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Effect of Phosphoric Acid on the Self Etching Primer Bond Strength and its Relation to Oral Health Status

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Abstract

Self etching primers, due to ease of manipulation, have been extensively used in recent years. These self etching primers containing a relatively weak acid, may not provide an optimal bond strength. The purpose of the present in-vitro investigation was to evaluate the effects of 37% phosphoric acid application prior to applying self etching primers on composite bond strength. In this experimental study a total of 48 premolar and molar teeth, free of caries, filling, abrasion, crack or other dental defects were selected. The extracted teeth were immediately stored in physiologic serum and divided randomly into two equal groups (n=24).Each group was also divided into two subgroups of twelve teeth each as follows: Subgroup A: enamel was not acid-etched, subgroup B: enamel was acid-etched (group I).Subgroup C: dentin was not acid- etched, subgroup D: dentin was acid-etched (group II).In acid-conditioned groups, water rinsing was followed by the application of a bonding agent (Etch & Primer 3), however for non-acid-treated groups, just the bonding agent was used. Then composite resin blocks (1.5×2 mm and 2.5 mm in diameter) were formed and light cured at all directions for 40 seconds, following this the specimens were placed in an Instron universal testing machine to determine shear bond strength. The data were analyzed by t-test. Results showed that no statistically significant differences were between the mean values of etch and un-etch enamel (P=0.232), similarly those of etch and un-etch dentin (P=0.148). In this investigation we concluded that acidic components employed in self-etching primers were of weak type, but self-etching primers could be used without phosphoric acid conditioning.

Key words: *Dentin bonding, Shear bond strength, 37% phosphoric acid, Self etch primer, Iran*

Introduction

Insufficient bond strength and microleakage are the main failure reasons in composite resin restorations. However, using the so-called acid-etch technique and bonding systems leads to a significant reduction in microleakage and provide the surface with the most retentive appearance (1-3).

Self- etching primer adhesives are becoming increasingly popular in restorative dentistry these acids primer include phoshonated resin molecule that performs three functions simultaneously etching, priming and bonding of enamel and dentin (4).

The self- etching primer has a pH of 1 or less and interact more profoundly with dentin (5).

Acidic monomers in the primer remove or modify the smear layer, superficially demineralize the dentin surface and simultaneously infiltrate into the demineralized space.

These systems do not require etching, rinsing or drying steps, therefore, the risk of over- etching and over drying and consequently the collapse of the collagen fibers is eliminated and operating time is reduced (4-8).

As the pH value of self- etching priming solution is generally low enough to demineralize the smear layer and underlying dentinal surface,

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etching and priming of dentin can be accomplished simultaneously (9,10).
Niyaska and others have reported that self-etching primer might not be able to penetrate through the smear layer, the acidity of the primer might be buffered by the smear layer, there by reducing the potential for primer pentration (11).
Some studies show that self- etching primers on enamel are a useful alternative to the multi- step system (12,13), but other studies have demonstrated that bond strength to enamel is lower than the value of multi- step system (14,15).
So the use of additional acid has been suggested by some investigators as means of improving the bonding of self- etching adhesive to enamel and denting (11).
The purpose of the present in- vitro investing was to evaluate the effects of 37% phosphoric acid application on composite bond strength prior to applying self- etching primers and its relation to oral health status.

Materials and Methods

Forty-eight intact human premolar and molar teeth were stored in physiologic serum at 37°C immediately following extraction. The interval between tooth extraction and experiment was maximally 3 months and all specimens were store in 37°C physiologic serum. In order to control infection, all the specimens were disinfected by an autoclave under 125°C and 20 Psi, for 16 min (16).
The extracted teeth were randomly divided into two equal groups (n=24). Each group was also divided into two subgroups of twelve teeth as follows:
Subgroup A: enamel was not acid-etched, subgroup B: enamel was acid-etched (group I).
Subgroup C: dentin was not acid- etched, subgroup D: dentin was acid-etched (group II).
In order to do the experiment, the buccal and lingual surfaces (1.5×2 mm) of specimens were wet ground to expose a flat enamel and polished by silicon carbide disks of the 24 samples in group I and similarly the same treatment were prepared to expose a flat dentin and polished by silicon carbide disks of the 24 samples in group II, to be restored with composite resin blocks (1.5×2 mm).
In group A (enamel was not conditioned) and group C (dentin was not conditioned), bonding agent Etch & Prime 3 (Degussa) was applied by a single- use brush for 30 S, strictly following the manufacturers' directions, then dried with forced air for 5 and light cured for 10 S. This procedure was repeated to obtain a strong and reliable bonding. Afterwards, composite resin (Z100, Shade A_2, 3M ESPE, USA) blocks (1.5×2mm and 2.5 mm in diameter) were placed on the bonded area and photocured at all directions for 40 S.
Group B (acid-etched enamel) and group D (acid-etched dentin) were conditioned with 37% phosphoric acid Gel (3M ESPE, USA) for 30 and 10 S, respectively. Then, rinsed for 15 S and dried with forced air, so as they were slightly wet.
Following this, the acid-etched surfaces, similar to groups A and C, were light cured by Etch & Prime 3 bonding agent. At the next stage, composite resin blocks were placed and cured at all directions for 40 S. All teeth (group I, II) were mounted in self cure acrylic resin (with a diameter of 3 cm), at 1 mm below the CEJ. All samples were stored in physiologic serum at 37°C just prior to the experiment and their shear bond strengths were measured by an Instron machine at a crosshead speed of 0.5 mm/min. The data were analyzed by independent sample *t*-test.

Results

The results are summarized in Table 1. The results of *t*-test exhibited that shear bond strength of un- etch enamel was 16.25± 2.75 and etch enamel 17.36± 5.44 MPa. There were no significant differences between the mean values of un- etch and etch enamel (P= 0.232) and S.B.S of un- etch dentin was 13.89± 2.57 and etch

dentin 14.72± 2.79 MPa. There were no significant differences between un- etch and etch dentin too (P= 0.148).

Results showing that no statistically significant difference between the mean values of etch and un- etch enamel (P= 0.232), similarly those of etch and un- etch dentin (P= 0.148)

Table 1: The characteristics of various parameters

Parameter	Mean±SD	Range
Un- etch enamel	16.25±2.75	26.66-10=16.66
Etch enamel	17.36±5.44	21.66-13.33=8.33
Un- etch dentin	13.89±2.57	18.33-10=8.33
Etch dentin	14.72±2.79	18.33-10=8.33

Bond strength= MPa

Discussion

In recent dentin bonding generations, known as one bottle or fifth generation, acid is frequently used separately whereas primer and adhesive are mixed together. As a result, following enamel and dentin acid- conditioning and water rinsing, they should be gently air dried to provide a slightly wet state for dentin in order to prevent the collapse of collagen fibers. Consequently, adhesive component should be used.

The probability of the creation of a weak bonding system among the fifth generation bondings, due to dentin over drying followed by inadequate penetration of adhesive and primer, has resulted in production of a new generation (the sixth) called self-etching primer.

In self-etching primer systems, two steps of water rinsing and air drying have been eliminated since three components of acid, primer and adhesive have been mixed together. Thus, the probability collapse of the collagen fibers is eliminated. The acidic component of this system as compared to 37% phosphoric acid is a weak etchant (17-19).

Smear layer covers the dentin surface, adheres weakly to the underlying dentin and it may impede the direct contact of the bonding material with the dentin. To obtain good adhesion to dentin, the smear layer should be removed or modified with conditioners such as acidic solutions. Therefore, it should be accepted that dentin bonding strength depends on the characteristics of the smear layer that should be modified by the acidic component.

The self-etching primer's acidic components deminearlize through the smear layer and diffuse a short distance into the underlying dentin, resulting in the creation of a thin hybrid layer with strong bonds to dentin (20). However, it is believed that some of the smear layer can not be completely removed by these self etching primers due to their weak acidity. Thus, demineralization of the underlying dentin and further penetration of the bonding resin into the demineralized dentin can be insufficient for optimal bond strength (21).

Hannig et al reported that although using self etching systems did not create an etching pattern similar to that of 37% phosphoric acid etchant the resultant bond strength was reliable (12).The results of this study was parallel to our findings about enamel.

In another study it was shown that there were no statistically significant differences between self-etch-system and one-bottle system in which acidic solution was used separately prior to the primer and adhesive mixture (22).

Grodan indicated that enamel acid etching prior to the application of self-etching dentin bondings increased bond strength significantly, however, pretreatment of dentin by etchants decreased bond strength. Both results contradicted the findings of the present research (23).

Yamada observed that, enamel phosphoric acid conditioning could generate more durable, higher bond strength (24).

On the other hand, using 35% phosphoric acid etchant on bovine enamel for 15 S before self-etching system application resulted in a significant increase in bond strength but conditioning bovine dentine with phosphoric acid of the same viscosity and application time decreased bond strength. Both conclusions contradicted the results of our present research(25).

Hashimoto showed that total etch system created a stronger enamel bond strength comparing to self-etching system (26).

Finally, Pimenta et al reported that self-etching primer adhesive did not provide bond strengths of equivalent or better quality compared to the bond strengths generated by the total- etch technique (27).

It can be concluded that the presence of non-significant differences depends on the sampling error and real differences do not exist between the mean values.

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