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Original research

DENTIN BOND STRENGTH AND MICROLEAKAGE COMPARISON OF THREE DIFFERENT UNIVERSAL ADHESIVES

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ABSTRACT

Objectives: The aim of this study is to evaluate and compare the bond strength and micro-leakage of three different universal adhesive systems applied in self-etch mode to dentin.

Materials and Methods: To evaluate bond strength, the mid-coronal dentin surfaces of forty-five human molar teeth were exposed and randomly assigned into three groups according to the following adhesive application: Single Bond Universal (3M ESPE), Optibond XTR (Kerr), and Tokuyama Universal (Tokuyama Dental) (n=15). The shear bond strength test was performed after composite build-up. Then, the fractured surfaces were evaluated using a scanning electron microscope (SEM). To evaluate micro-leakage, facial class V cavities were prepared to forty-five human premolars and randomly assigned into identical three experimental groups described above (n=15). After composite resin restoration of cavities, the specimens were thermo-cycled for 500 cycles and then immersed in basic fuchsine, sectioned, and examined under a stereo-microscope. Data were evaluated using one-way ANOVA, Tukey's, Chi-square and Mann Whitney U tests.

Results: Among the adhesives, the highest bond strength was achieved in Optibond XTR, while Tokuyama Universal showed the lowest bond strength values ($p<0.05$). In micro-leakage results, no significant difference was reported in occlusal margins among groups. In gingival margins, Optibond XTR showed less leakage compared to Tokuyama and Single Bond Universal ($p<0.05$).

Conclusions: The study findings indicated that two-step universal adhesive system is more successful than one-step universal adhesive systems in bonding to dentin. Considering that bonding plays a major role in the longevity of the restoration, it can be said that the use of two-step universal adhesive systems in dentin can give more successful results.

Keywords: Adhesive systems, dentin bond strength, micro-leakage.

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INTRODUCTION

Owing to the growing patient demand for esthetic restorations and the application of more conservative cavity preparations, direct composite resin materials have become widespread in recent years. There is a direct relation between the success of composite restorations and the effectiveness of the adhesive system used.[1]

Nowadays, adhesive systems are categorized according to their different characteristics. In etch-and-rinse systems, which are among the subgroups of classification according application mode, 30-40% concentration of orthophosphoric acid is applied as a separate step. In this way, collagen is exposed by removing the smear layer completely. The applied resin then flows into the tubules of dentin and polymerizes by entering between the collagen fibers to provide a basis for the hybrid layer. In the clinical environment, it is better to use etch-and-rinse systems with “wet bonding” technique.[2] However, it is not practically possible to leave the dentin moist while drying the enamel and then to determine whether the dentin is sufficiently moist. The problem of dentin moistness, which reduces the spread of adhesive resin between collagen fibrils, has been eliminated with self-etch adhesive systems. Self-etch adhesives are systems that etching and primer application steps are applied simultaneously to enamel and dentin, and do not need a separate etching and rinsing step. However, the acids in self-etching adhesive are not as strong as phosphoric acid. Therefore, they constitute weak enamel bonding and long-term restorations show gaps in the enamel edges.[3] To solve this problem, roughening the enamel edges of the cavity with ortho phosphoric acid before applying self-etch adhesives is recommended.[4] In clinical use, etching the edges of the enamel without overflowing into the dentin is difficult.

Recently, studies aimed to eliminate the disadvantages of multi-step bonding procedures and to ease clinical use have resulted in products called “universal” or “multi-mode”.[5] This system provides clinician with many options during use. Thanks to these adhesive systems, the clinician can use etch-and-rinse, self-etch and selective-etch techniques together. This enables the clinician to choose the desired system using an adhesive agent in different situations.

This *in vitro* study aimed to compare the bond strengths and micro-leakage values of three different universal adhesive systems applied in the self-etch mode to dentin. The null hypothesis was that there are no differences between the universal adhesive systems in terms of bond strength and micro-leakage.

MATERIALS AND METHODS

The study was approved by the Non-Interventional Clinical Research Ethics Committee of Sivas Cumhuriyet University under approval number 2018-01/30.

A total of extracted 90 permanent human molar (45) and premolar (45) teeth were used in the study. The extracted teeth were stored in the 2.5% sodium hypochlorite (NaOCI) solution and then in distilled water at room temperature.

Shear Bond Strength (SBS) Test Procedure

For the SBS tests, 45 molars were buried in a silicon mold using self-curing acrylic (IMICRYL Dental, Konya, Turkey). The occlusal thirds of molars were separated with using a water-cooled diamond saw (IsoMet 1000, Buehler, USA). The exposed dentin surfaces were ground with 600 grid silicon carbide abrasive papers and prepared samples were divided randomly into three groups (n=15); Single Bond Universal (3M ESPE, St. Paul, MN, USA), Optibond XTR (Kerr, Orange, CA, USA) and Tokuyama Universal (Tokuyama Dental, Japan). All information about tested adhesive systems are presented in Table 1.

Table 1. Chemical compositions and application procedures of the tested adhesives.

Adhesive/Manufecturer	pH	Composition	Application procedure
Single Bond Universal (3M ESPE, USA)	2.7	10-MDP phosphate monomer, Vitrebond copolymer, HEMA, BISGMA, dimethacrylate resins filler, silane, initiators, ethanol, water	**1.** Apply adhesive to tooth surface by scrubbing action for 20 s. **2.** Dry the adhesive for 5 s. **3.** Light cure for 10 s.
Optibond XTR (Kerr, USA)	2.4	**Primer:** GPDM, HEMA, Dimethacrylate, CQ, water, ethanol, acetone. **Adhesive:** Bis-GMA, HEMA, trifunctional monomer, ethanol, CQ, barium glass filler, fluoride-containing filler, nano-filler.	**1.** Apply the self-etch primer using a micro brush with a scrubbing motion for 20 s. **2.** Air thinning for 5 s. **3.** Shake the adhesive briefly. **4.** Apply the adhesive using a light brushing motion for 15 s and air thin for 5 s. **5.** Light cure for 10 s.
Tokuyama Universal (Tokuyama Dental, Japan)	2.2	**Primer A:** Acetone, 3D-SR monomer, MTU-6, Bis-GMA, TEGDMA, HEMA **Primer B:** Acetone, isopropyl alcohol, water, borate catalyst, peroxide, silane bonding agent	**1.** Mix by dropping one drop of bottles A and B. Scrub to surface with agitation for 20 s. **2.** Air thinning for 5 s.

MDP: 10-methacryloyloxy-decyl-dihydrogen-phosphate; HEMA:-hydroxyethyl methacrylate; BIS-GMA: bisphenol-A-diglycidyl methacrylate; GPDM: glycero-phosphate dimethacrylate; CQ: camphorquinone; 3D-SR: three dimensional surface-reinforcing monomer; MTU-6: 6-methacryloyloxyhexyl 2-thiouracil-5-carboxylate; TEGDMA: triethyleneglycol dimethacrylate.

All of adhesive agents applied in accordance with the manufacturer's -instructions and polymerized with a LED-curing light (Valo Cordless, Ultradent, South Jordan, USA) for 10 s. A cylindrical plastic tube (4x3 mm) was placed on exposed dentin surface where the adhesive had been applied. Composite resin (Estelite Sigma Quick, Tokuyama, Japan) was built-up and polymerized for 40 s. Then, SBS test was performed using a universal testing machine at 0.5mm/min (LLOYD Instruments, Ametek Inc. England). Obtaind fractured specimens were examined on a stereo-microscope (Nikon SMZ800, Tokyo, Japan) under 25x magnification. The failure modes (cohesive, adhesive, and mixed) were identified for each specimen. After examination of all samples with the stereo-microscope, fractured surfaces were evaluated in detail on SEM analysis (TESCAN MIRA3, Brno, Czech Republic).

Micro-leakage Test Procedure

Class V cavity preparations (4x3x2 mm) without bevels were prepared on the facial surfaces of the 45 premolars with diamond burs underwater cooling. The gingival margin was 1 mm below the cemento-enamel junction. The teeth were then randomly divided into the specified groups as in the bond strength test procedure (n=15). After the bonding agents were applied according to the manufacturer's instructionspolymerized with the same dental light device for 10 s. All cavities were restored with composite resin. The restorations were then finished and polished (Astropol, Ivoclar Vivadent, USA) under water cooling. After the specimens stored in distilled water for 24 h, thermocycling procedure were applied. This procedure was done with 500 times between 5-55 °C and 30 s of dwell time. The entire surface of specimens of which root apex were closed using sticky wax was applied two layers of nail varnish starting at a distance of 1 mm from the margins. The samples were kept in 0.5% basic fuchsine at room temperature. Samples removed from solution after 24 hours were rinsed under water. Occlusal (enamel) and gingival (cementum) margins of samples that are divided into two parts as mesio-distally using a low-speed diamond disc were evaluated with a stereo-microscope at 40x magnification. The dye infiltration was observed according to the following classification. [6]

0: No infiltration;

1: Dye infiltration at 1/3 of cavity walls;

2: Dye infiltration at 2/3 of cavity walls;

3: Dye infiltration entire or more than 2/3 of the cavity walls;

4: Infiltration involving axial wall.

Statistical Analysis

Data analysis was carried out using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). One-way ANOVA complemented by post hoc Tukey Test were used for inter-group comparison. The data obtained by counting were assessed by using Chi-square and Mann-Whitney U tests. The value of 0.05 was accepted as statistical significance.

RESULTS

Shear Bond Strength

Values obtained from shear bond strength test and distribution of the fracture modes are given in Table 2 and Table 3, respectively.

Table 2. The maximum, minimum, mean shear bond strength values (Mpa) and standard deviation (SD) of the tested adhesive systems.

Adhesive system	N	Minimum (Mpa)	Maximum (Mpa)	Mean ± SD (Mpa)
Single Bond Universal	15	9.23	16.97	12.66 ± 2.5 [a]
Optibond XTR	15	13.53	21.67	18.57 ± 2.3 [b]
Tokuyama Universal	15	4.01	8.33	5.5 ± 1.3 [c]

[a,b,c]: Values with the different superscript letters are significantly different. ($p<0.05$).

Table 3. Distribution of the fracture modes after shear bond strength (SBS) testing.

Adhesive system	Fracture mode			
	Adhesive	Dentin cohesive	Composite cohesive	Mixed
Single Bond Universal	3	5	2	5
Optibond XTR	-	-	2	13
Tokuyama Universal	14	-	1	-

When the groups are analyzed with one-way variance analysis, the differences were statistically significant (p=0.001). As a result of multiple comparisons between adhesive systems, it was observed that Optibond XTR showed significantly the highest bond strength (p=0.001), while Tokuyama Universal showed significantly the lowest (p=0.001. In the fracture surface analysis, Single Bond Universal showed more cohesive fractures, Optibond XTR had more mixed fractures, and Tokuyama Universal had more adhesive fractures (Table 3).

SEM photographs of the fracture surfaces of the groups are presented in Figure 1.

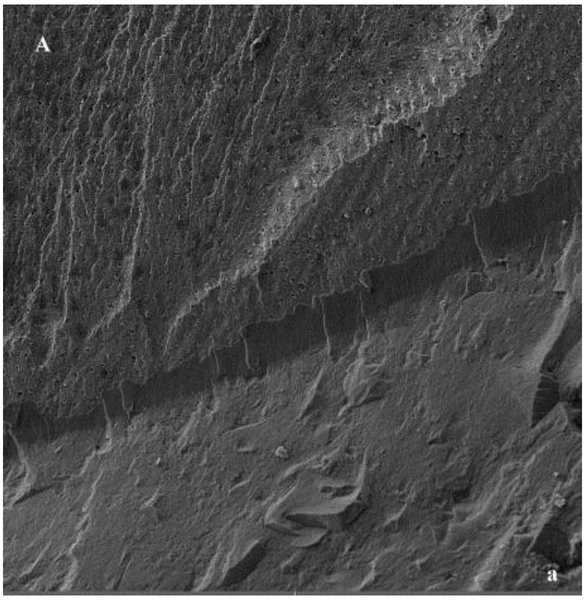

Figure 1. Mixed failure SEM micrograph of Single Bond Universal (A) at 500x (a) magnification.

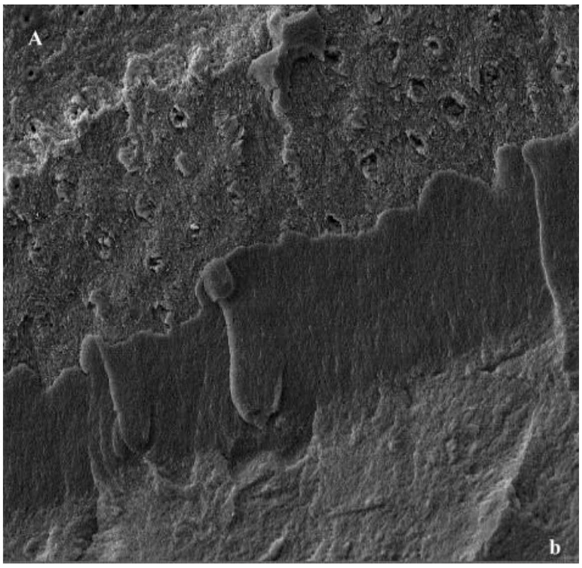

Figure 2. Mixed failure SEM micrograph of Single Bond Universal (A) at 2000x (b) magnification.

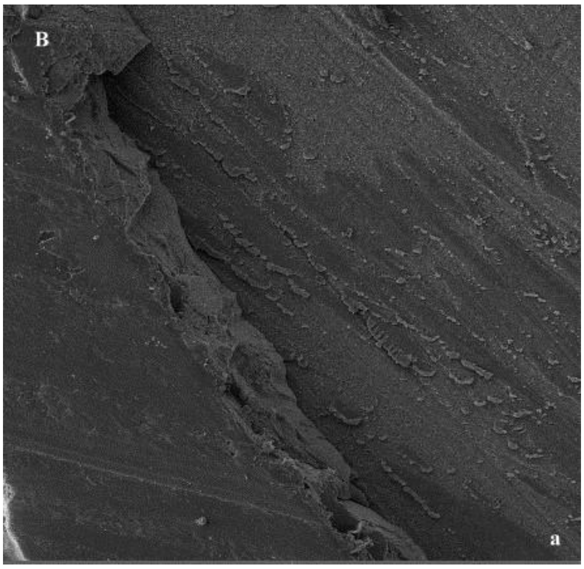

Figure 3. Cohesive failure SEM micrograph of Optibond XTR (B) at 500x (a) magnification.

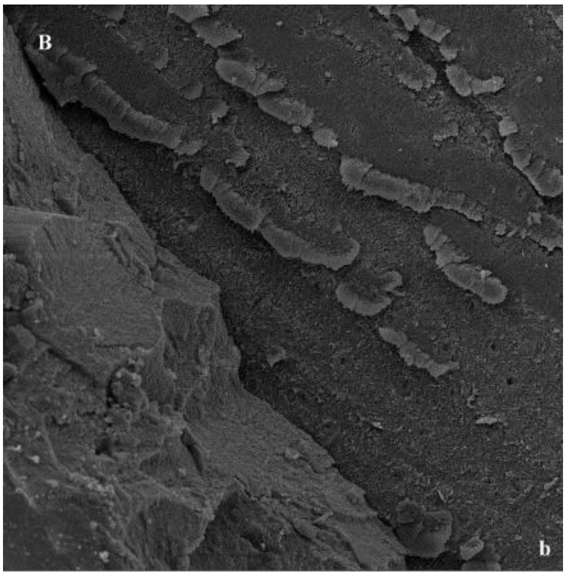

Figure 4. Cohesive failure SEM micrograph of Optibond XTR (B) at 2000x (b) magnification.

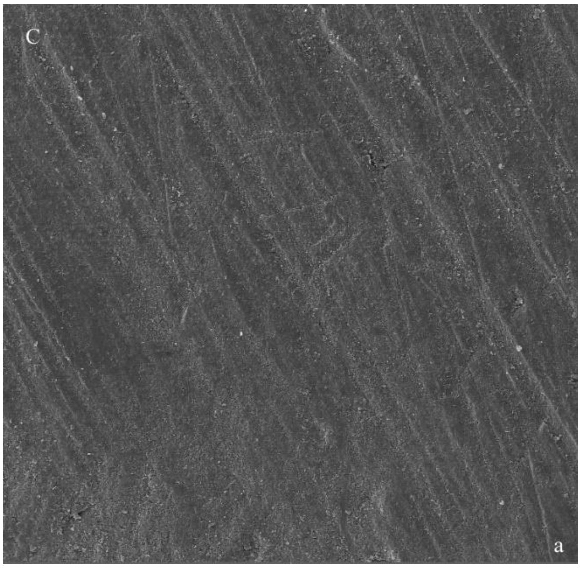

Figure 5. Adhesive failure SEM micrograph of Tokuyama Universal (C) at 500x (a) magnification.

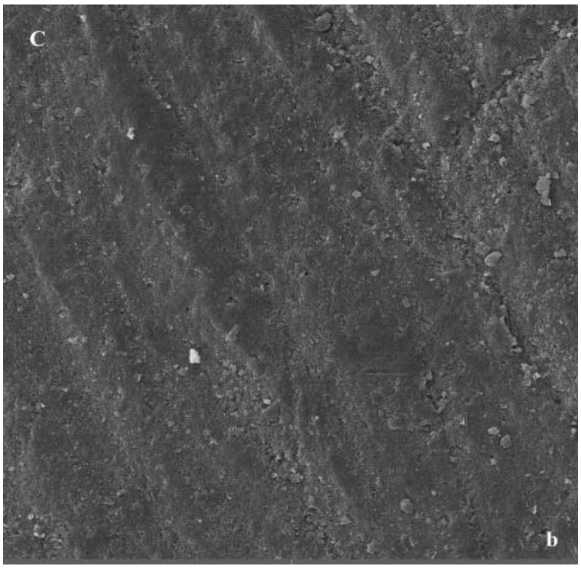

Figure 6. Adhesive failure SEM micrograph of Tokuyama Universal (C) at 2000x (b) magnification.

When the fracture surface of the Single Bond Universal was examined under the SEM, the composite cohesive region, the dentin cohesive region (where the tubules can be clearly seen) and the adhesive layer were observed. In the fractured specimens of Optibond XTR, the composite cohesive region and the dentin surface where the tubules were not clearly visible were observed. Sealed dentin surfaces with detectable adhesive agent and composite residues were visible. When the fracture surface of Tokuyama Universal was examined with the SEM, dentin tubules and adhesive residues appeared to be indistinct.

Microleakage

The occlusal and gingival microleakage scores of the universal adhesive systems are shown in Table 4.

Table 4. Occlusal and gingival microleakage scores.

Adhesive system		Microleakage scores 0	1	2	3	4
Single Bond Universal	**occlusal**	10	3	2	0	0
	gingival	7	4	1	1	2
Optibond XTR	**occlusal**	14	0	1	0	0
	gingival	10	4	0	0	1
Tokuyama Universal	**occlusal**	8	4	1	2	0
	gingival	4	2	1	2	6

When comparison was made between the mean microleakage scores of different materials at the occlusal margins, Optibond XTR exhibited the least microleakage and Tokuyama Universal showed the most. However, there were no statistically significant differences in microleakage of the occlusal margins between the groups ($p>0.05$). When comparison was made between mean microleakage scores of different materials, Optibond XTR exhibited the least microleakage and Tokuyama Universal exhibited the most microleakage at the gingival margins. Intragroup comparisons revealed that there was a statistically significant difference in microleakage between Optibond XTR and Tokuyama Universal adhesive systems ($p=0.006$). In the evaluation made separately for the occlusal and gingival microleakage, while there was no statistically significant difference between the samples of Single Bond Universal and Optibond XTR groups for both regions ($p>0.05$), Tokuyama Universal showed more microleakage in the gingival than occlusal. ($p=0.02$) ($p<0.05$). Also, all adhesives showed more leakage in the gingival than occlusal margins (Table 5).

Table 5. Statistical values of microleakage levels in occlusal and gingival margins.

	Adhesive system	N	Mean ± SD	Median (minimum-maximum)
Occlusal	**Single Bond Universal**	15	.4667 ± 0.74 [a]	0.00(0.00-2.00)
	Optibond XTR	15	.1333 ± 0.51 [a]	0.00(0.00-2.00)
	Tokuyama Universal	15	.8000 ± 1.08 [a]	0.00(0.00-3.00)
Gingival	**Single Bond Universal**	15	1.1333 ± 1.45 [ab]	1.00(0.00-4.00)
	Optibond XTR	15	.5333 ± 1.06 [a]	0.00(0.00-4.00)
	Tokuyama Universal	15	2.2667 ± 1.75 [b]	3.00(0.00-4.00)

[a,b]: Values with the different superscript letters are significantly different. ($p<0.05$).

DISCUSSION

Although the production of adhesion systems recently introduced as “universal” adhesives are an exciting step for the development of adhesive dentistry, it remains unclear whether they are suitable for all adhesive procedures. In this study, Optibond XTR showed the highest bonding strength and lowest microleakage values while Tokuyama Universal showed the lowest bonding strength and highest microleakage values. Therefore, the null hypothesis of the study was rejected.

Optibond XTR is a two-step universal adhesive system developed to increase the acidification capacity of the primer. This system has a moderate self-etching primer (pH = 1.6). The primer contains glycerol phosphate dimethacrylate (GPDM) as the monomer and water, ethanol and acetone as the solvent. Shortly after the primer of the adhesive system is applied, the acetone evaporates and the concentration of water and GPDM increases. Due to the increase in GPDM and water concentration, the pH of the primer initially decreases from 2.4 to 1.6.[7,8] Increased acidity of the primer increases the depth of demineralization in dentin. It has been reported that increasing the depth of demineralization in dentin provides better bonding.[9-11] The high bond strength of Optibond XTR can be attributed to strong demineralization and micromechanical locking due to its strong acidity. Also, the fact that GPDM in the Optibond XTR has two polymerizable groups forms a stronger polymerization network and may tend to react more strongly with adhesives and other monomers in the restorative material. This may explain the high bonding performance. Juloski *et al*.[12] examined the bond strength of different adhesive systems used etch-and-rinse and self-etch modes on enamel and dentin. They concluded that Optibond XTR used in self-etch mode gave similar results to etch-and-rinse adhesive systems. Meharry *et al*.[13] compared the shear bond strength of nine different adhesive systems. They reported that Optibond XTR gave high bonding values.

Single Bond Universal is a one-step universal adhesive system with monomer containing methacryloyloxyethyl dihydrogen phosphate (MDP). MDP is a monomer that can acidify enamel and dentin and chemically bond with calcium (Ca) in hydroxyapatite (HAp). This ionic bond of MDP with HAp is highly resistant to hydrolytic degradation. Therefore, chemical bonding between MDP and HAp have critical importance in maintaining the stability of the adhesive layer.[14-16] In addition, more than 50% of the polyalkenoic acid copolymer contained in Single Bond Universal except MDP can be bond with HAp. Munoz *et al.*[17] showed that Single Bond Universal had a lower conversion degree than other groups in their studies comparing the bonding efficiency of eight adhesive systems to dentin. They reported that this is because Vitrebond's high molecular weight prevents monomer convergence during polymerization. They also reported that Vitrebond reduced the bonding strength of the MDP monomer, resulting in low bonding strength. Takamizawa *et al.*[18] compared the effectiveness of various smear layers in dental hard tissues on the fatigue strength and shear bond strength of four different bonding systems. They found that two-step adhesive systems are more successful than one-step adhesive systems regardless of the smear layers and reported that Single Bond Universal has lower bond strength than Optibond XTR. Michaud *et al.*[19] examined the bond strength in various etching proctocols of three different adhesive systems. They concluded that when applied in self-etch, Single Bond Universal gave lower bonding values than Optibond XTR in dentin.

In study, Single Bond Universal showed lower bond performance values compared to Optibond XTR. The cause for this, it may be shown that the adhesive system has polyalkenoic acid copolymer in addition to its ultra-mild acidity. It has been explained that the high molecular weight polyalkenoic acid copolymer competes with the MDP monomer to bond with HAp and prevents monomer convergence.[18, 20]

Yoshihara *et al.*[21] examined the molecular interaction of two different solutions containing GPDM and MDP with the dentin surface using transmission electron microscopy (TEM). They reported that the monomer interaction difference with HAp was clearly visible at the dentin interface. According to the study results, initially, chemical bonding occurs between the Ca of the HAp and the acids (Stage 1). The first bonding stage is accompanied by the dissolution of phosphate and hydroxide ions from HAp to reach electron neutrality. Whether the monomer will remain bonded (stage 2, adhesion route) or de-bonded along with an abundant decalcification (stage 2, decalcification route) is affected by the stability of the monomer-Ca formation. GPDM-Ca salt is less stable than MDP-Ca salt. GPDM basically follows the decalcification route, while MDP-Ca follows the adhesion route.[21] Thus, it was observed that a submicron HAp-rich hybrid layer without obvious collagen exposure formed in the MDP-based adhesive system while GPDM-based adhesive system is formed a thicker and HAp-poor hybrid layer with visible collagen exposure.[22]

The current consensus regarding the studies is that chemical interactions provide more benefits from abrasion in bonding to dentin.[14,23,24] The different bonding performances shown by Single Bond Universal and Optibond XTR can be explained by the chemical composition of the monomers. Although Optibond XTR with GPDM monomer follows the decalcification route, its high bonding values can be attributed to the fact that it has two methacrylate groups and forms a stronger polymer network than the MDP monomer.

The Tokuyama Universal adhesive system demonstrated the lowest bond strength values between all universal adhesive systems. Tokuyama Universal is a chemically polymerized two-component, one-step universal adhesive system. Regarding this newly developed universal adhesive system, Katsumata *et al.*[25] examined the microtensile bond strength of different universal adhesive systems using various restorative materials and concluded that Single Bond Universal showed higher values than Tokuyama Universal, although there was no statistical difference in microtensile bonding values. Similarly, Single Bond Universal showed higher bonding values than Tokuyama Universal in this study. Although Tokuyama Universal has mild acidity, its low bond strength compared to Single Bond Universal, which has ultra-mild acidity, can be attributed to its interactions with HAp depending on polymerization types and monomer differences. The absence of statistical differences between the two adhesive systems maybe the result of using different bond strength tests and restorative materials.

When the fracture types of the groups were examined, a certain relationship was found between bond strength values and fracture type. It was seen that the cohesive fracture type was found more in the adhesive systems with high bonding values, while the adhesive fracture type was more present in the adhesive systems with low bonding values. Available data are compatible with previous studies.[26,27]

Currently, there is no consensus on which type of adhesive system reduces microleakage. The one-step adhesive systems produced today have not achieved the success of conventional multi-step adhesive systems. There are several reasons why these systems failure. One-step self-etch systems are highly hydrophilic even after polymerization and so they act as semi-permeable membranes. These systems have a high solvent concentration. This makes it difficult to obtain a sufficient thickness of resin layers and to remove residual solvent. One-step self-etch adhesives tend to evaporate the solvent so the membranes become permeable after polymerization.[28] During the evaporation of the solvent contained in the one-step systems, the monomer/water ratio can also vary. In later periods, hydrophilic areas and water-filled tunnels (so-called ‘water trees’) are formed that allow the water movement in the substrate.[29] In addition, in this adhesive systems, the hybrid layer thickness is thinner compared to multi-step adhesive systems.[30,31] This layer is inhibited by oxygen and causes poor polymerization, which is one of the important factors of microleakage.[32]

In the study, Single Bond Universal, which is a one-step universal adhesive system, gave higher microleakage values than the Optibond XTR group, which is a two-step system. Single Bond Universal's inability to acidify enamel and dentin/cement due to its ultra-mild acid primer resulting in incomplete hybridization may explain more microleakage. Also, hybrid layer formation that arises from high hydrophilicity and solvent ratio in one-step adhesives can be considered the cause of high microleakage. The polyalkenoic acid copolymer contained in Single Bond Universal competes with the MDP monomer to bond to Ca in HAp. This prevents the convergence of monomers during polymerization due to the high molecular weight, resulting in high microleakage values by affecting the adhesive bond.

In the study, Optibond XTR showed low microleakage values compared to other groups. Rengo *et al.*[9] compared the leakage resistance between different adhesive systems and stated that Optibond XTR used in self-etch mode gave results comparable to Optibond FL, a three-step adhesive system. Sadeghi *et al.*[33] examinated the microleakage values of four different adhesive systems and reported that Optibond XTR applied in self-etch mode gave lower microleakage values than other groups. In parallel with previous studies, the reason for the less microleakage of the Optibond XTR can shown to be a two-step adhesive with a moderate acidic primer that makes a strong chemical bond.

When the microleakage results of adhesive systems were evaluated, the highest microleakage values were observed in the Tokuyama Universal group. Further studies are needed to examine why the formulation of Tokuyama Universal leads to more microleakage. To our knowledge, there is no study comparing the data obtained from self-etch application of Tokuyama Universal published in full text in the relevant literature.

In the evaluation cavity margins of the tested adhesives, it was seen that the amount of leakage at the gingival margins of all three adhesive groups was more than at the occlusal margins. In many studies examining the leakage values of restorative materials, it has been reported that gingival margins have more microleakage than occlusal margins.[34-38]

According to the studies, the microleakage variation between enamel and dentin/ cementum margins is multifactorial and depend on issues such as the hypermineralization and collagen fibrillary network, organic component of the dentin, tubular fluids movement, dentin tubule orientation, the interaction of acidic primers with the smear layer and demineralization and hybrid layer formation.[39,40] Furthermore, the fact that solvents in the adhesive resin react differently with varying dentin moisture can be shown as the cause of microleakage differences between the adhesive resins.[40] In this study, cavity are limited in two separate tooth regions as enamel and dentin/cementum. That the dentin/cementum-composite thermal expansion coefficient is higher than the difference between enamel-composite may be the cause of high leakage in the gingival margin.

The main limitation of this present study was that long-term clinical follow-up was not investigated, because it is difficult to perform in a standardized manner and is time-consuming. *In vitro* tests are frequently used to assess properties and quality of dental materials and technical procedures. Because of the limitation of the methods of investigation using shear strength and dye penetration, further investigations are needed, especially regarding the dentin bonding when universal adhesives are used. Another limitation of this study was the low number of observations. A higher number of observations could show minor changes among the products and highlight further significant differences.

CONCLUSIONS

The results demonstrated that one-step universal adhesive systems did not show bond strength and leakage resistance that was as good as the two-step universal adhesive system. Optibond XTR showed better bonding performance in comparison with other universal adhesives; while Tokuyama Universal showed the worst performance between all adhesive systems. Starting from the study, it can be said that two-step universal adhesive systems are preferable in dentin due to their success in bonding performance and microleakage. *In vivo* research is necessary to evaluate the long-term clinical success of universal adhesive systems.

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CONFLICT OF INTEREST

The authors declare no conflict of interest with respect to the authorship and publication of this article.

Üç Farklı Üniversal Adeziv Sistemin Dentine Makaslama Bağlanma Dayanımlarının ve Mikrosızıntı Değerlerinin Karşılaştırılması

ÖZ

Amaç: *Bu çalışmanın amacı, self-etch modda kullanılan üç farklı üniversal adeziv sistemin dentine olan bağlanma dayanımını ve mikrosızıntısı değerlendirmek ve karşılaştırmaktır.* ***Gereç ve Yöntemler:*** *Bağlanma dayanımını değerlendirmek için, 45 adet çekilmiş insan molar dişlerinin orta koronal dentin yüzeyleri açığa çıkartıldı, hazırlanan dişler adeziv sistemler uygulanmak üzere rastgele 3 gruba ayrıldı: Single Bond Universal (3M ESPE), Optibond XTR (Kerr) ve Tokuyama Universal (Tokuyama Dental) (n=15). Kompozit rezin yerleştirilmesinin ardından örneklere makaslama bağlanma dayanımı testi uygulandı. Kırılan örneklerin* *kopma yüzeyleri taramalı elektron mikroskobunda incelendi. M,ikrosızıntıyı değerlendirmek için, 45 adet çekilmiş insan premolar dişlerinin bukkal yüzeylerinde Sınıf V kaviteler hazırlandı. Hazırlanan dişlere bağlanma dayanımında belirtilen gruplarda olduğu gibi aynı adeziv sistemler uygulandı (n=15). Kaviteler kompozit rezin ile restore edildi ve örnekler 500 devir termal siklusa tabi tutuldu. Ardından bazik fuksinde bekletilen örnekler ikiye ayrıldı ve kesit yüzeyleri stereomikroskop altında incelendi. Veriler tek yönlü ANOVA, Tukey, Ki-kare ve Mann Whitney U testleri kullanılarak analiz edildi.* ***Bulgular:*** *Çalışmada kullanılan adeziv sistemler arasında en yüksek bağlanma dayanımı Optibond XTR'de görülürken, en düşük bağlanma dayanımı ise Tokuyama Üniversal'de gözlendi. ($p<0,05$). Mikrosızıntı değerleri incelendiğinde ise, okluzal kenarlarda gruplar arasında anlamlı bir farklılık görülmezken; gingival kenarlarda Optibond XTR'nin, Tokuyama Üniversal'den anlamlı derecede daha az sızıntı gösterdiği görüldü. ($p<0,05$)* ***Sonuçlar:*** *Çalışma bulguları, dentine bağlanmada iki aşamalı universal adeziv systemin tek aşamalı universal adeziv sistemlerden daha başarılı olduğunu göstermiştir. Bağlanmanın restorasyonun uzun ömürlülüğünde major bir rol oynadığı düşünüldüğünde, dentinde iki aşamalı universal adeziv sistemlerinin kullanımının daha başarılı sonuçlar verebileceği söylenebilir.* ***Anahtar kelimeler:*** *Adeziv sistemler, dentine bağlanma dayanımı, mikrosızıntı.*

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