

Effect of Acid Etching on Clinical Performance of a Universal Adhesive in Class V Non-Carious Lesions

Ali I Abdalla^{1*}, Emna Hidoussi Sakly² and Mohammad Aly Ibrahim³

¹Professor, Department of Restorative Dentistry, Faculty of Dentistry, University of Tanta, Tanta, Egypt and Visiting Professor at Department of Orthodontics, Saveetha Dental College and Hospital, Saveetha University, Chennai, India

²Associate professor, Department of Conservative Dentistry and Endodontics, Dental Clinic of Monastir, Faculty of Dental Medicine of Monastir, Tunisia

³Teaching Assistant, Faculty of Dentistry and Oral Surgery, Al Salam University, Tanta, Egypt

***Corresponding Author:** Ali I Abdalla, Professor, Department of Restorative Dentistry, Faculty of Dentistry, University of Tanta, Tanta, Egypt and Visiting Professor at Department of Orthodontics, Saveetha Dental College and Hospital, Saveetha University, Chennai, India

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Abstract

Purpose: To evaluate the clinical performance of a universal adhesive Futurabond U in Class V abrasion lesions with and without acid etching procedures.

Materials and Methods: A total of 183 Class V non-carious cervical lesions (NCCL) with incisal or occlusal margins in enamel and gingival margins in dentin/cementum were selected and restored with Futurabond U adhesive and thermo-viscous bulk fill composite (Viscocal bulk fill composite). Restorations were made using three different techniques: after etching of the enamel, after etching the whole cavity for 20 seconds and without acid etching (control). The restorations were evaluated at baseline, 1- and 2-year using USPHS criteria.

Results: No loss of restorations was recorded after one and two years for all the three restorative techniques. There was no significant difference between the baseline and 2-years results for any of the tested technique. However, restorations made after acid etching showed less marginal discoloration at the enamel margins.

Conclusion: Futurabond U adhesive was effective in restoring Class V non-carious cavities after 2 years. Acid etching of the enamel margin or the whole cavity did not improve the clinical performance but showed improvement in Cavosurface marginal discoloration.

Keywords: Universal Adhesives; Clinical; Class V Non-Carious

Introduction

Dentin bonding systems are available as three-step, two-step and one-step systems, depending on how the three steps; etching, priming and bonding were accomplished or simplified. The total-etch systems are offered as three- or two-step systems (one-bottle). The self etching systems are divided into two- or one-step systems (all-in-one). Several clinical studies have shown that reliable and long lasting adhesive restorations can be obtained following the total-etch technique [1-6]. In contrast, scarce information is available on the clinical performance of self-etch adhesives [7-9]. When using the total-etch technique, the quality of resin-dentin adhesion can be greatly influenced by the duration of the acid

etching process and the amount of surface wetness left prior to adhesive application [3,10]. By using this strategy, some problems could occur, such as the collapse of the collagen networks following the application of etching agent, the necessity of rinsing or the correct interpretation of the wet or dry bonding [8].

Self-etching primers use non-rinsed acidic monomers that simultaneously dissolve the smear layer, demineralize the dentin surface beyond the smear layer and prime dentin as well as the enamel [11]. The adhesive in two-step self-etching adhesives agent is often a solvent-free component. Newer self-etching systems combine the etchant, primer and adhesive in one container

[12]. As they etch, they also infiltrate the exposed collagen with hydrophilic monomers, where they copolymerize with the placed adhesive resin to the same depth in the dentin [13]. The result is the formation of a hybridized complex; a hybridized smear layer and hybrid layer which thickness is related to the aggressiveness of the self-etching agent [13]. With these systems the smear layer is a bonding substrate. Moreover, these systems are used under dry bonding conditions.

Laboratory studies evaluating self-etch materials showed different findings. Some studies [14-17] have reported that self-etch adhesives bond less effectively to enamel than total etch systems. Others [18-20], however, have noted that both self-etch and total-etch adhesive systems perform equally well on ground enamel. Self-etch adhesives have also been reported to interact less effectively with dentin compared to total-etch ones [21-23]. In particular, with regard to bond durability, a bond produced by self-etch adhesives appears more vulnerable to degradation due to areas of increased permeability present at the hybridized adhesive dentin interface [24]. Water was suggested to be incompletely removed and resulted in regions of incomplete polymerization making the interface permeable and more degradation sensitive.

Though *in vitro* testing methodology tends to predict clinical performance, clinical trials remain necessary to ultimately evaluate the clinical efficacy of adhesives. To date few clinical trials [25,26] are available on the influence of prior acid etching of enamel on the clinical performance of self-etch adhesives. They reported no differences in clinical performance of the tested adhesive when applied with and without prior etching of enamel.

The objective of this study was to evaluate the effect of prior acid etching of enamel only or etching enamel and dentin on the clinical performance of a universal adhesive in Class V non-carious lesions. The null hypothesis tested was that the use of acid before universal adhesive may not improve its effectiveness to restore non-carious cervical lesions.

Materials and Methods

Two experimental and one control groups were tested. In the experimental groups, Futurabond U adhesive (Table 1) was applied on phosphoric acid etched enamel or enamel and dentin. In the control group it was applied according to the manufacturer’s instructions on non-etched enamel and dentin.

Twenty-four subjects with ages ranging between 18-44 years participated in this study. A total of 183 wedge-shaped non-carious erosion/abrasion/abfraction lesions (NCCL) were restored us-

Adhesive system	Composition	Manufacturer
Futurabond U adhesive	Liquid 1 (HEMA, bis-GMA, HDDMA, UDMA, acidic monomer, catalyst, silica nanoparticles).	VOCO Gmbh, CUXhaven, Germany
	Liquid 2 (ethanol, initiator, catalyst)	
VisCalor Bulk Fill (Thermoviscous, Nano hybrid bulk-fill composite)	Organic matrix: BIS-GMA (10-25%), aliphatic dimethacrylate (2.5-5%) Inorganic particle: nano-scale filler	

Table 1: Composition of the adhesive system and composite resin used in the study.

ing the tested adhesive “Futurabond U adhesive”. All lesions were selected only in the maxillary anterior (Incisors and canines) and premolars and mandibular premolar teeth. For each subject, at least two restorations were made with different adhesive techniques. Subjects with a compromised medical history, severe or chronic periodontitis, extreme caries, and abnormal occlusion were excluded from the study. All procedures were explained to the patients and their written informed consents were obtained.

Restorative procedures

Operative procedures were performed by two specially instructed and experienced dentists from the university dental school. If needed to prevent patient discomfort during restorative procedures, local anesthesia was applied with 2% Lidocaine solution.

All restorative procedures were done under rubber dam isolation using the gingival retraction clamp Ivory 212^c. The tooth surface was first cleansed with slurry of pumice and water to remove the salivary pellicle and any remaining dental plaque. The dentin walls of the lesion were superficially roughened with a coarse diamond bur to remove any superficial caries or discolored tooth tissue before the bonding procedure was initiated. No tooth preparation was carried out and no lining materials were applied.

The materials were used according to the manufacturers’ instructions as follows: Futurabond U adhesive was applied after mixing the components by pressing on the area marked press here using micro brush. The adhesive was thinned with gentle blast of air for 5 seconds and light cured for 10 seconds (Celalux 2, Voco). The output of the light curing unit was regularly checked with a curing radiometer (Demetron Research Corp., Danbury, CT, USA) to be at least 600 mW/mm².

Three restorative techniques were used

- The enamel margins were etched with 36% phosphoric acid (Vococid, Voco) for 15 seconds, rinsed with water spray for 20 seconds and dried with mild air for 3-5 seconds.
- The entire cavity was etched with phosphoric acid for 15 seconds, rinsed with water spray and air dried for 20 seconds.
- The material was applied without acid etching (control).

All cavities were restored with Viscalor bulk fill composite using Viscalor dispenser in one bulk increment using programme 1 setting. This delivery system is claimed to provide homogeneous warming of the highly filled VisCalor bulk fill composite using near-infrared technology. Thus, reducing its viscosity. During application it is flowable and when it comes in contact with the tooth it reaches body temperature within a short time and thus returns to the high viscosity, sculptable state and light cured for 20 seconds using a Celalux 2 light curing unit.

Finishing was accomplished using contouring diamond at high speed and polishing was done with flexible discs and finishing strips at low-speed hand piece with water cooling (Sof-Lex Pop-on set, 3M Espe, AG, Seefeld, Germany). Polishing was performed using rubber points (Kenda dental polishers, Liechtenstein) together with polishing paste (EZ-SHINE, EZ-PAC, Egypt) and golden brush (Kavo Kerr Composite Polishing Brush, China).

Evaluation procedures

Each restoration was clinically evaluated after finishing and polishing, after 1 and 2 years in accordance with modified US Public Health Service (USPHS) criteria [27]. The variables evaluated were: retention, color match, anatomic form, marginal adaptation, marginal discoloration, postoperative sensitivity and recurrent caries. Two independent examiners who used the same criteria in similar investigations were chosen for the evaluation of the restorations. The evaluators were blinded to the adhesive technique used in any given restoration. When disagreement occurred during evaluation, consensus evaluations were obtained between evaluators. An initial agreement of at least 85% between evaluators was considered statistically significant.

The obtained data were tabulated and statistically analyzed with a Chi-square test at a level of significance of 5% (p < 0.05).

Adhesive techniques	Max anterior	Maxillary premolar	Mandibular premolar	Total
Enamel etching	20	18	16	54
All etch	25	20	19	64
No etch	27	23	15	65
Total	72	61	50	183

Table 2: Distribution of restorative techniques and tooth location.

Adhesive technique	Color match	Anatomic form	Marginal adaptation	Marginal discoloration	Retention rate (%)
	A B C	A B C	A B C	A B C	
Enamel etching					
Baseline (54)	54 0 0	54 0 0	54 0 0	54 0 0	100%
1-year (50)	50 0 0	50 0 0	50 0 0	49 1 0	100%
2-year (46)	43 3 0	46 0 0	45 1 0	43 3 0	100%
Total etching					
Baseline (64)	64 0 0	64 0 0	64 0 0	64 0 0	100%
1-year (57)	57 0 0	57 0 0	54 3 0	53 4 0	100%
2-year (52)	50 2 0	52 0 0	47 5 0	47 4 1	100%
No etching					
Baseline (65)	65 0 0	65 0 0	65 0 0	65 0 0	100%
1-year (59)	59 0 0	59 0 0	57 2 0	56 3 0	100%
2-year (54)	54 0 0	54 0 0	50 4 0	50 4 0	100%

Table 3a: Clinical evaluation of Futurabond U restorations after 1 and 2 years.

() indicate the number of restorations evaluated.

Adhesive techniques	Postoperative sensitivity		
	A	B	C
Enamel etching			
Baseline (54)	54	0	0
1-year (50)	47	3 (6%)	0
2-year (46)	45	1 (2.2%)	0
Total etching			
Baseline (64)	64	0	0
1-year (57)	53	4(7%)	0
2-year (52)	50	2(3.8%)	0
No etching			
Baseline (65)	65	0	0
1-year (59)	58	1 (1.7%)	0
2-year (54)	54	0	0

Table 3b: Results of postoperative sensitivity of Futurabond U restorations after 1 and 2 years.

- () indicate the number of restorations evaluated.
- A: No sensitivity, B: Mild sensitivity,C: Sever sensitivity

Results

The data for color match, anatomic form, marginal adaptation and Cavosurface marginal discoloration for the tested techniques are presented in table 3a.

After 1 year, 166 restorations were available for evaluation (recall rate 91%). No loss of restoration was recorded (retention rate 100%).

Restorations made after enamel etching showed Alfa ratings for all the inspected criteria except marginal discoloration. One restoration showed minor localized area of discoloration at the gingival margin. For the total-etch group, all restorations showed Alfa rating regarding all color match and anatomic form. For marginal adaptation, three restorations showed Bravo rating. For marginal discoloration, four restorations showed Bravo score. These stains were mainly located at the gingival margins of the restorations. Restorations made without etching (control) showed 100% Alfa rating for color match and anatomic form. For marginal adaptation two restorations (3.3%) showed Bravo score. For Cavosurface marginal discoloration three restorations (5%) were rated Bravo. In these restorations stains were mainly located in enamel margins.

Statistical analysis revealed no significant differences ($P > 0.05$) between the 1-year and baseline evaluation for the three tested methods. Also, there were no significant differences between the three tested techniques after 1 year.

After 2 years, 152 restorations were available (recall rate 83%). No loss of restorations was recorded for any of the tested techniques. Restorations made after enamel etching showed three restorations with Bravo score for color match, For marginal adaptation, one restoration showed Bravo rating and for Cavosurface marginal discoloration, three restorations showed Bravo score. These stains were localized mainly at the gingival margins.

Restorations made after total etch showed for color match two restorations with Bravo ratings. Also, five (9.6%) restorations showed Bravo score for marginal adaptation. For marginal discoloration, four restorations (7.6%) showed Bravo scores and one restoration (1.9%) showed Charlie rating. These areas of discoloration were located mainly at the gingival margins.

Restorations made without etching (control) showed 100% Alfa rating for color match and anatomic form. For marginal adaptation, four restorations showed Bravo rating (7.4%). For marginal discoloration, three restorations (5%) showed Bravo rating. Most marginal discrepancies and discoloration were located at the enamel margins.

Statistical analysis revealed no significant differences ($P > 0.05$) between the 2-year and baseline evaluations for all tested techniques. Also, there was no significant difference between the three tested methods after 2 years.

None of the restorations showed secondary caries and no teeth became non vital due to the placed restorations.

Postoperative sensitivity (Table 3b): After one-year, mild post-operative sensitivity was reported with 6%, 7% and 1.7% of restorations for each treatment. After 2 years, the percentage of mild sensitivity was 2.1%, 3.8% and 0% for each restorative technique respectively.

Discussion

In the present study, the effect of acid etching on the quality of restorations made with a universal adhesive and resin composite was evaluated after 1 and 2 years.

This clinical trial was randomized, and the examiners were blinded for the adhesive technique applied for any restoration. The rationale for this study design was that laboratory studies [19,20,28]. on bond strength reported high bond strength of self-etch adhesives to enamel after acid etching compared to those produced without etching.

This study revealed that both enamel etching and total-etch procedures had no improvement in the quality of Class V non-carious resin composite restorations at least after 2 years compared to the baseline values. However, restorations made after enamel etching procedures showed less deterioration regarding marginal adaptation and marginal staining. This difference in clinical performance although not significant may raise some concern about the etching capability of self-etch adhesives on enamel. In contrast, restorations made after total etching showed more deterioration at the dentin margins compared to other groups.

The favorable clinical effectiveness of Futurabond U adhesive in this study may have resulted from the strong and reliable bond obtained when the material was applied to dental tissues [29]. This is attributed to its chemical composition which contains highly functionalized SiO_2 nanoparticles ($\varnothing 20$ nm) which facilitate a cross-link of the resin components and enhance its film-building properties and reinforce the hybrid layer for long lasting high bond strength. In addition to its acidity ($\text{pH} = 2.3$) which considered a mild self-etch adhesive which interact with dentin superficially, dissolve the smear layer and penetrate it to form a more uniform and stable, resin-infiltrated hybrid layer [30].

Restorations made without acid-etching (control) showed localized area of marginal discrepancies and stains at the enamel margins. These marginal enamel discrepancies and stains may raise a concern about the etching capability of self-etch adhesives. The etching pattern resulting from self-etch adhesive is less defined when compared to that resulting from phosphoric acid etching [31]. This shallower etching pattern and subsequent reduced micro-mechanical retention might reduce bond strength [32].

Restorations made after total-etch technique showed less marginal defects at the enamel margins. However, there was increased tendency toward marginal discrepancies and stains at the gingival margins. Several studies [33-36], have shown increased bond strength of self-etch adhesive when applied to etched enamel. The increased in bond strength may have been attributed to the increased surface roughness and irregularities associated with acid etching. In a study on bond strength, Van Landuyt., *et al.* [37] failed to find any detectable resin tag formation on enamel treated only with the self-etching adhesive. In contrast, distinct infiltration of the self-etching resin into enamel tags was evident after prior acid etching.

The reported deterioration at the gingival margin seems to come from the reverse effect of etching on dentin-bond produced by self-etch adhesives. This was attributed to the incomplete infiltration of the bonding resin to the demineralized collagen [38]. As Futurabond U adhesive was applied following the "dry bond" technique, collapse and shrinkage of collagen networks could have occurred. This may prevent efficient resin infiltration leading to porous zone at the bottom of hybrid layer.

Conclusion

Enamel etching prior application of Futurabond U adhesive had no improving effect on the qualities of composite resin restorations. However, more marginal defects at the enamel side were noticed when enamel was not etched. These defects were small and of clinical negligible relevance. Etching the whole cavity, however, resulted in more deterioration at the gingival walls of the restorations.

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