EVALUATION OF THE ADHESIVE INTERFACE BETWEEN ENAMEL AND A SINGLE-COMPONENT ADHESIVE APPLIED IN SELF-ETCHING AND SELECTIVE-ETCHING PROCEDURES

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ABSTRACT

**Aim of the study** The aim of this study was to analyze the adhesive joint with enamel for a single-component system which can be used in either self- or selective-etching procedures. **Material and methods** The study group included 10 extracted third molars. Class V cavities were prepared in both lingual and labial surface and restored using a composite resin (Filtek Z550, 3MESPE) and the adhesive Single Bond Universal (3M ESPE). For the facial cavities, the adhesive was applied using a total-etch procedure. In the lingual cavities no etching gel was applied. The prepared teeth were split in an axial linguo-facial direction. The sections were observed by scanning electron microscopy using a VEGA II LSH (TESCAN) microscope. **Results** The images have showed that an adhesive joint was formed between composite and enamel regardless of the chosen technique (with or without etching). The adhesive layer interposed between the enamel and the composite resin was thicker in most samples were the specimens were subjected to acid etching. **Conclusions** Phosphoric acid pre-treatment could be beneficial for bonding to enamel when using mild self-etching adhesive systems.

**Keywords:** self etching adhesive, selective etching, enamel

INTRODUCTION

Self-etching adhesives were developed in order to reduce the shortcomings related to the variability of demineralization, water content and impregnation of the dentine substrate and further simplify the operative protocol. These adhesives contain monomeric acids that dissolve the smear layer, demineralize and infiltrate the tooth substrate at the same time. However most self-etching adhesives are less aggressive than phosphoric acid. The assessment of the bond-strength to enamel has reached conflicting results. Several studies have reported similar bond strengths to etch-and-rinse systems (1-3) while some studies have found a weaker adhesion (4-6). Therefore attempts have been made to combine phosphoric acid-etching with self-etching systems in selective or total etching procedures, yet the results have been contradictory. Several studies have found that phosphoric acid-pretreatment of the enamel surface led to a significant increase in bond strength values especially with the mild self-etching adhesive (7-10).

The purpose of our study was to analyze the adhesive joint with enamel for one of the simplified system which has been recently
introduced on the market. According to the manufacture instructions, this adhesive can be used in techniques which involve the complete removal of the smear layer (total-etching procedures) and techniques which preserve and include the components of dissolved smear into the hybrid layer (self-etching procedures).

MATERIAL AND METHODS
The study group included 10 caries-free third molars, extracted for orthodontic reasons. Class V cavities were prepared in both lingual and facial surfaces, using a 330 bur. The cavities had an oval contour with the mesio-distal diameter of 3.5mm, the axial diameter of 2.5mm and the depth of 2mm. Only the occlusal margin was bevelled using a diamond flame bur. The cavities were cleaned with water and lightly air-dried using cotton pellets. For restorations we used a composite resin (Filtek Z550, 3MESPE) and the adhesive Single Bond Universal (3M ESPE) in a bulk-technique. For the facial cavities, the adhesive was applied using a total-etch procedure. The phosphoric acid (Scotchbond Universal Etchant – 3M Espe) was applied on both dentin and prepared enamel for 15s, than rinsed thoroughly with water and dried with cotton pellets. In lingual cavities no etching gel was applied.

In all the cavities, the adhesive was applied on the entire prepared surface and rubbed for 20s. Subsequently a gentle stream of air was directed over the adhesive for about 5s, than it was polymerized using a curing LED light for 10s, according to manufacture’s instructions. The cavities were filled with the composite resin and light-activated for 40s.

The prepared teeth were split in an axial linguo-facial direction. The sections were observed by scanning electron microscopy using a VEGA II LSH (TESCAN) microscope.

RESULTS
The images obtained by scanning electron microscopy have showed that an adhesive joint is formed between composite and enamel regardless of the chosen technique (with or without etching). However, the thickness of the adhesive layer at the interface and the morphology of the hybrid layer were quite different.

Figure 1. Enamel/composite resin interface for Universal Single Bond applied without acid etching. There is a thin layer of remaining adhesive interposed between the enamel and composite resin. There is a line of cohesive fracture of enamel parallel to the interface

Figure 2. Enamel/composite resin interface for Universal Single Bond system without etching enamel. There is a thin hybrid layer and a thin layer of adhesive which seems to intermediate the bond between the two substrate of the adhesive joint
In the absence of etching, the remaining adhesive between composite and enamel formed a thin layer (fig. 1-2).

In the absence of phosphoric acid-etching, in three specimens of ten, the adhesive layer could not be observed even in higher magnifications (fig. 3, 4).

The presence of the layer of adhesive resin was more constant and thicker in most samples where the specimens were subjected to acid etching (9 of 10 specimens) (fig. 5-8).

Figure 3. Enamel/composite resin interface for Universal Single Bond applied without etching. There is no layer of adhesive at the joint between enamel and composite resin. Still the composite resin seems to have a tide contact with enamel, with the exception of the fragment which overlaps the edge of the cavity.

Figure 4. Composite resin/enamel interface for Universal Single Bond application without etching the enamel. The resin composite has a tide contact with enamel. No layer of adhesive could be observed between the lateral walls of the enamel rods and the composite resin.

Figure 5. Enamel/composite resin interface for Universal Single Bond with phosphoric acid etching. There is a distinct layer of adhesive within the joint which perfectly seals the margin of the restoration. A cohesive fracture line can also be observed parallel to the interface.

Figure 6. Enamel-composite resin interface for Universal Single Bond adhesive system applied on etched enamel. The layer of adhesive resin in the joint is very thin.
Figure 7. Enamel-resin composite resin interface for Universal Single Bond adhesive system on etched enamel. There is a layer of adhesive in the junction which becomes thinner at the margins of the restoration. Also, there is an oblique line of fracture in enamel.

Figure 8. Enamel/composite resin interface for Universal Single Bond with phosphoric acid etching. The adhesive mediates the adhesion, although the thickness of the layer is not constant, being almost absent at the margin. There is a complete fracture in enamel with the fragment remaining attached to the adhesive and composite resin.

However, for both procedures no marginal gaps have been observed although several cohesive fractures have been observed in enamel, demonstrating the high stress beared by the samples during vacuum processing (fig. 1-8).

DISCUSSIONS

The self-etching systems are subdivided into three categories based upon their pH value: strong systems have a pH of 1 or below, intermediary strong systems have a pH of approximately 1.5, and mild systems have a pH of 2 or more (11). Most of the mild acidic systems can be buffered by enamel quickly resulting in more superficial demineralization and impregnation. Although the thickness of the hybrid layer is not always correlating with bonding strength (12), this specific feature has led both practitioners and scientists to question the performance of these systems.

Some studies have shown that the phosphoric acid-etching of the enamel margins has some positive effects related to bonding performances of self-etching systems (12-14).

Single Universal Bond is a self-etching mild acidic adhesive (pH 2.7), whose specific feature is that the manufacturers indicate it for total, selective etching or self-etching procedures, the chosen protocol being at the discretion of the practitioner.

In our study, the morphology of the adhesive joint varied even for the same type of procedure (total etch or self etch). The layer of adhesive was inconsistent, even undetectable in some samples. However, for both techniques, no adhesive failure was observed although in some cases cohesive failure was present in adjacent enamel. Looking at the pictures, it seems that sealing of the enamel margins is effective even in self-etching procedures, as no gap was observed even after such a high stress as that exerted by vacuum preparation.
A previous study that evaluated the microleakage of two adhesive systems (Prime & Bond NT and Xeno III - Dentsply DeTrey), showed that etching with phosphoric acid prior to the adhesive application decreased microleakage in the occlusal margin (15). This is in agreement with Ihab et al. (10) who investigated the topography of the interface between enamel and composite resin for different self-etching systems with and without previous etching with phosphoric acid. They found that in the case of mild acidic self-etching adhesive with no surface pretreatment, there was a very mild irregular etch pattern not related to prism morphology. Pretreatment with phosphoric acid created adequate microporosities, allowing the resin infiltration in the form of a very thin hybrid-like layer. A thick, uniform, and continuous adhesive layer was also evident.

In our study the images haven’t been as conclusive, yet the joint of the adhesive substrates seemed tighter and the sealing more clear in the presence of the adhesive layer, which was more consistent when the enamel was etched with phosphoric acid previous to adhesive application.

The variability and inconstancy of the adhesive layer in case of self-etching procedures is probably the result of decreased demineralization and preservation of the components of the smear layer which decrease the impregnating ability of the adhesive. The low energy surface of unetched enamel may also contribute to reduced retention of the adhesive on the surface of prepared enamel when air spray is used to evaporate the solvent. In such conditions, the high viscosity of the adhesive could lead to difficulties in wetting the enamel and creating a uniform thickness. Further studies should clarify this issue and provide a clear and reproducible application protocol.

These results suggest that the mild self-etching adhesive system used might not provide an adequate level of demineralization to achieve optimum impregnation of enamel. Pretreatment with phosphoric acid could be useful in order to remove smear layer and to create adequate microporosities, which enhance the penetration of the resin.

CONCLUSIONS

1. The results of this study emphasizes that the investigated adhesive system provides a proper sealing of the enamel, creating an adequate adhesive joint in most cases.
2. Etching seems to improve the quality of the adhesive joint with the enamel by increasing the thickness of the adhesive layer and favoring a more intimate contact with enamel.

REFERENCES

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