Effects of different types of adhesive systems on the microleakage of compomer restorations in Class V cavities prepared by Er,Cr:YSGG laser in primary teeth

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INTRODUCTION

The aim of this in vitro study was to evaluate the effects of different types of adhesive systems on the microleakage of compomer restorations in Class V cavities prepared by erbium, chromium: yttrium scandium garnet (Er,Cr:YSGG) laser. There were five test groups according to the type of adhesive applied to the cavities: Adper Single Bond 2 (Group 1), Scotchbond Multi-Purpose Plus (Group 2), Xeno III (Group 3), Clearfil Protect Bond (Group 4), Prime&Bond NT (Group 5). Dye penetration was evaluated under a stereomicroscope, and data were statistically analyzed by Kruskal-Wallis and Wilcoxon Signed Ranks tests. Gingival margins showed significantly higher microleakage than occlusal margins in all the test groups (p<0.05). Groups 1 and 2 showed significantly less microleakage than Group 5 (p<0.05), and there were no statistically significant differences among Groups 3, 4, and 5 (p>0.05). None of the dentin bonding agents eliminated microleakage completely, and higher microleakage scores were observed along the gingival margin than the occlusal margin.

Keywords: Adhesive systems, Compomer, Er,Cr:YSGG laser, Microleakage, Primary teeth

The longevity of cervical restorations is threatened by both mechanical and non-mechanical causes. On the one hand, microshear and microtensile forces during chewing compromise their long-term clinical success. On the other hand, carious lesions located in the cervical region of restorations can involve both enamel and the underlying dentin. Caries management for cervical restorations is especially challenging because of the difficulties of moisture control, access to the caries, and proximity of lesions to the gingival margin. One key focus of dentistry today is on adhesive restorative materials which can minimize or eliminate microleakage and which require minimal cavity preparation.

Compomers were introduced in the early 1990s as a hybrid of composite resins and glass ionomer cements. They were developed to counter the disadvantages of moisture sensitivity and microleakage associated with glass ionomer cements, and possessing the mechanical and esthetic properties of composites with the fluoride-releasing advantage of conventional glass ionomer cements (GICs). Glass ionomer cements chemically bond to dental hard tissues via ionic exchange at the interface, and composite resins adhere to tooth surfaces via micromechanical retention. For compomers, they require bonding agents for optimum adhesion.

Today, adhesive systems are classified as “etch-and-rinse” or “self-etch” according to their application procedure and adhesion mechanism. Etch-and-rinse dentin adhesive systems are applied in three steps: etching, priming, and bonding. Priming the surface to be bonded decreases surface tension and increases surface wettability, so that bonding agents can infiltrate the acid-etched dentin easily. To simplify bonding procedures, primers and bonding agents have recently been combined such that priming and bonding can be achieved by applying one solution only.

With self-etching adhesive systems, there is no separate acid-etching step. They contain acidic monomers which can etch both enamel and dentin surfaces like a primer does, thus preparing the tooth surface for resin penetration into the demineralized dentin. The acidic polymerizable monomers dissolve the smear layer, penetrate the aqueous channels formed between its particles, and subsequently react at the top of the underlying dentin. The adhesive layer formed includes the smear layer. Generally, self-etching adhesives are the preferred materials because they eliminate the washing and drying steps, save chairside time, and reduce procedural errors.

For restorations bonded with an adhesive system, there is an ever-continuing competition between dentin bond strength and polymerization contraction stress. Polymerization shrinkage of bonded restorations can cause stress to accumulate at the bonded interface and restoration to be detached from the tooth surface. Microleakage induced by polymerization shrinkage continues to be a major concern for the clinical longevity of dental restorations. Although improved adhesive systems have been developed, they do not completely prevent microleakage at enamel and dentin margins.

The relationship between marginal leakage in restorations and type of restorative materials used has been extensively studied both in clinical and laboratory experiments. In the absence of definitive clinical data,
laboratory microleakage studies are a well-accepted method of screening adhesive restorative materials for marginal seal. To date, only a limited number of marketed restorative materials (composites, composite resins, or glass ionomer cements) were investigated for microleakage, but in general have shown adequately sealed restoration margins\(^\text{11,12}\). Microleakage is also a major criterion to determining the success of new surface preparation methods and new adhesive restorative materials\(^\text{13}\). It has been reported that microleakage was significantly reduced in cavities prepared by laser alone\(^\text{13}\).

In recent years, there has been growing interest in the use of lasers for routine cavity preparation and for conditioning enamel and dentin surfaces, the latter as an alternative to conventional acid-etch methods\(^\text{14}\). While not a panacea for all restorative dentistry procedures, caries removal and cavity preparation with middle infrared lasers (Er:YAG and Er,Cr:YSGG) has replaced conventional high- and low-speed dental drills in many situations, providing the same clinical effectiveness with freedom from pain and discomfort by eliminating pressure, intense vibration, noise, and in most cases, the need for injected local anesthetic\(^\text{15}\). However, studies on surface alterations of enamel and dentin after Er,Cr:YSGG laser irradiation demonstrated micro-irregularities on both tissues and lack of a smear layer. Such alterations have both macro- and micro-roughness. Laser-induced changes in the surface texture of enamel and dentin could potentially affect the microleakage of adhesive restorative materials\(^\text{16}\).

Microleakage is the main causative factor for the high incidence of secondary caries in the cervical region and accounts for many failed restorations. In the restoration of cervical lesions using composite resins, glass ionomer cements or composites, studies have shown that marginal leakage was more severe at the gingival margin located in cementum or dentin than at the occlusal margin located in enamel\(^\text{17,18}\). Surface conditioning methods before adhesive application were also found to influence microleakage\(^\text{19,20}\). Some manufacturers have suggested that composites can be used without a separate etching step. However, some microleakage studies showed that the marginal adaptation of composite restorations without prior etching deteriorated with time\(^\text{21,22}\). Alternatively, some investigators have shown that Er,Cr:YSGG laser irradiation might substitute for acid-etching\(^\text{23}\).

There is widespread use of adhesive dentistry in pediatric patients and an increasing use of laser technology in dental practice\(^\text{24}\). These parallel trends prompt a growing interest in the interaction between adhesive systems and lased primary dentin substrates\(^\text{24}\). There are many structural and morphological differences between primary and permanent teeth. Therefore, results obtained with permanent teeth should not be extrapolated without caution and discernment to primary teeth. However, studies on cavity preparation by laser irradiation in primary teeth before adhesive application are few and far between.

In the present study, Er,Cr:YSGG laser was used to prepare Class V cavities in primary teeth. Compomer restorations were bonded to enamel and dentin surfaces using different adhesive systems (etch-and-rinse versus self-etch). Microleakage scores at the occlusal and gingival margins were evaluated to assess the influence of adhesive systems on microleakage of compomer restorations in Class V cavities prepared by Er,Cr:YSGG laser.

**MATERIALS AND METHODS**

This study was approved by the Karadeniz Technical University Ethics Committee (Approval number: 2011/147). Fifty sound human primary molar teeth, free of caries and any other microscopic defects, were extracted from subjects requiring such extraction as part of their dental treatments. They were used in this study after having obtained informed consent from the subjects.

**Cavity preparation by Er,Cr-YSGG laser**

The extracted teeth were stored in distilled water at 4°C for a maximum of 1 month before use. To prevent bacterial growth, the water was changed weekly. After surface debridement with hand scaling instruments, cleansing was done using a slow-speed hand piece and a brush with pumice. The buccal and lingual surfaces were cleaned using a rubber cup and a polishing paste (Detartrine, Septodont, Saint-Maur, France), and standard Class V cavities were prepared at the cervical margin on the buccal and lingual surfaces of each tooth. 

Class V cavities were prepared using an Er,Cr:YSGG laser system (Waterlase MD, Biolase Technology Inc., San Clemente, CA, USA) under these operating conditions: wavelength of 2,790 nm, pulse duration of 140–200 µs, repetition rate of 20 Hz. Laser energy was delivered through a fiber optic system to a sapphire tip terminal 600 µm in diameter and 6 mm long. Tip-to-target distance was 1 mm. For enamel and dentin cutting, the manufacturer’s recommended settings were used: 3 W power, 85% air flow, and 85% water flow for enamel; 2 W power, 65% air flow, and 55% water flow for dentin. Standardized cavities (3 mm high, 1.5 mm wide, and 2 mm deep) were prepared using metal templates.

**Test groups according to adhesive applied**

The cavities were randomly assigned into five groups of 10 teeth each, according to the type of adhesive system applied to the cavities: Adper Single Bond 2 (Group 1), Scotchbond Multi-Purpose Plus (Group 2), Xeno III (Group 3), Clearfil Protect Bond (Group 4), and Prime&Bond NT (Group 5). Chemical compositions and application procedures of the adhesive systems used in this study are shown in Table 1.

**Restoration with compomer**

All cavities were restored with a compomer, Dyract® eXtra (685402 Shade A3; Dentsply, Milford, DE, USA), according to manufacturer’s instructions. The compomer was applied in three increments, each light-cured for
40 s (XL 3000™, 3M Dental Products, St. Paul, MN, USA). The first increment was applied obliquely against the occlusal wall and the second increment obliquely against the gingival wall. The final increment was placed flush with the contour of the tooth and covered with a transparent cellulose acetate strip. After light-curing, finishing was carried out immediately using graded Sof-Lex discs (3M Dental Products, St. Paul, MN, USA) according to manufacturer’s instructions.

**Dye penetration test**

All compomer-restored teeth were placed in deionized water at 37°C for 24 h and thermocycled (500 times at 5±2°C to 55±2°C; dwell time 15 s and transfer time 10 s). After thermocycling, all teeth were stored in distilled water at 37°C for 24 h to prevent dehydration. Marginal leakage was evaluated using a conventional dye penetration method. Tooth apices were sealed with an epoxy resin (Struers, Copenhagen, Denmark), and the specimens were covered with two coats of nail varnish up to 1 mm from the sealant margins to prevent dye penetration.
infiltration. The specimens were immersed in 0.5% basic fuchsin solution (Wako Pure Chemical Industry, Osaka, Japan) at 37°C for 24 h.

After rinsing with distilled water, each specimen was embedded in an epoxy resin and sectioned longitudinally in a bucco-lingual plane through the midline of the restoration with a water-cooled, slow-speed diamond saw (Mecatome T201, Presi, France) to obtain two sections of each tooth. The cut sections were examined under a stereomicroscope (Olympus SZ40, Olympus Optical, Tokyo, Japan) at 20× magnification by two examiners who were unaware of the groupings of the teeth, using the linear scoring criteria shown in Table 2. Both sections per tooth were examined, and the worst scores for both the occlusal (enamel) and gingival (dentin) margins were used for data analysis.

### Statistical analysis

Inter-examiner reproducibility was calculated using Kappa statistics. All data recorded were analyzed by Kruskal-Wallis one-way analysis of variance (ANOVA) and Wilcoxon Signed Ranks test, where \( p < 0.05 \) was considered statistically significant. All analyses were performed using a statistical package, SPSS 14.0.0 for Windows (SPSS Inc., Chicago, IL, USA).

### Results

Kappa value for inter-examiner agreement was 0.88 (almost perfect agreement) for the cut tooth sections. Distributions of the microleakage scores according to adhesive system and margin location are shown in Table 3. Descriptive statistics (median, minimum, maximum) and statistical analysis results are shown in Table 4.
DISCUSSION

Microleakage is defined as the clinically undetectable passage of bacteria, fluids, molecules, or ions between a cavity wall and the restorative material applied to it \(^{11}\). This seepage can cause hypersensitivity of restored teeth, tooth discoloration, recurrent caries, pulpal injury, and accelerated deterioration of some restoration materials \(^{8,12}\).

In vitro microleakage studies are a valuable means of evaluating clinical restorative materials and techniques on their ability to reduce, and perhaps eliminate, microleakage. Some in vitro studies have already demonstrated the influencing role of adhesive systems on microleakage \(^{25,26}\). This in vitro study was carried out to further investigate the role of adhesive systems (etch-and-rinse versus self-etch) on microleakage in laser-prepared cavities in primary teeth. Primary teeth were considered for this study because the morphological characteristics as well as the mineral quantities and distributions of primary teeth are different from those of permanent teeth. This means that differences may exist between the restorative treatments for primary teeth and permanent teeth. In our previous study, we found that use of a 2 W laser at 20 Hz could reduce the microleakage of fissure sealants \(^{27}\). Since the aim of this study was on reducing microleakage, cavities were prepared using Er, Cr:YSGG laser instead of the conventional method with burs.

In the present study, the dynamic environment of the oral cavity was simulated by exposing the compomer-restored teeth to thermal changes via thermocycling. Thermal cycles ranging between 200 and 1,000 were used in many studies \(^{25,27}\). In this study, 500 thermal cycles between 5 and 55°C were applied. Dye penetration test was used to assess marginal leakage. It is a widely accepted and generally preferred method because it is readily available, cheap, and non-toxic \(^{28}\). In addition, the most effective dye for revealing microleakage, 0.5% basic fuchsin, was used in this study \(^{27}\). After immersing the compomer-restored teeth in dye for 24 h, two blinded examiners evaluated the level of microleakage between each restoration and the cavity wall. To increase evaluation reliability, two cut sections per tooth were obtained for microleakage assessment.

Class V cavities are located in both dentin/cementum and enamel. Studies have shown that microleakage was greater on the gingival wall localized in dentin or cementum than on the occlusal wall \(^{15,29}\). Sidhu and McCabe \(^{29}\) performed a study to compare the marginal adaptation of composites in cervical cavities when applied with different bonding agents. They found greater microleakage along the gingival margin than along the occlusal margin \(^{30}\) —findings which were in agreement with our results for all the test groups. One probable reason might be the compromised bonding of compomers to the cavity wall due to lack of or absence of enamel bonding.

It must be highlighted that primary teeth were used in this study. There are minor differences between primary and permanent teeth in terms of dentin composition and morphology. An SEM study of the resin-dentin interface in primary and permanent teeth revealed that the hybrid layer produced with etch-and-rinse adhesive systems was significantly thicker in primary than in permanent teeth, and hence lower bond strengths to primary dentin \(^{31}\). Primary tooth dentin might be more reactive to acid conditioning, which meant that primary teeth might need a differentiated surface conditioning protocol, such as a shorter dentin conditioning time \(^{31}\). On the bond strengths of different types of restorative materials in primary and permanent teeth, composites reportedly had shear bond strengths between those of resin-modified glass ionomers and resin composites \(^{22}\). While lower bond strengths were reported for primary dentin when restored with resins and composites \(^{22}\), higher bond strengths were reported for primary dentin when restored with compomers \(^{35}\). Interestingly, it was reported in another study that while neither compomers nor resin composites could provide the minimum recommended bond strength of 17.6 MPa to primary dentin, this bond strength was achieved with an etch-and-rinse adhesive system \(^{35}\).

Where adequate enamel tissue is found, the etching procedure reportedly helped to prevent microleakage \(^{36}\). Di Lenarda et al. \(^{36}\) suggested etching before compomer application to remove the smear layer, as this was found to increase adhesion and provide good marginal sealing. Ferrari et al. \(^{36}\) recommended additional enamel etching for self-etch adhesives in Class V restorations to provide the perfect seal. Owens et al. \(^{37}\) reported that Scotchbond Multi-Purpose and iBond, which are etch-and-rinse adhesives, decreased microleakage in Class V cavities. These results supported by Owens et al. \(^{37}\) agreed with those of the present study.

Marginal adaptation of restorations to enamel was reportedly more effective with etch-and-rinse adhesives \(^{38}\). Perdigao et al. \(^{39}\) carried out a comparison on enamel bond strengths between a pair of etch-and-rinse and self-etch adhesives from the same manufacturer. After comparing pairs of adhesives from different manufacturers (Adper Prompt vs. Adper Single Bond; AdheSE vs. Excite; OptiBond Solo Plus SE vs. OptiBond Solo Plus; Tyrian SPE/One-Step Plus vs. One-Step; Xeno III vs. Prime&Bond NT), they concluded that optimal bond strengths were obtained when etch-and-rinse systems were used on roughened enamel surfaces \(^{39}\). Koliniotou-Koumpia et al. \(^{40}\) evaluated the microleakage performance of composites bonded with different adhesive systems in Class V cavities. They reported that etch-and-rinse adhesives revealed significantly less microleakage than self-etch adhesives. These results \(^{40}\) were supported by the present study’s
results for etch-and-rinse adhesives, Adper Single Bond 2 and Scotchbond Multi-Purpose Plus.

Although Prime&Bond NT is a one-bottle etch-and-rinse system, it showed more microleakage than Adper Single Bond 2 and Scotchbond Multi-Purpose Plus (Tables 3 and 4). Prime&Bond NT is an acetone-based adhesive (Table 1), while Adper Single Bond 2 and Scotchbond Multi-Purpose Plus are ethanol/water-based and water-based adhesives respectively. Etch-and-rinse adhesives that contain acetone require a wet bonding technique\(^{17,36,41}\). For adhesives that contain ethanol and water, a dry bonding technique is key to delivering good bonding performance\(^{17,38,42}\). The wet bonding technique is technique-sensitive and constantly begs the question “how wet is wet?”. Therefore, the wet bonding technique has a shortcoming of overwetting the etched dentin surface if water is not effectively removed\(^{42}\). Application mistakes could then adversely affect bond strength and marginal adaptation, thus accounting for the higher microleakage of Prime&Bond NT than Adper Single Bond 2 and Scotchbond Multi-Purpose Plus.

Adper Single Bond 2 is a two-step etch-and-rinse adhesive, while Scotchbond Multi-Purpose Plus is a three-step etch-and-rinse adhesive. With the two-step etch-and-rinse adhesive system, the smear layer was completely removed by acid-etching followed by rinsing and application of adhesive agent. With the three-step etch-and-rinse adhesive system, the increase in procedural steps posed a greater technique sensitivity, which might result in incomplete penetration of resin in the demineralized dentin surface\(^{43}\). Both adhesive systems have good resin monomer penetration capability, but remaining water in the water-based system (Scotchbond Multi-Purpose Plus) might hamper resin penetration/polymerization\(^{46}\). This explained why Adper Single Bond exhibited better microleakage performance than Scotchbond Multi-Purpose Plus in this study, although not with a significant difference (p>0.05).

Self-etch adhesives are preferred in clinics because of their ease of use and low technique sensitivity. More importantly, resin penetration into demineralized dentin is not hampered because demineralization of tooth surfaces and resin infiltration occur simultaneously\(^{46}\). Contemporary self-etch adhesives are classified into three categories according to acidity: mild (pH≥2), moderate (pH=1.5), or aggressive (pH<1). Studies have been conducted to examine the effects of adhesive acidity on the morphology of interfacial ultrastructure and on bond strengths to enamel and dentin\(^{46,47}\). Pasley and Tay\(^{46}\) evaluated and compared the effects of three moderate or aggressive self-etch adhesives (Clearfil SE Bond, Non-Rinse Conditioner, Prompt L-Pop) on bond strength to unground enamel surfaces. They exhibited low bond strengths, and it was concluded that there was no correlation between adhesive acidity and bond strength\(^{46}\). Similarly, Sugizaki et al.\(^{49}\) reported that the bond strength of Xeno III, which has weak acidity, was not significantly different from that of Clearfil SE Bond, which has moderate acidity. In the present study, there were also no statistically significant differences in microleakage scores between Clearfil Protect Bond and Xeno III, which are moderately and mildly acidic self-etch systems respectively.

To evaluate and compare the microleakage performance between etch-and-rinse and self-etch adhesive systems, Casagrande et al.\(^{50}\) evaluated the cervical microleakage of Scotchbond Multi-Purpose (etch-and-rinse) and Clearfil SE Bond (self-etch) in occluso-proximal composite restorations of primary molar teeth. They reported that neither of the adhesive systems prevented cervical (gingival) microleakage\(^{50}\). Similarly in the present study, none of the adhesive systems eliminated microleakage completely, with higher microleakage observed along the gingival margin than along the occlusal margin.

Prime&Bond NT contains nanoscale fillers in its formulation, and thus one single coat of application is sufficient. The nanofiller strengthens the hybrid layer and the adhesive layer, making these interfaces more compatible with both the tooth structure (containing inorganic calcium apatite) and the compomer material (containing inorganic glass filler). Besides, the viscosity of Prime&Bond NT has not increased significantly, allowing deep penetration of the bonding resin into the dentin\(^{18,36,43}\). Rosa and Perdigao\(^{51}\) claimed that compomers bonded with Prime&Bond NT, without any prior etching, yielded the highest bond strength. Since Prime&Bond NT can be used with or without prior acid-etching\(^{8,38,39,41,50}\), it was applied to the cavity wall without a separate etching step in the present study. However, since smear layers do not exist in laser-prepared cavities\(^{20,25,27}\), and without prior acid-etching, Prime&Bond NT showed higher microleakage than the other adhesives in the present study.

Apart from adhesive systems, focus was also turned to the effect of cavity preparation methods on microleakage. Many studies have examined the effects of erbium laser and diamond bur preparation on microleakage\(^{14,15,29,52-55}\). Some studies found that laser irradiation exhibited same or even better microleakage outcome than did the conventional bur method\(^{53-55}\), but other studies had contradictory results\(^{29,52}\).

During cavity preparation with burs, the inevitable noise, vibration, pressure, and heat caused by high-speed drilling inevitably brings much discomfort and displeasure to the patient\(^{56,57}\). Detrimental temperature increase in the pulp can cause the cells to deteriorate, leading to pulpal pain and sensitivity\(^{56}\). Other drawbacks pertaining to the use of burs include unnecessary removal of sound tooth tissue\(^{58}\) and failed root canal treatments due to microbial infection\(^{59}\). Microorganisms inhabit the deep layers of dentin and can cause failures in the conventional treatment of infected root canals if they are not sufficiently removed by preparation and chemical disinfection of the root canal\(^{59}\). But, cavity preparation with burs is not without merits. No smear layers were detected with laser preparation\(^{61}\), but a thick and compact smear layer was produced with the bur method\(^{29}\). The smear layer enhances adhesion, and it was found that cavities prepared by laser were less
receptive to adhesive procedures than conventional bur-cut cavities\(^6^9\).

Numerous studies have shown that etch-and-rinse adhesives had a higher bond strength than self-etch adhesives. This could be attributed to the inadequate etching ability of self-etch adhesives and the presence of insoluble calcium phosphate which was not removed by irrigation. However, self-etch adhesives were found to produce bond strengths similar to etch-and-rinse adhesives on enamel surfaces roughened by burs, which could be due to the more retentive etch patterns produced by self-etch adhesives on the bur-roughened enamel surfaces\(^6^9\). Conversely on Er,Cr:YSGG laser-irradiated enamel, one-step self-etch adhesive (Clearfil S3 Bond) exhibited a lower bonding effectiveness than etch-and-rinse adhesive (OptiBond FL).

In the present study, both one-step and two-step self-etch adhesives contained 10-methacryloyloxydecyl dihydrogen phosphate (MDP), which enables adhesives to chemically bond to the mineral content of the partially demineralized dentin\(^6^9\). This ability to bond to the calcium ions of hydroxyapatite seems to play an important role in the bonding effectiveness of these self-etch adhesives to Er,Cr:YSGG laser-prepared cavities in this study. Using SEM to evaluate surfaces prepared with Er,Cr:YSGG laser (6 W; 20 Hz; air and water cooling) or mechanically with a bur, Lin et al.\(^6^7\) found that there was a smear layer on the surface prepared with the bur, such that the prismatic structure of enamel was not clearly seen. In contrast, the laser-prepared surface was clear, had no smear layer and had a prismatic structure. Ekworapoj et al.\(^6^6\) ablated dentin by using Er,Cr:YSGG laser with different power levels (3, 3.5, 4, 4.5 W; 20 Hz; air and water cooling) and used SEM to observe the microstructures of ablated dentin. At all power levels, the smear layer was eliminated, peritubular dentin was prominently observed, and dentin tubules were completely opened\(^6^6\). Starting from 3.5 W power level, peritubular dentin began melting\(^6^6\).

Using Class V cavities prepared using a laser (2 W; 10 Hz; water and air cooling) or a bur, Niu et al.\(^6^7\) investigated the effects of Er:YAG laser and diamond bur on microleakage in human teeth. No statistically significant differences in microleakage were found between these two cavity preparation methods\(^6^7\). Delme et al.\(^4^0\) also investigated the effects of Er:YAG laser and diamond bur on microleakage in human teeth in vitro. With Class V cavities prepared with a laser or a bur at 1.5 mm below the enamel-cement junction, no statistically significant differences in microleakage were found between these two cavity preparation methods\(^4^0\). When cavities were prepared with Er,Cr:YSGG laser, there was excellent adhesion between restorative materials and lased surfaces, hence contributing to the reduction of microleakage\(^1^3,6^8\).

Ergucu et al.\(^6^9\) investigated the microleakage of Class V composite restorations located at the enamel-cement junction, which were prepared using Er,Cr:YSGG or a diamond bur. Cavities prepared using the laser (enamel: 5 W, dentin: 4 W; water and air cooling) were divided into three test groups: Clearfil SE Bond, Acid etch+ Scotchbond Multi-Purpose Plus, and Scotchbond Multi-Purpose Plus. Cavities prepared using a diamond bur were conditioned with Clearfil SE Bond and Scotchbond Multi-Purpose Plus. Gingival microleakage in the lased group with acid-etching was statistically less than the other groups. After Er,Cr:YSGG irradiation, no smear layer was created. Thus, additional acid-etching after Er,Cr:YSGG laser preparation was recommended to reduce the microleakage of Class V cavities\(^6^9\). This recommendation was supported by the results of this study. Microleakage along both gingival and occlusal margins of Adper Single Bond 2 and Scotchbond Multi-Purpose Plus, both etch-and-rinse adhesive systems with a separate acid-etching step, was less than the other adhesives tested in this study.

**CONCLUSIONS**

Restorations in Class V cavities are in close proximity to the gingival wall, making the selection of restorative materials difficult. Therefore, adhesive systems selected for compomer restorations are advisedly less technique-sensitive, less time-consuming, and with fluoride-release ability to prevent microleakage, and hence secondary caries formation. Within the limitations of the present study, the following conclusions are drawn on the effects of different types of adhesive systems on microleakage of compomer restorations in Class V cavities:

1. None of the tested adhesive systems eliminated microleakage completely.
2. Higher microleakage was observed along the gingival margin than along the occlusal margin.

To date, no studies have been carried out to investigate and compare the microleakage of compomer restorations in primary teeth prepared using Er,Cr:YSGG laser. While studies were carried out to evaluate the microleakage of adhesive systems which eliminate the smear layer, none has been carried out to evaluate these adhesive systems in lased primary dentin with no smear layer formation. The results of this study should be leveraged to conduct more studies in the future on this subject.

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