphoric acid increases the infiltration of adhesive resin monomers into the enamel, thereby increasing micromechanical bonding (45). In in vitro studies, it has been reported that there is marginal deterioration of the enamel over time in the Clearfil SE Bond material, which is a two-stage self-etch material, and as a result of this deterioration, the bonding efficiency of the enamel decreases significantly and microleakage is increased (46,47,48,49). The increase in microleakage over time makes selective etch even more important in cases where marginal coverage is critical, such as pulp treatments. Although there are studies reporting that this deterioration in enamel is significantly reduced with selective etch application, some studies have reported that selective etch application does not make a difference (49,50,51,52). At the end of the 5-year evaluation in which they clinically compared the selective etch and self-etch application forms of an adhesive material (AdheSE, Ivoclar Vivadent), no difference was observed between the selective etch and self-etch groups in terms of retention. was found to be high (53). Perdigao *et al.*(54), in their clinical study, concluded that there was only a marginal adaptation difference in their clinical studies, in which they applied 3M Single Bond Universal in etch-and-rinse, self-etch, selective etch mode and followed them for 18 months. It has been stated that since 3M Single Bond Universal has a pH of 2.7, it cannot reach the effect of phosphoric acid on enamel, and therefore selective acidification of enamel is a prerequisite (55).

Souza-Junior *et al*. (52) reported that selective application of phosphoric acid to the enamel prior to the Clearfil Tri-s Plus Bond application increased marginal integrity. At the same time, these data overlap with studies suggesting that selective enamel etching with phosphoric acid increases the bond strength of the composite to enamel (48-50,56,57). Especially in single-stage self-etch adhesives, the application of the selective etch method significantly increases clinical success (58,59). In our study, acid etched applications (selective etch and etch-and-rinse) showed similar microleakage values with G2-Bond Universal and Tokuyama Bond Force II adhesive systems according to self-etch application; Prime&Bond Universal and Clearfil Tri-S Bond self-etch application showed greater microleakage value.

Conclusion

Within the limitations of the this *in-vitro* experiment, the study found that additional roughening of adhesive materials with phosphoric acid (selective etch and etch-and-rinse) reduces microleakage. Therefore, it may be preferred to roughen the enamel and/or dentin with phosphoric acid, as this results in low levels of microleakage. The applications of G-2 Bond Universal and Tokuyama Bond Force II using selective etch, self-etch, and etch-and-rinse methods did not statistically differ from each other. However, treatments of Clearfil Tri-S Bond Universal and Prime&Bond Universal using selective etching and etch-and-rinse methods differed significantly from each other. Based on the results of the study, Clearfil Tri-S Bond Universal exhibited the least tightness in Prime&Bond Universal etch-and-rinse application. Further research and long-term clinical follow-up studies can contribute to simplifying the application technique and achieving good adhesion in clinical success.

Türkçe özet: *Sınıf II kavitelerde adeziv sistemlerin self etch, selektif etch, etch and rinse uygulanması sonucunda oluşan mikrosızıntı miktarının incelenmesi. Amaç: Bu çalışmanın amacı, sınıf II kavitelerde adeziv sistemlerin self etch, selektif etch, etch and rinse uygulanması sonucunda oluşan mikrosızıntı miktarını değerlendirmektir. Gereç ve Yöntem: Çekilmiş 60 adet daimi diş rastgele olarak 12 gruba ayrılmış ve çalışmada kullanılan adeziv materyaller (G2-Bond Universal (GC Corp., Tokyo, Japan), Clearfil Tri-S Bond Universal (Kuraray Noritake, Niigata, Japan), Prime&Bond Universal (Dentsply Sirona Pennsylvania, USA), Tokuyama Bond Force II (Tokuyama Dental, Tokyo, Japan)) uygulandı. Tüm gruplar G-aenial A'CHORD (Nanohibrit) (GC, Tokyo, Japan) A2 kompozit ile restore edildi. Restorasyon sonrası dişlere 1000 kez termal siklus uygulandıktan sonra örnekler %0,5'lik bazik fuksin içerisinde 24 saat bekletildi. Bazik fuksin ile boya penetrasyonu sonrasında oluşan mikrosızıntı değerleri, her örnekten mesiodistal yönde alınan kesitler üzerinde skorlama yöntemiyle kantitatif olarak tespit edildi. Verilerin istatistiksel analizinde tek yönlü Varyans Analizi (ANOVA) ve Tukey testi kullanıldı (p<0.05). Bulgular: Adeziv sistemlerin (G2-Bond Universal, Clearfil Tri-S Bond Universal Prime and Bond Universal ve Tokuyama Bond Force II) etch and rinse ve selektif etch uygulamaları arasında istatiksel anlamlı farklılık bulunmazken (p>0.05), self etch uygulamada istatiksel olarak anlamlı farklılık görüldü (p<0.05). Prime and Bond Universal'in self etch uygulaması sonucunda diğer üç adeziv sisteme göre istatistiksel olarak daha fazla mikrosızıntı gösterdi (p<0,05). Sonuç: Mine ve/veya dentinde ek olarak fosforik asit ile pürüzlendirilmenin mikrosızıntı miktarını azalttığı görülmüş bundan dolayı test edilen adeziv materyallerin ek olarak fosforik asit ile pürüzlendirilmesinin klinik başarıyı arttırabileceği söylenebilir. Anahtar Kelimeler***:*** *Adezyon; multimod adeziv sistemler; etch and rinse adezivler; self etch adezivler; selektif etch*

Ethics Committee Approval: The study protocol has been reviewed and approved by the local ethics board (2021/117).

Informed Consent: Participants provided informed constent.

Peer-review: Externally peer-reviewed.

Author contributions: MY, SK, EAO participated in designing the study. MY, SK, ETA participated in generating the data for the study. MY, SK, NA participated in gathering the data for the study. MY, SK, NA participated in the analysis of the data. MY, SK, BE wrote the majority of the original draft of the paper. MY, SK, ETA participated in writing the paper. MY, SK, EAO have had access to all of the raw data of the study. MY, SK have reviewed the pertinent raw data on which the results and conclusions of this study are based. MY, SK, ETA, EAO, NA, BE have approved the final version of this paper. MY, SK, ETA guarantee that all individuals who meet the Journal's authorship criteria are included as authors of this paper.

Conflict of Interest: : The authors had no conflict of interest to declare.

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