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Evaluation of a New Self-etching Primer on Bracket Bond Strength In Vitro

Julio Pedra e Cal-Neto;[a] Felipe Carvalho;[b] Rhita Cristina C. Almeida;[c] José Augusto M. Miguel[d]

ABSTRACT

The purpose of this in vitro study was to evaluate the influence of a new self-etching primer (Adper Prompt L-pop; 3M ESPE, St Paul, Minn) on shear bond strength of orthodontic brackets. Forty extracted human premolars were obtained and randomly divided into two groups of 20 each: group 1 (control), phosphoric acid + Transbond XT primer (3M Unitek, Monróvia, Calif) and group 2, Adper Prompt L-pop. Transbond XT adhesive paste (3M Unitek) was used in both groups for bracket bonding. All products were used according to the manufacturer's instructions. Instron Universal Testing Machine was used to apply an occlusal shear force directly onto the enamel-bracket interface at a speed of 0.5 mm/min. The groups were compared using Student's *t*-test. Mean results and standard deviation for the groups were: group 1 = 16.23 MPa (4.77), group 2 = 13.56 MPa (4.31). No significant difference was observed in the bond strengths of the two groups evaluated (P = .069). However, the adhesive remnant index was significantly less when conditioning the enamel with Adper Prompt L-pop compared with phosphoric acid (P = .0003). The results suggest no difference in bond strength whether a conventional etching and primer or Adper Prompt L-pop is used. The amount of adhesive on the enamel after debonding was significantly less when using Adper Prompt than when using phosphoric acid. These results indicated that Adper Prompt is potentially adequate for orthodontic bonding needs.

KEY WORDS: Phosphoric acid etching, Self-etching primer, Shear bond strength.

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INTRODUCTION Return to TOC

The enamel-etching technique presented by Buonocore[1] is commonly used with composite resin when attaching brackets to the enamel surface. In the past few years, there has been a major research drive to increase bond strength between dental materials and dental hard tissues, although most of the adhesive systems have provided clinically acceptable bond strengths. Despite the fact that the acid-etching technique is a useful procedure in orthodontics, there is a need to improve the bonding procedure to maintain clinically useful bond strengths while minimizing the amount of enamel loss and to simplify the technique reducing the number of steps.[2,3]

In restorative dentistry, newly bonding systems were developed to combine conditioning and priming agents into a single acidic primer for simultaneous use on enamel and dentin, eliminating steps of separate etching, rinsing, and drying.[4] The use of a self-etching primer (SEP) would have the advantage of a faster and simplified application technique, allowing adequate etching and priming of enamel and dentin in only one step.[2,5] In addition to saving time, fewer steps in the bonding process might translate into fewer procedural errors, minimizing technique sensitivity.

Bishara et al[2] evaluated the effectiveness of using Prompt L-pop (ESPE, Seefeld, Germany) to bond orthodontic brackets with composite resin. Prompt was an SEP containing metacrylated phosphoric acid esters to perform the etching step. According to the results, this SEP provided significantly lower (but clinically acceptable) shear bond strength when compared with a conventional etch/priming technique before bonding brackets with Transbond XT adhesive paste (3M Unitek, Monróvia, Calif).

More recently, additional modifications were done, and a new release, Adper Prompt L-pop (3M ESPE, St Paul, Minn), was introduced to improve enamel and dentin bond strengths for more consistent performance. The purpose of this study was to determine the effects of this newly introduced SEP on the shear bond strength of orthodontic brackets bonded to enamel. The null hypothesis was that there would be no difference in the shear bond strength between groups whether a conventional multistep or a SEP system was used.

MATERIALS AND METHODS Return to TOC

A total of 40 human premolars free from caries, cracks, and fillings were used. These teeth had been extracted for orthodontic reasons and with the informed consent of the patients. The teeth were washed in water and stored in a 0.1% thymol solution, for no longer than six weeks before use. The buccal surfaces were cleaned and polished with a rubber cup and a slurry with pumice and water, followed by rinsing with water spray and drying with compressed air.

Orthodontic metal maxillary premolar brackets (Dental Morelli, São Paulo, Brazil) were used in this study. The average bracket base surface area was determined to be 14.18 mm^2. The teeth were divided into two groups, and brackets were bonded on the buccal surfaces according to the manufacturer's instructions following one of the two protocols.

- Group I (control group)—phosphoric acid/Transbond XT primer. The area where the bracket was to be located was etched with a 37% phosphoric acid gel (3M ESPE) for 15 seconds and then washed with water. After washing, the enamel surface was completely dried with compressed oil-free air. A layer of Transbond XT primer was applied on the tooth. Transbond XT paste was applied to the base of bracket and pressed firmly onto the tooth. Excess adhesive was removed from around the base of the bracket, and the adhesive was light cured positioning the light guide of an Ortholux XT Visible light-curing unit (3M Unitek) for 20 seconds. The light was applied for 10 seconds at both the mesial and distal aspect of the bracket.

- Group II—Adper Prompt L-pop. The SEP was gently rubbed onto the surface for approximately 15 seconds with the disposable applicator supplied with the system. Then a moisture-free air source was used to deliver a gentle burst of air to the enamel. The bracket was bonded with Transbond XT adhesive paste as in group I.

The extracted teeth were immersed for 24 hours in distilled water at a temperature of 37°C. The specimens were mounted in plastic rings with acrylic. A mounting jig was used to align the bracket base to be perpendicular with the bottom of the mold and parallel to the force during the shear strength test. An Instron Universal Testing Machine (Instron Ltd, High Wycombe, UK) was used to apply an occlusogingival load onto the bracket, which produced a shear force at the tooth-bracket interface with a crosshead speed of 0.5 mm/min. The force in newtons was recorded for each specimen and divided by the surface area of the bracket pad to obtain the shear stress value in megapascals (MPa).

After debonding, the teeth and brackets were examined under a 10× magnification to evaluate the amount of resin remaining on the tooth. The adhesive remnant index (ARI)[6] was used to describe the quantity of resin remaining on the tooth surfaces. The ARI score has a range between 0 and 3 as follows: 0, no adhesive remained on the tooth; 1, less than half of enamel bonding site was covered with adhesive; 2, more than half of the enamel bonding site was covered with adhesive; and 3, the enamel bonding site was entirely covered with adhesive.

Descriptive statistics, including the mean, standard deviation, and minimum and maximum values, were calculated for each group tested. The data of bond strength were tested for normality with the Shapiro-Wilk method. The Student's *t*-test was used to determine whether significant differences were present in the bond strength between the two groups. The chi-square test was used to evaluate differences in the ARI scores between groups. All statistical analyses were performed with the software Prism 4.0 (GraphPad Software, San Diego, Calif) at the 5% level of significance.

RESULTS Return to TOC

The descriptive statistics comparing the shear strength of the two groups are shown in Table 1. The Student's *t*-test did not show significant differences ($t = 1.868$, $P = .069$) between the groups evaluated. The SEP group had a mean shear bond strength of 13.56 ± 4.31 MPa, whereas the control group with conventional etch/priming system had a mean of 16.24 ± 4.77 MPa (Figure 1).

The ARI scores for the two groups tested are listed in Table 2. The results of chi-square comparisons for the ARI indicated that there was a significant difference ($P = .0003$) between the group that was bonded with Adper Prompt L-pop as compared with the control group. With the use of the SEP, there was a higher frequency of ARI scores of 0 and 1, which indicated that less composite remained on the teeth.

DISCUSSION Return to TOC

The null hypothesis was accepted. The results of this study did not detect significant differences in bond strength measurements between the Adper Prompt L-pop and the conventional multistep system. Adper Prompt contains different percentages of the same components as the original Prompt L-pop. The manufacturer claims that maximizing bond strength has been achieved, in part, by optimizing the relative amounts of nonacid functional methacrylates with acidic methacrylated phosphoric esters. Afterward, Adper Prompt also introduces better activation control and other chemical modifications enhancing a uniform adhesive film, improving the quality of hybridization between the adhesive and the enamel surface.

There is not a universally accepted minimum clinical bond strength. However, the bond strength required to withstand normal orthodontic forces is believed to be between eight and nine MPa.[7] In this study, bracket failure occurred between 13.56 and 16.24 MPa. These results are in agreement with other studies, which suggest that adequate bond strengths can be achieved with SEPs when bonding is carried out to a dry enamel surface.[8–11]

The evaluation of the ARI scores indicated significant difference in bond-failure site between the two groups. These results showed that Adper Prompt left less adhesive on the enamel than when phosphoric acid was used. This fact can be advantageous for clinicians when removing the adhesive after debonding brackets,[12] although bond failure at the bracket-adhesive interface or within the adhesive is more desirable than at the adhesive-enamel interface because enamel fracture has been reported at time of debonding.[13,14] Previous investigations have shown conflicting results regarding the amount of residual adhesive on teeth with SEP. Some investigations reported more residual adhesive with SEP than with conventional phosphoric acid etching, whereas others found significantly less.[2,8,14,15]

Because of its new properties, Adper Prompt L-pop can be considered as an interesting and promising material. From a clinical standpoint, the use of SEPs can be desirable because they reduce clinical steps, save chair time, improve the adhesive procedures, and reduce the risk of salivary contamination. However, this was a laboratory study and care should be taken in interpreting the results. To recommend the use of this product in a large scale, more studies are required particularly in vivo studies and clinical trials.

CONCLUSIONS Return to TOC

- Under the conditions of this investigation, the results suggest no difference in bond strength whether a conventional etching and primer or Adper Prompt L-pop is used.
- The amount of adhesive on enamel after debonding was significantly less when using Adper Prompt than when using phosphoric acid.
- These results indicated that Adper Prompt is potentially adequate for orthodontic bonding needs.

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TABLES Return to TOC

TABLE 1. Results of Student's *t*-test Comparing Shear Bond Strengths (in MPa) of Groups

Groups Tested	n	Mean[a]	SD	Range
Phosphoric acid + Transbond XT primer	20	16.24	4.78	9.24–25.92
Adper Prompt L-pop	20	13.56	4.31	7.11–23.40

[a] $t = 1.868$; $P = .069$.

TABLE 2. Frequency Distribution and Results of Chi-square Analysis of the ARI of Experimental Groups

		ARI Scores[a,b]			
Groups Tested	n	0	1	2	3
Phosphoric acid + Transbond XT primer	20	0	3	17	0
Adper Prompt L-pop	20	8	7	5	0

[a] ARI indicates adhesive remnant index; 0, no adhesive remaining on tooth; 1, less than half of enamel bonding site covered with adhesive; 2, more than half of enamel bonding site covered with adhesive; and 3, enamel bonding site covered entirely with adhesive.

[b] $\chi^2 = 16.15$; $P = .0003$.

FIGURES Return to TOC

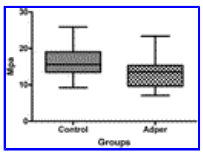

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FIGURE 1. Box plots for shear bond strength (in MPa) of experimental groups

[a]Graduate Student, Department of Orthodontics, State University of Rio de Janeiro, Rio de Janeiro, Brazil

[b]Undergraduate Student, School of Dentistry, State University of Rio de Janeiro, Rio de Janeiro, Brazil

[c]Undergraduate Student, School of Dentistry, State University of Rio de Janeiro, Rio de Janeiro, Brazil

[d]Professor, Department of Orthodontics, State University of Rio de Janeiro, Rio de Janeiro, Brazil

Corresponding author: Julio Pedra e Cal-Neto, DDS, MSc, Department of Orthodontics, State University of Rio de Janeiro, Boulevard 28 de Setembro 157/2° Andar-Vila Isabel, Rio de Janeiro, RJ- 22541-100, Brazil (E-mail: juliocalneto@yahoo.com.br)