

# Comparison of Microleakage of Class V Restoration with Self-etch and Selective-etch Adhesive Systems: An *In Vitro* Study

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## ABSTRACT

**Purpose:** This *in vitro* study is to evaluate the microleakage of the universal and self-etch adhesives in selective-etch and self-etch techniques by evaluating dye penetration.

**Materials and methods:** In this study, a total of 48 restoration and caries-free maxillary or mandibular anterior teeth were used. Standardized class V cavities (1.5 mm deep, not beveled, rounded corners) were prepared on buccal surfaces of all teeth, which were gingival edges above from the enamel-cement junction. A total of 48 teeth were randomly separated into four groups. The first group was restored with Clearfil S3 Bond Plus (Kuraray, Tokyo, Japan) in the self-etch technique. The second group was restored with single bond universal (SBU) adhesive L-pop (3M ESPE, St. Paul, USA) in the self-etch technique. The third group was restored with Clearfil S3 Bond Plus (Kuraray, Tokyo, Japan) in the selective-etch technique. The fourth group was restored with single bond universal adhesive L-pop (3M ESPE, St. Paul, USA) in the selective-etch technique. Final finishing and polishing of the restorations were performed by using discs (ZenitFlex, Munich, Germany). They were thermocycled for 5,000 thermal cycles between water baths at 5°C and 55°C. All surfaces were isolated with two layers of nail polish, except up to 1 mm from the restoration margin for correct evaluation of the microleakage. The apices of all teeth were covered with a composite resin (Clearfil Majesty Esthetic, Kuraray, Tokyo, Japan). The teeth were stored in an oven with 2% methylene blue solution for 24 hours. The samples were embedded in acrylic resin in plastic molds.

**Results:** Microleakage scores (count and percentages) for all four groups are shown in Table 2. The Kruskal–Wallis test was applied to determine the differences between microleakage scores in the four study groups at a 0.05 level of significance. No statistically significant difference was found ( $p > 0.05$ ).

**Conclusion:** The two adhesive systems showed clinically acceptable microleakage values in two different application techniques.

**Keywords:** Adhesive, Composite resin, Microleakage, Self-etch adhesives.

*International Journal of Prosthodontics and Restorative Dentistry* (2019); 10.5005/jp-journals-10019-1229

## INTRODUCTION

Adhesion is defined as where two different surfaces are held together by physical or chemical bonding. In restorative dentistry, adhesion comes about between mineralized tooth structures and restorative materials.<sup>1,2</sup> Adhesive systems play an important role in the adaptation of resin-based materials to tooth structures. Therefore, manufacturers are trying to find the ideal adhesive system and adhesive technique for a better adaptation.<sup>3</sup> Dental adhesive systems have changed from the past to present, and producers have focused on developing single-stage and easy-to-use systems. These developments provide ease of application and save treatment time on the patient to dentists. Dental adhesive systems can be divided into two main groups as “total-etch” and “self-etch.”<sup>4,5</sup>

Total-etch systems are the oldest systems on the market and can be applied in two or three stages. In three-stage systems, first phosphoric acid is applied to enamel and dentin. The etching procedure is aimed to increase the surface area and surface energy of the enamel.<sup>6</sup> Then, the tooth is washed and dried with an air–water spray and primer applied. The primers replace water in the collagen network to ease the infiltration of the monomer.<sup>5</sup> Then, the adhesive resin is applied to primer applied tooth. In two-stage systems, primer and adhesive resin are in the same bottle and applied after the etching process.<sup>5,7</sup> Total-etch systems are still the gold standard in terms of dental adhesion, but today’s trend is on the development of self-etch systems.<sup>4,5,8,9</sup>

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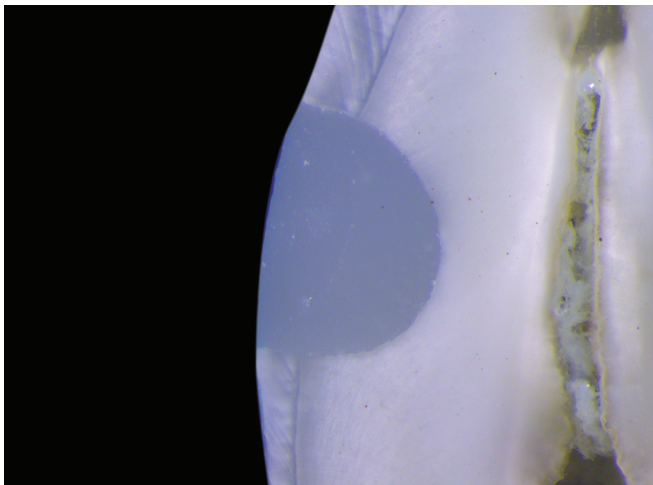
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**How to cite this article:** Yalniz AM, Karacan AO, *et al.* Comparison of Microleakage of Class V Restoration with Self-etch and Selective-etch Adhesive Systems: An *In Vitro* Study. *Int J Prosthodont Restor Dent* 2019;9(2):51–55.

**Source of support:** Nil

**Conflict of interest:** None

From the view that the smear layer protects the dentine and pulp against irritations, it is intended to obtain a hybrid layer containing the smear layer.<sup>10</sup> Unlike total-etch systems, hydrophobic and hydrophilic monomers, polymerization initiators, solvents, stabilizers, and filler particles are blended in self-etch systems.<sup>11</sup> Self-etch systems can be applied in one or two stages.<sup>4,7</sup> In two-stage self-etch systems, acid and primer have been combined in a bottle. This is called the self-etch primer. The adhesive resin is applied after the self-etch primer has been applied. In single-stage self-etch systems, acid, primer, and adhesive resin have been combined in one bottle. Thus, the application is simplified by reducing the number of steps.<sup>8,12</sup> All components in one bottle are called “all-in-one” systems (Figs 1 and 2).



**Fig. 1:** Sample of experimental second group which is restored with single bond universal adhesive L-pop (3M ESPE, St.Paul, USA) in self-etch application technique (x12.5)

Self-etch systems contain special acidic monomers. These monomers contain acidic carboxylate and phosphate groups and thus act as “conditioners.” These monomers provide enamel and dentin etching.<sup>11,13</sup> Due to these features of self-etch systems, they are easy to use and enable facile application.<sup>4,14</sup>

While both of these systems provide an adequate connection to the dentine, total-etch systems have been preferred on the enamel.<sup>4,15,16</sup> To strengthen the bonding of self-etch adhesives to enamel, acid application only to the enamel edges is called “selective-etch.” The purpose of selective-etch is to increase enamel bonding force like total-etch.<sup>17</sup> Nowadays, the purpose of dental adhesive systems is to get the same result in different dental tissues (caries, sclerotic dentin, enamel, and dentin).<sup>4</sup>

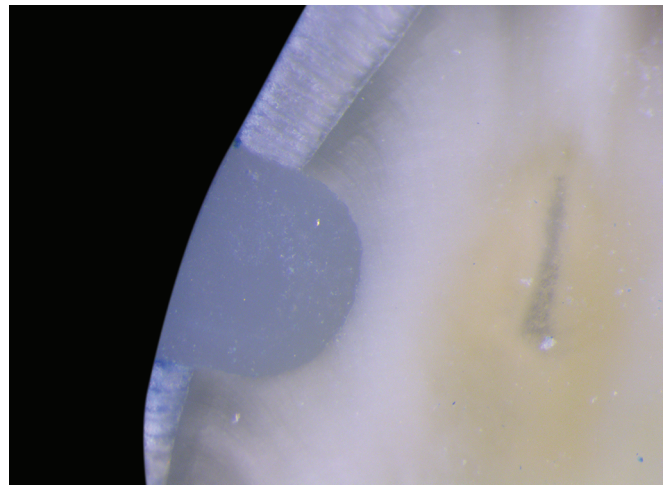
Universal adhesives that can be used in multimodes have been marketed as the latest-generation adhesive systems. Universal adhesives can be used in combination with “self-etch” and “total-etch” adhesive systems, as well as in the enamel “selective-etch,” as a “self-etch” adhesive system in dentin.<sup>18,19</sup> Universal adhesives have content similar to single-stage self-etch adhesives. They have been designed according to the “all-in-one” concept.<sup>19</sup> Universal adhesives, which allow users to use different application techniques, are most suitable for cavity.<sup>20</sup>

Composite restorative materials are frequently used today. However, there are some disadvantages such as microleakage, color changes, and polymerization shrinkage.<sup>21,22</sup> Polymerization shrinkage is one of the most important reasons of microleakage. Although adhesive systems have been developing, microleakage didn't have totally prevented. Microleakage allows the ingress of bacteria, ions, and fluids. Microleakage may cause postoperative sensitivity, recurrent caries, marginal discoloration, and pulp inflammation.<sup>23–25</sup>

Numerous studies about microleakage have still been made from the past to the present. The aim of this *in vitro* study was to evaluate the microleakage of class V composite restorations by using two different adhesive systems with two different application techniques.

## MATERIALS AND METHODS

The present study has compared the microleakage between Clearfil S3 Bond Plus (Kuraray, Tokyo, Japan) and Single Bond Universal



**Fig. 2:** Sample of experimental fourth group which is restored with single bond universal adhesive L-pop (3M ESPE, St.Paul, USA) in selective-etch application technique (x12.5)

Adhesive L-pop (3M ESPE, St. Paul, USA) in selective-etch and self-etch application techniques.

The research protocol used was approved by the Ethics Committee of the relevant institution of Ankara University. In this study, a total of 48 restoration and caries-free maxillary or mandibular anterior teeth were used. Before starting study, teeth were cleaned out of soft tissue residues under water with the help of a wire brush. Standardized class V cavities (1.5 mm deep, not beveled, rounded corners) were prepared on buccal surfaces of all teeth, which were gingival edges above from the enamel-cement junction. A total of 48 teeth were randomly separated into four groups.

The first group was restored with Clearfil S3 Bond Plus (Kuraray, Tokyo, Japan) in the self-etch technique. The second group was restored with single bond universal adhesive L-pop (3M ESPE, St. Paul, USA) in the self-etch technique. The third group was restored with Clearfil S3 Bond Plus (Kuraray, Tokyo, Japan) in the selective-etch technique. The fourth group was restored with single bond universal adhesive L-pop (3M ESPE, St. Paul, USA) in the selective-etch technique.

In the self-etch application technique, Clearfil S3 Bond Plus (Kuraray, Tokyo, Japan) was applied into the cavity for 10 seconds and the entire cavity wall was dried sufficiently by blowing mild air for more than 5 seconds until the bond didn't not move. Then, it was light-cured for 10 seconds with a LED dental curing light device (Acteon, France). Single bond universal adhesive L-pop (3M ESPE, St. Paul, USA) was applied into the cavity for 10 seconds and the entire cavity wall was dried sufficiently by blowing mild air for more than 5 seconds until the bond didn't not move. Then, it was light-cured for 10 seconds with a LED dental curing light device (Acteon, France).

In the selective-etch application technique, enamel margins were etched by 37% phosphoric acid (i-Gel, i-Dental, Lithuania) for 20 seconds. Then, they were rinsed and dried by an air–water spray. All cavities were completed with a nanohybrid composite resin (Clearfil Majesty Esthetic, Kuraray, Tokyo, Japan) according to manufacturers' instructions.

The restoration surfaces were finished, respectively, with coarse code zp.01, medium code zp.02, fine code zp.03, and super fine code zp.04 discs (Zenit Flex, Munich, Germany) using an air-driven water-cooled rotary tool. All the teeth were stored in an oven for 24 hours at 37°C. They were thermocycled for 5,000 thermal cycles between

**Table 1:** Microleakage scores (count and percentages) of the groups

Scores	Groups							
	Clearfil S3 bond plus self etch		3M single bond universal adhesive L-pop self etch		Clearfil S3 bond plus selective etch		3M single bond universal adhesive L-pop selective etch	
	Count	Column N%	Count	Column N%	Count	Column N%	Count	Column N%
Scores 0	8	66.7	8	66.7	9	75.0	10	88.3
Scores 1	3	25.0	4	33.3	2	16.7	1	8.3
Scores 2	0	0.0	0	0.0	1	8.3	0	0.0
Scores 3	1	8.3	0	0.0	0	0.0	0	8.3

**Table 2:** Kruskal–Wallis and Chi-square test statistics ( $p = 0.05$ )

Test statistics	Score
Chi-square	0.850
df	3
Asymp. sig.	0.838

water baths at 5°C and 55°C. All surfaces were isolated with two layers of nail polish, except up to 1 mm from the restoration margin for correct evaluation of the microleakage. The apices of all teeth were covered with the composite resin (Clearfil Majesty Esthetic, Kuraray, Tokyo, Japan). The teeth were stored in an oven with 2% methylene blue solution for 24 hours. The samples were embedded in acrylic resin in plastic molds. For the examination of microleakage, the teeth were perpendicular sectioned in buccolingual direction and evaluated under a 12.5× stereomicroscope (Figs 1 and 2).

It was scored as follows: –0 no dye penetration, –1 dye penetration less than half of the cervical/occlusal wall, –2 dye penetration more than half of the cervical/occlusal wall, –3 dye penetration along the axial wall.

The statistical analysis of microleakage measurements was performed using the SPSS 11.5 program (SPSS, Chicago, Illinois, USA). The Kruskal–Wallis variance analysis was used to compare the microleakage amounts of self-etch and selective-etch methods of the materials used ( $p = 0.05$ ). Descriptive statistics were reported in the form of counts and percentages.

## RESULTS

Microleakage scores (count and percentages) for all four groups are shown in Table 1. Table 2 shows that the Kruskal–Wallis test was applied to determine the differences between microleakage scores in the four study groups at a 0.05 level of significance. No statistically significant difference was found ( $p > 0.05$ ). Also, Table 2 shows that the Chi-square test, ( $p = 0.850$ ), showed no statistical difference among the microleakage scores of the different adhesive system techniques.

## DISCUSSION

This *in vitro* study compares different adhesive system modes (self-etch and selective-etch) in point of microleakage in class V cavities of upper or lower permanent anterior extracted human teeth.

Adhesion is the most affected property in using adhesive systems. The adhesion is only proportional to microleakage. The literature has shown that three main factors can affect the adhesion. The first factor is the composite polymerization shrinkage that leads to stresses at the adhesive interface. The second factor is that the substrate is a biological tissue that makes adhesion difficult. The third factor is the chemical composition of the adhesive.<sup>33</sup>

Polymerization shrinkage in composite resin restorations is induced to microleakage.<sup>34</sup> In restorative dentistry, many

materials and different techniques are developed to reduce polymerization shrinkage.<sup>35,36</sup> Some of them are effective in reducing polymerization shrinkage but cannot completely eliminate it.<sup>35</sup> It is suggested that the light sources used in the polymerization of composite resins affect the clinical success of the restorations.<sup>37,38</sup> Therefore, various light sources, such as halogen light source (QTH), LED, plasma arc (PAC), and laser, have been developed. LED light sources have some advantages: no heat during polymerization, short polymerization time, light, wireless, and ergonomics.<sup>39</sup> Because of these advantages, an LED light device was used in this study. However, it is reported that there is no significant difference between the LED and halogen light source in the different light sources leakage surveys by Oberholzer et al.<sup>40</sup> It has been reported that in order to keep minimum the polymerization shrinkage resulting from the polymerization of composite resins, the composite layers applied to the cavity should not exceed 2 mm, and that the light source should be positioned at the closest possible point to the polymerized surface.<sup>41,42</sup>

Microleakage is an important indicator of the clinical durability of a restorative material. Because microleakage between the tooth and the filling material is a problem in adhesive restorations, in these restorations, dyes, radioisotopes, bacteria, air pressure, and scanning electron microscopy are used for the evaluation of microleakage.<sup>43</sup> It is the easiest and most common method to examine the sections taken under the stereomicroscope after the sections are stored in the dye solution.<sup>44,45</sup> For this reason, in this study, microleakage has been investigated *in vitro* by the dye penetration method that is an easy, cheap, quantitative, and comparable technique. By the way, the evaluation of microleakage has been done using a stereomicroscope at 12.5× magnification, which is enough to evaluate dye penetration.

For self-etch adhesives, the acidic properties of the active monomers are responsible for dissolving the smear layer and demineralizing the underlying dentin. This demineralization is self-limiting because the acidity of the monomers is gradually buffered by the mineral content of the dentin. This implies that the resulting morphological aspect of the bound interface depends largely on the properties of the dentin to which the adhesive is applied and on the aggressiveness of the acidic monomers.<sup>46</sup> Adhesives with a pH above 2.5 are defined as “ultra-mild self-etch adhesives.” These “ultra-mild self-etch adhesives” interact with both enamel and dentin tissue superficially. Adhesives with a pH above 2 are defined as “mild self-etch adhesives.” These “mild self-etch adhesives” reach the hybrid layer.<sup>4</sup>

Siso et al. in their *in vitro* study have compared the microleakage of SBU in self-etch, selective-etch, and total-etch. As a result of this study, the minimum microleakage value for SBU has been reported in the total-etch mode.<sup>47</sup> Souza-Junior et al. have demonstrated that selective-etching provides better marginal integrity for Clearfil Tri-S, which proves to be an efficient additional step for class I



composite restorations. However, this study has no evidence of reducing microleakage.<sup>48</sup> Gupta et al. in their *in vitro* study have evaluated microleakage with total-etch, self-etch, and universal adhesive systems in class V restorations.

It has been suggested that one of the reasons of failure in studies with composite resins is that the *in vitro* studies do not exactly simulate the oral conditions.<sup>26</sup> To simulate oral conditions in *in vitro* studies, aging methods such as water degradation, thermocycling, and occlusal loading (chewing stimulator) are used.<sup>27</sup> To create similar clinical conditions, we have chosen the thermocycling, which is the commonly used aging method. The effect of thermocycling has been the subject of discussion among researchers.<sup>28,29</sup> Despite the fact that it is the most common used method of aging restoration for microleakage evaluation, there is no consensus in the literature.<sup>30</sup> The number of cycles used in microleakage studies varies in literature. Crim et al. and Gale et al. have stated that the number and duration of the cycle don't affect microleakage.<sup>31,32</sup> All the teeth were thermocycled for 5,000 cycles to look alike age of the restoration in the mouth and then were stored in 2% methylene blue solution to detect microleakage.

As a result of this study, all adhesives under investigation have shown microleakage.<sup>46</sup> In the study by Motevaselian et al., microleakage scores have been similar in the use of three different adhesive systems.<sup>49</sup>

With today's developments in dentistry, adhesive systems are available with many new dental restorative materials. With this progress, we believe that the new generation of adhesive systems and resin-based composite applications can eliminate the failures such as microleakage, which is one of the most important reasons for the dental restorations. According to the results acquired in the present study, no statistically significant difference has been found between the groups—neither between the selective-etch and self-etch techniques nor between the universal and self-etch adhesives. The two adhesive systems showed clinically acceptable microleakage values in two different application techniques.

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