
Evaluation of Different Adhesive Systems on Dentin Bond Strength

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Abstract

The objective of this paper was to compare the *in vitro* effect of a conventional and three self-etching adhesive systems as regards bond strength to human dentin substrate by means of the microtensile test. A total of eight sound third molars were used. The teeth had their roots embedded in acrylic resin and underwent removal of the occlusal enamel and abrasion of dentin surface. Then, specimens were divided as two teeth into each group according to the adhesive system to be assessed: G1: Adper Single Bond 2 (3M/ESPE), G2: Clearfil SE Bond (Kuraray), G3: Adper SE Plus (3M/ESPE), and G4: Adper Easy One SE (3M/ESPE). The tooth bottom was sectioned perpendicularly to its long axis so we had "stick-like" specimens to be subsequently subjected to the microtensile test. Data were submitted to the analysis of variance (ANOVA) test and multiple comparison of Tukey, with a significance level of 5%. The bond strength means were: G1: 36.54 (± 13.57), G2: 37.46 (± 19.04), G3: 26.07 (± 9.77) and G4: 19.66 (± 7.09), with statistical significant differences between groups ($p < 0.05$). The adhesive systems Adper Single Bond 2 and Clearfil SE Bond showed *in vitro* similar behavior, and performance higher than that of Adper SE Plus and Adper Easy One.

Introduction

Bonding to dental structure has been one of the most addressed issues in scientific research. As a result of several studies, advances have broadened the possibilities for restorations with higher security, avoiding fractures, caries recurrence, staining, and pulp irritation, in addition to the performance of minimally invasive cavity preparations [1,2]. As primarily described in 1982 [3], the composite-dentin bond is achieved by demineralizing the dentin collagen matrix, which serves as a way for composite to penetrate into the hybrid layer [4].

The etching of enamel promotes an uneven surface, representing therefore a perfect substrate for the bond of resin [5]. Nevertheless, this has not been well established for dentine, because it is a very

heterogeneous substrate, composed of a collagen matrix with organic base and fluid in the dentinal tubules, what results in bond strength and integrity values lower than those for enamel [6,7].

Several dental adhesives have been developed in order to have a more effective behavior upon the dentin substrate. As such, two different groups have been the most used: conventional adhesives, applied after total etching of the tissue, removing the smear layer and exposing the collagen matrix [6]; and self-etching adhesives, which do not require prior conditioning and can be applied in one or two steps [8].

The self-etching adhesives have in their primers composition high concentrations of more acid monomers, which promote bond through direct connections with the smear layer [9]. An improved sealing could occur with the use of such adhesives, since there would be no discrepancy between the depth of conditioning and extent of infiltration of resin monomers into the substrate, in addition to the avoiding of postoperative sensitivity [10].

Thus, it is understood that different adhesive systems have been used because of clinical difficulties encountered in the steps for the restorative procedure. Therefore, this study aimed to compare the *in vitro* bond strength to human dentin of different adhesive systems by means of the microtensile test.

Methods

A total of eight third molars were used in the present study. The teeth had their roots embedded in acrylic resin, and their occlusal enamel was completely removed by cutting perpendicular to the long axis of the teeth made with diamond disc spinning at low speed. With the aid of a universal polishing machine (Panambra Zwick Com. Maq. and Eqpts. Ltd., Sao Paulo, SP, Brazil), the dentin surface was roughened with silicon carbide sandpaper, with the purpose of producing a standardized smear layer. The specimens were divided as two teeth into each group, according to the adhesive system to be assessed.

Four adhesive systems were tested, as follows: G1: Adper Single Bond 2 (3M/ESPE Brasil, Sumare, SP, Brazil); G2: Clearfil SE Bond (Kuraray, Otemachi, Tokyo, Japan); G3: Adper SE Plus (3M/ESPE Brasil,

Sumare, SP, Brazil); and G4: Adper Easy One SE (3M/ESPE Brasil, Sumare, SP Brazil).

After applying the adhesive systems of each group, it was placed the increments of the restorative material (Composite resin Z250 - 3M/ESPE Brazil, Sumare, SP, Brazil), resulting in the production of a composite block with 4 mm height. Then, the specimens were stored in plastic containers with distilled water, for 24 hours, in bacteriological incubator at 37 °C. After this period, the specimens were adapted to a metallic holder to then be attached to the Elsav serial-section machine (Elquip, Sao Carlos, SP, Brazil). So, we obtained several "stick-like" specimens with cross-sectional area for testing of approximately 1 mm. The peripheral "sticks", which corresponded to the areas containing enamel, were discarded.

Subsequently, the specimens were fixed by their ends to a microtensile device (similar to the Geraldelli's Claws) with an adhesive cyanoacrylate-based gel, and adapted to the Universal Testing Machine - INSTRON 5564 (Instron Corp., Canton, Massachusetts, USA), in such way that adhesive interfaces were positioned perpendicular to the long axis of the pulling force and subjected to a speed of 0.5 mm / min [11].

The results were obtained as Kgf and converted into MPa to be subjected to statistical analysis of variance (ANOVA) and multiple comparison of Tukey, with a significance level of 5%. The statistical analysis was carried out on the Statistical Package for the Social Sciences software (SPSS), version 17.

Prior to execution, this research project received the approval of the Research Ethics Committee at the State University of Paraiba (CAAE: 0110.0.133.000-09).

Results

The results of microtensile strength for each group are expressed as means in Table 1. It was noted that the means of bond strength values were correspondingly higher in the groups Clearfil SE Bond and Single Bond 2 and lower in the groups Easy One and Adper SE with statistical significant differences between them ($p < 0.05$).

Table 1. Comparison between the means of microtensile bond strength (MPa) of the groups.

Groups	Adhesive	N	Mean ⁽¹⁾	SD
G1	Adper Single Bond 2	23	36.54 ^(A)	13.57
G2	Clearfil SE Bond	17	37.51 ^(A)	19.04
G3	Adper SE Plus	23	26.07 ^(B)	9.77
G4	Easy One	20	19.66 ^(B)	7.09

(1): Means followed by distinct letters indicate statistical differences at a significance level of 0.05.

Discussion

The *in vitro* tests assessing bond to dentin tissues are complex as they limit variables and mimic as much as possible the natural conditions of the oral environment [12,13] Although the data obtained in laboratory studies require greater caution in their interpretation, certainly an adhesive that has a poor performance on a laboratory study will not be suitable for clinical application [14].

Microtensile tests are more convenient to be undertaken than tensile tests, due to the lower number of teeth required for their execution [14]. For this study, two teeth were used in each group so we obtained a minimum of 15 sticks for each type of adhesive. This is currently the most reliable test to evaluate the true bond strength between an adhesive and a substrate in question, since the coefficient of variation of this test is minimized due to the small adhesion interface used [15].

Previous studies [9,16,17] have pointed out that some self-etching adhesives may have performance similar to systems that use the phosphoric acid as conditioning agent¹⁸. Such fact was confirmed by the present investigation when we compared the results obtained for the adhesive systems Adper Single Bond 2 and Clearfil SE Bond, which were found to present equivalent *in vitro* performance.

Despite having a relatively high cost, the self-etching adhesive systems offer good clinical outcomes by reducing the number of operative steps and clinical time as well as the likelihood of errors, promoting better postoperative results [16]. In this study, the adhesive that showed the best behavior regarding microtensile strength was the Clearfil SE Bond self-etching adhesive.

Nonetheless, conflicting results on bond strength to dentin of self-etching adhesive systems might still be found. It can also be verified a low quality of the hybrid layer produced, consequently promoting lower bond strength [14]. Hence, other studies report higher bond strength to dentin when it is used a self-etching adhesive system (Clearfil SE Bond) against an adhesive (Single Bond) proceeded by etching [19], corroborating with the data obtained in this study. Self-etching adhesive systems are more resistant to flowing of fluids as they are applied on the dentin coated by smear layer, that is, with reduced permeability [20].

In contrast, in the present study, two of the self-etching adhesive systems showed lower *in vitro* behavior in

relation to the positive and negative control groups. This is in agreement with several studies found in the literature [8,21-23], which have demonstrated higher performance of conventional adhesives.

The single-step products presented reduced bond strength values, since they do not have hydrophobic covering material like the two-step adhesives, what results in a layer probably less resistant to the phenomenon of permeation [20]. These data were also corroborated in this study, because the single-step adhesive tested was found to present lower performance against the others. In an attempt to streamline procedures and reduce the clinical time, sometimes, many professionals opt for single-step adhesives, what may compromise the quality of the fillings [6,23].

In the literature, it is notorious the variability of bond strength results of different dentin bonding systems [24]. The self-etching ones represent a relatively new generation of materials in the dental market, but further longitudinal clinical trials are still needed to evaluate their true performance.

Conclusion(s)

The adhesive systems Adper Single Bond 2 and Clearfil SE Bond showed *in vitro* similar behavior, and performance higher than that of Adper SE Plus and Adper Easy One. As regards single- and two-step self-etching adhesives, the two-step ones presented better results than the others.

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