

**Original Article**

## Composite-Dentin Bond Strength of Two Adhesives in Different Conditions

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**ABSTRACT**

**Introduction:** The purpose of this study was to evaluate the effect of thermo-cycling and curing mode of composites (light and chemical curing) on dentin bond strength of one all-in-one and an one-bottle bonding systems.

**Methods and Materials:** Occlusal enamels of eighty caries-free third molars were ground with a model trimmer to create flat surfaces in superficial dentin for bonding, and randomly divided into 4 groups. Teflon molds with 1 mm internal diameter were mounted on the flat surfaces, Prompt L-pop (all-in-one system) (3M-ESPE) and Single-Bond (one-bottle system) (3M-ESPE) were used and restored with FiltekZ250 (light-cured composite) (3M-RSPE) and Concise (chemically cured composite) (3M-ESPE) composites. Specimens were stored in 37°C distilled water for 24 hours. 10 specimens of each group were thermo-cycled 500 times between 5°C to 55°C. Micro-shear bond strength test was done with 0.5mm/min crosshead speed (Dartec, England). The data were analyzed by ANOVA and Duncan's tests.

**Results:** The mean shear bond strengths of two adhesive systems with light-cured composite showed no significant differences with and without thermo-cycling ( $P < 0.05$ ). Also, there was no significant difference between bond strength of two adhesive systems with light-cured composite ( $P < 0.05$ ). Use of chemically cured composite reduced the bond strength of Single-Bond significantly ( $P < 0.001$ ). There was not any bond between chemically cured composite to dentin, using prompt L-pop.

**Discussion:** Thermal cycles, in the range that we used them, did not have any influence on the bond strengths of two mentioned systems. The effect of increasing cycles should be evaluated. Use of chemically cured composite decreases the bond strength of Single-Bond and there was no bond between this kind of composite and Prompt L-pop system. So these systems, especially Prompt L-pop, shouldn't be used with chemically cured composite in routine dental treatments.

**Key Words:** Simplified Adhesives, Thermo-cycling, Chemically Cured, Composite Resins.

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**Introduction**

Over the last decade, the classic concept of three-step bonding to dental tissues has developed rapidly to more user-friendly, simplified adhesive systems. These comprise the two-step etch-and-rinse, two-step

self-etch, and one-step self-etch adhesives. Throughout this evolution, resin monomers have become more acidic and hydrophilic that affects their efficacy in providing long-lasting bond stability<sup>1,2,3</sup>.

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In spite of many advantages of light-cured composites application, self-cured and dual-cured composites and resin cements are indicated in some cases. However, some believe that there is an incompatibility between simplified step adhesives (two-step etch-and-rinse and self-etch adhesives) and chemical-cured composite resins. Different studies have stated the role of both adverse chemical interactions and adhesive permeability as main causes of bond strength reduction<sup>1,4,5</sup>. As a result, a study examined the effects of applying a hydrophobic insolvent matter, containing unfilled resin over self-etch bonding such as prompt L-pop. When this hydrophobic unfilled resin was polymerized and applied, incompatibility issues with auto-polymerizing composite resin were eliminated<sup>6</sup>.

Thermo-cycling is a widely used artificial aging method. The ISO TR 11 450 standard indicates that a thermo-cycling regimen comprising 500 cycles in water between 5 and 55°C is an appropriate artificial aging method<sup>7</sup>.

In the light of the aging effects, thermo-cycling should be applied to micro-specimens of which the interface is directly exposed to the changing temperature environment. Then, degradation of the adhesive tooth interface vulnerable restoration margins<sup>8,9</sup>. As a result in this study, micro-shear bond strength test was used to measure the bonding performance of adhesive systems.

The purpose of this study was to evaluate micro-shear bond strength of light- and chemical-cured composites bonded to dentin with a one-step self-etching adhesive (prompt L-pop) and a simplified total etch adhesive (Single-Bond) with and without thermo-cycling.

### Methods and Materials

Eighty unerupted third molars, stored in 4°C water saturated with thymol, were used within one month after extraction. The occlusal surface of each tooth was ground to remove enamel and expose dentin with a model trimmer. The teeth were mounted in

phenol rings and embedded with self-curing acrylic resin. The exposed dentin was then polished with 240, 400, and 600 grit silicon carbide papers (Sic) under water. Teflon molds with 1mm internal diameter were fixed on prepared dentin surface with cyanoacrylate adhesive.

The specimens were randomly assigned to one of the four experimental groups of 20 specimens in each (n=20). Bonding agents and composite resins were applied as follows:

**Group 1** (Prompt L-pop adhesive (3M-ESPE) and Filtek Z-250 (3M-ESPE) composite resin (P.LC)): After mixing the two components of prompt L-pop for five seconds, the mixture was applied for 15s, gently air dried and light-cured for 10s. Light curing was performed with QTH light curing unit (Coltolux, Colten, Swiss) at 450 mw/cm<sup>2</sup>.

After the application of bonding system, Z250 composite resin was condensed into Teflon mold and a tofflemire matrix band was placed over the composite. Then the composite resin was light-cured for 40s.

**Group 2** (Single-Bond System (3M-ESPE) and Filtek Z250 composite resin (S.LC)): Dentin was etched for 15s with 35% phosphoric acid (Ultra etch, Ultradent) and rinsed with water for 10s. Excess water was removed by blotting with a cotton pellet, leaving the surface moist. The adhesive was applied in two consecutive layers and gently air dried and light-cured for 10s. After bonding, Z250 composite material was applied as previously described.

**Group 3** (Prompt L-pop Adhesive System and a chemical-cured composite resin (Concise- 3M ESPE) (P.CC)): After application of the bonding system like as in group 1, equal amounts of the base and catalyst of concise chemical-cured composite were dispensed on a mixing pad, and condensed into molds and a tofflemire matrix band was placed over the composite.

**Group 4** (Single-Bond adhesive system and concise chemical-cured composite resin (S.CC)): After bonding steps similar to group 2, composite was applied like group 3.

After removing the molds, composite beams with width of 1mm and height of 1mm were on the dentin surface. All specimens were stored in distilled water at 37°C for 24 hours, and then 10 specimens of each group were thermo-cycled for 500 cycles (20s in 5°C and 20s in 55°C water bath and transfer time of 20s).

Micro-shear bond strength ( $\mu$ SBS) test was done with a universal testing machine (Dartec, England) at a cross head speed of 0.5mm/min. Data were analyzed with two-ways ANOVA and Duncan's tests. After testing, the specimens were observed under stereomicroscope to evaluate the type of failure.

**Results**

The mean  $\mu$ SBS and standard deviations of studied groups are summarized in table 1.

$\mu$ SBS of two adhesive systems bonded with light-cured composites were not significantly different ( $P>0.05$ ) except for P.LC.T and S.LC groups ( $P<0.05$ ). However, bond strengths were significantly lower when these adhesives were used with chemical-cured composites. Thermo-cycling did not affect bond strength of two adhesive systems. Failure was predominantly seen in adhesives of all groups (table2). All the mixed failures were adhesive / cohesive in resin, but no mixed failure was seen in dentin.

**Table 1.  $\mu$ SBS of two adhesives of different groups (Mpa).**

Adhesive system	Light-cured composite (LC)	Chemical-cured composite (CC)
S.B. with thermo-cycling	25.17 (8.17) <sup>a</sup>	8.41 (2.24) <sup>d</sup>
S.B. without thermo-cycling	29.02 (7.78) <sup>a</sup>	11.17 (2.88) <sup>d</sup>
PL-pop with thermo-cycling	21.75 (2.39) <sup>b</sup>	0 <sup>c</sup>
PL-pop without thermo-cycling	26.53 (4.11) <sup>a</sup>	0 <sup>c</sup>

\*The groups with same superscript letters are not significantly different ( $P>0.05$ ).

\* The groups with different superscript letters are significantly different ( $P<0.05$ ).

**Table 2. Mode of failure in different groups.**

Group	Mode of failure		
	Adhesive	Mixed	Total
S.LC.T	7	3	10
S.LC.	8	2	10
S.CC.T	5	5	10
S.CC.	6	4	10
P.LC.T	7	3	10
P.LC.	9	1	10
P.CC.T	10	-	10
P.CC.	10	-	10

**Discussion**

It appears that ISO standard of 500 cycles regimen<sup>7</sup> did not affect the bond strengths of two systems to dentin. This result is similar to other studies<sup>8,9</sup>.

However, another study has concluded that micro-tensile bond strength ( $\mu$ TBS) of contemporary adhesives (a three-step etch and rinse, a two-step, and a one-step self etch adhesives) bonded to class 1 cavity-bottom dentin didn't decrease after 20,000 cycles, as well as after 20 days of water storage<sup>10</sup>.

In our study,  $\mu$ SBS test was used to measure the bonding performance of adhesive systems. Several studies have also reported that bond strength is inversely proportional to the bonded cross-sectional area (11). Higher bond strength in comparison with shear bond strength test and lower cohesive failure occurrence are among the other results of this study.

Prompt L-pop provided bond strength to dentin that was comparable with Single-Bond when light-cured composite was used (9). However, when chemical-cured composite was used, the bond strength was low. Low bond strength of prompt L-pop with chemical-cured composite may be related to the adverse chemical interactions, adhesive permeability, and lower polymerization speed of chemical cured composites<sup>1,12,13</sup>.

The mean bond strength of Single-Bond was reduced to more than one-half when light-cured composite was substituted by

chemical-cured composite. These results were similar to the other studies<sup>1,14</sup>.

It is speculated that the incompatibility of simplified-step adhesive (Single-Bond) with chemical-cured resin may be related to the acidity of these systems.

Finally, it can be concluded that:

1- The self-etching adhesive (PL-P) provided a bond strength to dentin as comparable to that of a total-etch system

(S.B.), when light-cured composite was used.

2- The ISO standard of 500 cycles probably did not affect the strength of the studied systems bond to dentin.

3- Using Single-Bond System with chemical-cured composite leads to significant decrease in bond strength, also no bond was created using prompt-L-pop with chemical-cured composite.

## References

1. Tay FR, Pashley DH, Suh BI, Hiraishi N, Yiu CK. Water treeing in simplified Dentin Adhesives- Déjà vu? *Oper. Dent.* 2005;30(5):561-79.
2. Nakaoki Y, Nikaido T, Tagami J. Effect of residual water on dentin bond strength and hybridization of a one bottle adhesive system. *Oper. Dent.* 2002;27:563-568
3. Bergeron C, Vargas MA, Van Meerbeek B. Bond strength of self-etching adhesives to enamel. *J Dent Res* 2000;79:442 [abstract 2386]
4. Sanares AME, Itthagarun A, King NM, Tay FR, Pashley DH. Adverse surface interactions between one-bottle light-cured adhesives and chemical-cured composites. *Dent Mater* 2001;17:542-556.
5. Brackett WW, Ito S, Tay FR, Haisch LD, Pashley DH. Microtensile Dentin Bond strength of self-Etching Resins: Effect of a HydroPhobic layer. *Oper Dent* 2005;30(6):733-738
6. King NM, TayFR, Pashly DH, Hashimoto M, To S, Brachett WW, et al . Conversion of one step to two step self adhesives for improved efficacy and extended application. *Am J Dent* 2005; 18:126-34
7. International organization for standardization. ISO TR 11405. Dental materials-guidance on testing of adhesion to tooth structure, 1994.
8. Lelop G, D Hoore W, Boutz D, Degrange M. Meta- analytical review of factors involved in dentin adherence. *J Dental Res* 2001;80:1605-14.
9. Nikaido T, Kunzelmann K-H, Chen H, Harada N, Yamaguchi S, Hickel R, Tagami J. Evaluation of thermal cycling and mechanical loading on bond strength of a self-etching primer system to dentin. *Dent Mater* 2002;18:269-275
10. Munck JD, van landuyt K, Coutinho E, Poitevin Ae, Peumans M, Lambrechts P, et al. Micro-tensile bond strength of adhesives bonded to class-I cavity-bottom dentin after thermo-cycling. *Dent Mater* 2005;21:999-1007
11. Phrakkonon S, Burrow MF, Tyas MJ. Effect of cross-sectional surface area on bond strengths between resin and dentin. *Dent Mater* 1998;14:120-128
12. Shimada Y, Kikushima D, Tagami J. Micro-shear bond strength of resin-bonding systems to cervical enamel. *Am J Dent* 2002;15(6):373-377
13. Peutzfeldt. A, Richter R. Shear bond strength of self and total-etching Adhesive. *J Dent Res* 2000; 79:374 [Abstract 1848]
14. Peumans M, Kanumilli P, Munk JD, Van landut K, Lambrechts P, Van Meerbeek B. Clinical effectiveness of contemporary adhesives: A systemic review of current clinical trials. *Dent Mater* 2005;21:864-881