

# AN IN VITRO EVALUATION OF THE MICROLEAKAGE WITH ETCH-AND-RINSE AND UNIVERSAL ADHESIVE SYSTEMS IN CLASS V RESTORATIONS

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## ABSTRACT

**Objective.** The aim of this in vitro study was to evaluate the sealing ability of an etch-and-rinse (ER) adhesive and a universal adhesive using the "selective enamel etching" technique, in class V restorations.

**Materials and Methods.** Class V cavities were prepared on the facial surfaces of 20 extracted human teeth and divided into two groups (n=10). Group 1- an ER adhesive was used, Adper Single Bond 2 and for Group 2 a universal adhesive, Single Bond Universal was applied, respectively, followed by the restoration with composite. The teeth were sectioned facio-lingually and the specimens were examined for microleakage under a stereomicroscope using methylene blue dye as a marker.

**Results.** The images showed a significant difference between the two adhesive systems regarding the cavity marginal microleakage, with the net superiority of the universal adhesive.

**Conclusions.** Universal adhesives when used with the "selective etch" technique, may be a suitable method for improving the marginal sealing of cervical composite restorations.

**Keywords.** microleakage, universal adhesive, etch-and-rinse adhesive, selective enamel etching, dye penetration.

## INTRODUCTION

The acid-etched enamel/resin bond is the most important bond in adhesive restorative dentistry mainly because dentin bonds tend to deteriorate over time (1), thus microleakage at the tooth structure/resin interface represents a major dental problem (2). Microleakage is probably responsible for many cases of postoperative sensitivity and later in time, marginal discoloration and secondary caries leading to pulp inflammation and restoration failure. The adhesive systems are therefore critical for the success of aesthetic materials in restorative modern dentistry (2,3).

Cervical restorations are ever challenging because of difficulties in moisture control, caries access, and proximity to gingival margin (4), and in addition, the design of the preparation has a high configuration factor (C-factor) and therefore microleakage is more critical (2, 5).

Adhesive agents are important factors that prevent microleakage in composite resin restorations (6). Currently, adhesive systems provide a favorable marginal seal and decrease marginal microleakage, especially at the cervical margins of the cavity (7).

For many years, in clinical practice, adhesives were used following one of two adhesion strategies, self-etch (SE) or etch-and-rinse (ER). It's only recently that dentists have started to use a new generation of adhesives known as "universal" because they may be used as SE adhesives, ER adhesives, or as SE adhesives on dentin and ER adhesives on enamel (a technique commonly referred to as "selective enamel etching") (8). This technique was developed because, although the universal adhesives perform well on dentin, are unable to etch enamel well (9), and one of the consequences of poor enamel etching is marginal staining and leakage. In

fact, recent studies demonstrated that marginal staining increased significantly when applied in SE mode (8,10).

Regarding the investigation methods, microcomputed tomography and optical coherence tomography were recently used to detect marginal microleakage (10,11,12), but the most common technique remains dye penetration followed by the visual evaluation of the marginal microleakage under a stereomicroscope (3, 4, 6, 7, 14-18), which is inexpensive and handy.

Therefore, the purpose of this in vitro study was to evaluate the sealing ability of an ER adhesive and a universal adhesive using the "selective enamel etching" technique, in class V restorations, using dye penetration method. The research hypothesis was that there exists a significant difference in the extent of microleakage between tooth and restoration interface using a using a 5th generation adhesive and a universal adhesive.

## MATERIAL AND METHODS

A number of twenty freshly extracted human teeth, with intact enamel on facial surfaces were chosen for this study. After the extraction the teeth were cleaned of tartar and soft tissue using a manual scaler and stored in formalin 37% aqueous solution until use. Moderate Class V tooth preparations, that do not extend onto the root surface, were performed on the facial surface of each tooth using a round diamond instrument, ISO size

number 009 (Komet Dental Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany) at high speed and air-water spray cooling.

The prepared teeth were randomly divided into two groups (n=10 each group) according to the strategy of adhesion, as following:

- Group I: a two-step ER adhesive was used, Adper Single Bond 2 (3M Deutschland GmbH, Neuss, Germany) according to the manufacturer's instructions, with prior etching of enamel and dentin for 15 seconds with Scotchbond Universal Etchant (3M Deutschland GmbH, Neuss, Germany).

- Group II: a universal adhesive, Single Bond Universal (3M Deutschland GmbH, Neuss, Germany) was applied using the "selective etching" of the enamel for 15 seconds and a scrubbing technique.

Subsequently, teeth from both groups were restored with a nanohybrid composite, Filtek Z 550 (3M Deutschland GmbH, Neuss, Germany). A flame-shaped finishing bur ISO no. 014 (Kerr Hawe, Bioggio, Switzerland) was used for the removal of excess and contouring and a rubber polishing point (Opti1Step™ Polisher, Kerr Hawe, Bioggio, Switzerland) for final polishing.

The apical foramen of the teeth was sealed with composite, and the teeth surfaces were covered with two layers of an acid-resistant transparent nail polish, except the restoration and 1 mm around it. The teeth were immersed in methylene blue 1% solution (TIS Farmaceutic SA, Bucharest, Romania) for 24 hours at room temperature. Using a fine double-sided diamond disc (Komet Dental Gebr. Brasseler GmbH & Co. KG, Lemgo, Germany), under water cooling, the facio-lingual sections were cut passing through the middle of the restorations.

The sections were examined for microleakage with the Stereo Zoom Microscope Axio Zoom.V16 (ZEISS, Jena, Germany) and the images were captured with AxioCam MRm (ZEISS, Jena, Germany).

## RESULTS

The aim was to highlight the general microleakage rate of the methylene blue used as a marker using the dye penetration method. Therefore, to each section was assigned a certain score according to the degree of marker penetration, with dentin-enamel junction (DEJ) serving as a guide, according to the following scoring system:

Level 0 - no evidence of leakage

Level 1 – leakage up to DEJ, limited to enamel

Level 2 – leakage beyond DEJ, penetrating dentin

Level 3 – the leakage reaches the axial wall.

The images showed a significant difference between the two adhesive systems (ER Adper Single Bond 2 vs. SE Single Bond Universal) regarding the cavity margin microleakage (Chart 1).

Group I restored using Adper Single Bond 2 showed the following results regarding the microleakage degree:

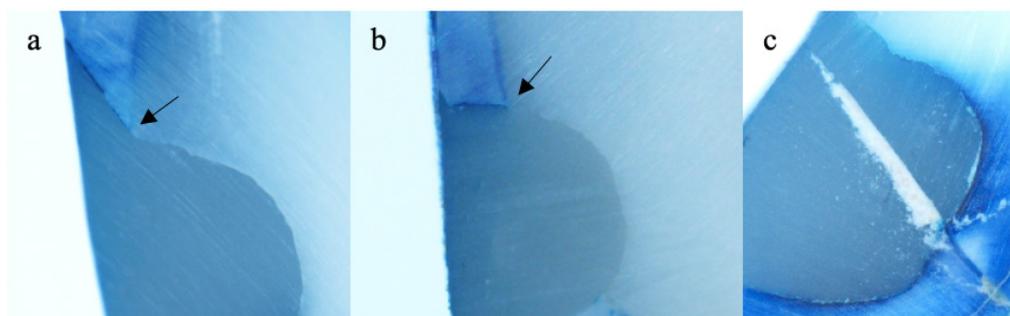
- 0 - no result

- 1 - nine teeth (Fig. 1a, b)

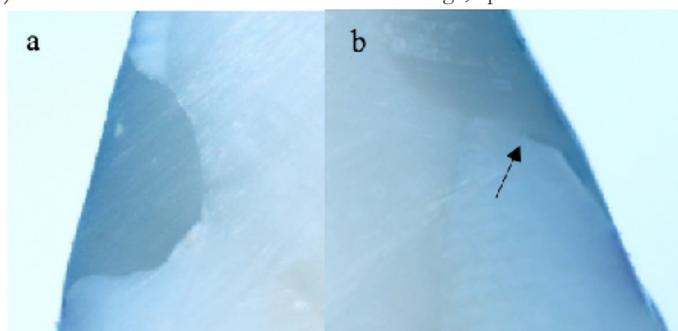
- 2 - no result

- 3 - one tooth (Fig. 1c)

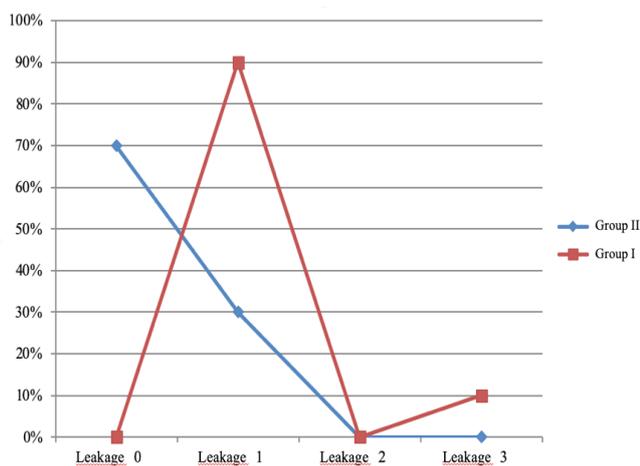
Because in this group only one tooth was found with level 3 of dye penetration, comparing to nine teeth with level 1, it may be due to an inconsistency that occurred during teeth manipulation.



**Figure 1.** In Group I nine out of ten teeth were found with level 1 dye penetration with the marker penetrating the entire enamel, up to DEJ (arrows) (a, b). One tooth was found with level 3 microleakage, up to the axial wall or the preparation (c).



**Figure 2.** Group II showing no microleakage (a) and level 1 dye penetration limited to the outer half of the enamel (arrow) (b).



**Chart 1.** The microleakage degree comparison between Group I and Group II.

The results for the second group, restored using the SE adhesive Single Bond Universal using the „selective etch” technique are the follows:

- 0 - 7 teeth (Fig. 2a)
- 1 - 3 teeth (Fig. 2b)
- 2 - no result
- 3 - no result

## **DISCUSSIONS**

The difference found between the two groups regarding the dye penetration rate is consistent with other studies regarding the superiority of the universal adhesives used in enamel “selective etch” mode. In a clinical study, Loguercio et.al showed that marginal staining worsened significantly from baseline to 36 months for Scotchbond Universal applied in full SE mode and the 36-month retention rate for the groups in which enamel was acid-etched was 98% (10), which suggests that, as for most SE adhesives, Scotchbond Universal retention rate depends on enamel etching for durable bonding to enamel (8).

A major development in enamel and dentin bonding has been the expiration of the patent held by Kuraray on the monomer containing a 10-carbon molecule known as 10-MDP (10 methacryloyloxydecyl dihydrogen phosphate) (1). 10-MDP is a functional monomer and the chief ingredient of the most universal adhesives, that bond ionically to calcium in hydroxyapatite and it has been identified as being capable of establishing a very intensive and stable chemical interaction with hydroxyapatite (19-21). Thus, provides the promise of achieving more stable and long-lasting adhesion, when compared to ER adhesives, whose principal adhesion mechanism is related to the micromechanical retention (21-23).

Regarding the enamel adhesion, phosphoric acid etching of enamel attacks the hydroxyapatite crystals, partially eroding them and creating a porous and retentive structure on the surface (24). Therefore, the acidic functional monomers may be able to bond chemically to

pre-etched enamel as effectively as to dentin (25). One study claims that the additional chemical bonding of 10-MDP to the enamel crystallites of etched enamel might increase the short- and long-term enamel bond strengths obtained with universal adhesives to etched enamel compared to bond strengths without the added chemical bonding provided by 10-MDP and surpass those of the ER adhesive alone (26).

Because of the limitations of this in vitro study and the method of investigation using dye penetration, further investigations are needed, especially regarding the enamel bonding when universal SE adhesives are used and moreover, particular attention is needed regarding to evidence derived from clinical studies. Stability of the composite restorations in the oral environment is highly dependent on the structure of the monomers used in composite and adhesive systems and the issues related to microleakage of fluids and bacteria at the interface represent the main causes of failure of adhesive restorations (27).

## **CONCLUSIONS**

Following the comparative analysis of the degree of marginal microleakage of the two groups, it was found that Group I, in which an ER adhesive system was used (Adper Single Bond 2), presented a higher penetration rate compared to Group II where an universal adhesive system (Single Bond Universal) was applied using the enamel „selective etch” technique.

Moreover, the teeth restored using Adper Single Bond 2 showed the dye penetrating the entire enamel, up to the DEJ, whereas in the group restored using Single Bond Universal, the marker penetration occurred only up to half of the enamel thickness.

This new generation of universal adhesives when used with the “selective etch” technique, which only involves the acid etching of enamel and not dentin, may be a suitable method for improving the marginal sealing of cervical restorations, and therefore of all classes of restorations with a high C-factor.

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