Original Article

Effect of the Type of Restorative Material on Bonding Efficacy and Microleakage of a Self-Etching Adhesive System

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Abstract

Background: Prompt L-Pop is a self-etching dentin adhesive, which is recommended to use with both compomers and composite resins. The aims of this investigation were to determine and compare the microleakage, shear bond strength, and shear push out strength of composite and compomer to dentin with application of Prompt L-Pop as adhesive system.

Methods: After application of Prompt L-Pop on the occlusal dentinal surfaces of 24 intact molar teeth, the specimens were divided into two groups (n=12). Composite resin(Filtec Z250) and compomer (F2000) were used to dentinal surfaces of group 1 and 2 respectively, using a plastic mold. Twenty-four truncated cavities were prepared in 24 horizontal occlusal coronal dentinal wafer. After application of Prompt L-Pop, the specimens divided into two groups (n=12), and the cavities in group 1 and 2 were filled with composite and compomer respectively. After application of Prompt-L-Pop on the surfaces of 20 class V cavities, the cavities were randomly divided into two groups (n=10), and were restored with composite resin and compomer respectively. The bond strength values and microleakage scores of groups were evaluated.

Results: Compomer material revealed more but not statistically significant different means (SD) of shear bond strengths (Mpa) and shear push out strength (MPa). There were no significant differences in enamel and also dentinal microleakage scores, between two groups ($p>0.05$).

Conclusion: Improving bonding efficacy and microleakage result of compomer in this study, would be because Prompt L-Pop is a water based material and therefore chemically more compatible with hydrophilic restorative materials, such as compomers.

Keywords: Restorative material, Bond strength, Microleakage, self-etching adhesive system, Composite, Compomer.

Current dentin adhesives employ two different means to achieve the goal of micromechanical retention between resin and dentin[1]. The first method removes the smear layer completely and demineralizes the subsurface intact dentin via acid-etching with chelating agents or mineral acids. Flowing rinsing, a multiple- steps application of a primer and an adhesive, or a simplified self-priming adhesive is applied to the conditioned substrate to complete the bonding protocol. The second method uses smear layer as a bonding substrate, known as self-etching primer. They are applied to the smear layer-covered dentin for a designated period of time. Without further rinsing, a layer of adhesive resin is then applied to the treated dentin. In these systems, the goals are to incorporate the smear layer into the hybrid layer and also to simplify the procedure[2].

Several self-etching, self-priming adhesives have been introduced recently, in which unsaturated, potentially polymerizable organic acids or acidic monomers are incorporated as different fundamental components of each system2. The compomer version that is the first version of prompt L-Pop (ESPE, Seefeld, Germany) contains methacrylated phosphoric acid esters as the acidic components and is an all-in-one, self-etching, self-priming adhesive[3].

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This self etching adhesive is an aggressive system that has the ability to dissolve smear layer and smear plug completely and demineralize the subsurface dentin, and form an authentic hybrid layer with about 2.5-5 μm thickness[2].

Blunk and Roulet have shown by quantitative SEM analyses that class V compomer restorations exhibited significantly better marginal adaptation to enamel and dentin when self-etching primer-adhesives were used[4]. Data published by manufacturer of prompt L-Pop showed higher bond strength to enamel than to dentin. The enamel bond strength of some compomers was higher in combination with Prompt L-Pop than with the bonding agents of respective manufacturer. Recent production of prompt-L-Pop is recommended to use with both compomers and resin based composites[5].

Microleakage studies, together with the shear bond strength testing provide good screening methods to determine if adhesive systems will be clinically acceptable[6, 7, 8]. So the purposes of this investigation were to determine and compare the shear bond strength, shear push out strength, and microleakage of composite and compomer to dentin with application of Prompt L-Pop as an adhesive system.

Materials and Methods

The tested materials are shown in table 1. Sixty eight extracted sound molar teeth were selected. The teeth were cleaned from soft tissue remnants and stored in 0.2% Thymol solution for 24 hours, and then in distilled water at 37˚C until use.

Table 1. Materials investigated in this study .

Material	manufacturer	country	Bath Number
Filtek Z250 Composite resin	3M, Dental Product St. Paul, MN 55144-1000	U.S.A	1370
F2000 compomer	3M, Dental Product St. Paul, MN 55144-1000	U.S.A	2020
Prompt L-Pop Dentin adhesive	3M, ESPE Dental Product	Germany	111700

Shear bond strength test

The occlusal surfaces of 24 teeth were ground to eliminate enamel and expose dentin as a flat surface. All parts of each tooth except of flat dentinal surface were embedded in self curing acrylic resin (Acropars, Iran). The ground dentinal surface was polished with 600 grit silicone carbide under running water for 1 minute to produce a flat bonding surface with thin smear layer. The dentinal surface was gently air dried for 5 second. Prompt L-Pop was applied to dentin surface and scrubbed for 15 seconds, and then gently air-dried for 3 seconds, and finally light cured.

After adhesive application, the composite resin material was applied to dentinal surfaces of 12 teeth and the compomer material was applied to dentinal surfaces of other 12 samples, using a plastic mold 2.7 mm in diameter and 2.5 mm in height. The materials were cured for 60 seconds using a light curing unit (Coltlux 2.5, Coltene / whaldent, USA).

After 24 hours storage in distilled water at room temperature, and thermocycling (x500, 5̊C˚and 55̊C), the loads (kgf) that lead to failure were measured using an Universal testing machine(DARTAC England) with a crosshead speed of 5 mm/min, and the shear bond strengths (MPa) of samples were calculated. The teeth were examined visually and under stereo microscope (x56, Olympus SC 35, Olympus Co, Lake Success, NY 12422) at the debonding site to determine the mode of failure.

Shear push out strengths test

Twenty-four intact molar teeth were individualy embeded in cubic blocks of acrylic material. The teeth were then sectioned on a horizontal plane just below the dentinoenamel junction, so that no enamel remained, using a 0.3 mm-thick Buehler Diamond Wafering Blade (Buehler ltd, Lake Bluff, Il 60044). Then with the tooth in position on its side, the diamond blade was moved apically and another section cut so that a 3.0 mm-thick wafer of occlusally oriented dentin was produced. A truncated cavity was prepared in each wafer (3.4mm and 4mm in diameters and 3mm in hight). The specimens were randomly divided into two experimental groups. After application Prompt-L-Pop according to manufacture's direction (as discussed above), the cavities of group one and two were filled with composite and compomer respectively. The composite resin and compomer material were light polymerized for 30 seconds from each side of cavity (60 seconds totally).

After 24 hours storage in distilled water, the specimens were polished, and thermocycled. The shear push out test was used to determine the shear push out strength of specimens with a cylindrical crosshead of 3.3mm in diameter and a crosshead speed of 0.5 mm/min.

Microleakage evaluation

Twenty class V cavities (2×3×1.5mm) were prepared at the cementoenamel junction of buccal surfaces of twenty molar teeth, so that the upper margins were in enamel and the lower margins were in dentin. The preparations were cut with a No.170 tungsten carbide bur operated at high speed with water spray coolant. A new bur was used for every five preparations.

After application Prompt L-Pop, the teeth were randomly divided into two groups of 10 specimens in each. The cavities in group 1 and 2 were restored with composite and compomer respect- ively, according to manufacturer's directions.

After being stored in distilled water for 24 hours, the specimens were polished with Soflex disk. A new disk was used for every five speciemens. The specimens were immersed in a 0.5% fucshin solution for 24 hours. The teeth were sectioned vertically and buccolingualy and microleakage scores were evaluated under an stereo microscope at x30 magnification, on a scale of 0 to 4. The scoring method was: 0=no dye penetration, 1=dye reaching up to ½ depth of cavity, 2=dye penetrating to the depth of cavity, 3=dye penetrating toward the axial wall, 4= dye penetrating toward the pulp.

The data of shear bond strengths and shear push out bond strengths were analyzed with Student t-test at a significant level of $p<0.05$ Mann Whitney test was used to analyze the scores of microleakage at the enamel and dentinal margins at a significant level of $p<0.05$.

The morphologies of the dentin-materials Interfaces were evaluated using scanning electron microscope (SEM).

Results

The means ± SD of shear bond strengths (Mpa) and the shear push out bond strengths (Mpa) of two groups are shown in table 2. The composite resin group had 7 adhesive failures and 5 mixed failures. These values for compomer group were 3 and 8 respectively. Table 3 shows the microleakage scores of enamel and dentinal margins of two groups. Statistical analysis of data revealed that there is no significant difference in enamel microleakage between two groups ($p>0.05$). The dentinal microleakage between two groups also was not significant ($p>0.05$). Figures 1 and 2 are the SEM microphotographs of dentin-composite and dentin-compomer interfaces using Prompt L-Pop as adhesive system.

Table 2. The mean (SD) shear bond strengths (Mpa) and mean (SD) of shear push out bond strengths of the restorative materials tested.

Restorative material	Shear bond strength	Shear push out bond strength
Filtec Z250 (composite Resin)	17.2±3.4	16.7±3.4
F2000 (compomer)	18.1±2.8	18.2±3.5
P value	0.45	0.32

Table 3. Microleakage scores on enamel and dentinal margins of two groups.

	Enamel score	Dentin score
Specimen Number	1 2 3 4 5 6 7 8 9 10	1 2 3 4 5 6 7 8 9 10
Filtec Z250	0 0 0 0 0 0 1 0 0 0	0 0 0 2 0 0 0 0 1 0
F2000	0 0 0 0 0 0 0 0 0 0	0 1 0 1 0 0 0 0 1 0

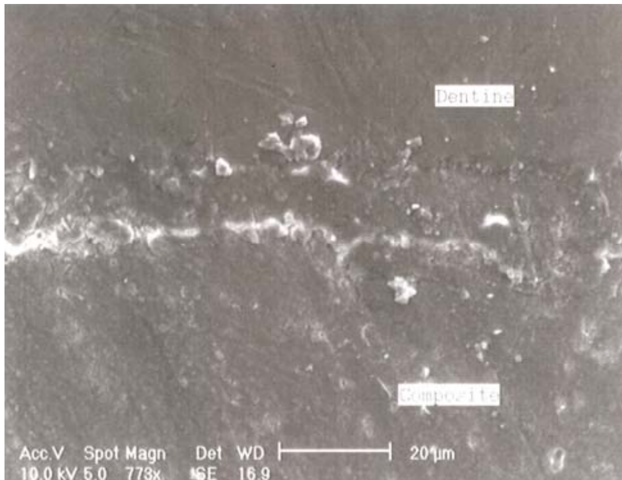

figure 1. SEM microphotograph of the dentin –Composite interface.

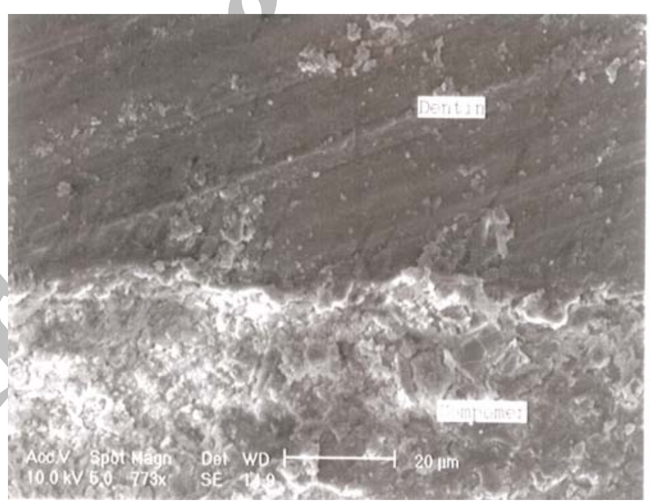

figure 2. SEM microphotograph of the dentin –Compomer interface.

Discussion

The magnitudes of bond strengths for compomer and composite resin materials that were obtained in this study would be considered adequate, according to literatures[9, 10].

Present investigation showed that the bonding efficacy and also microleakage results of compomer material (F2000) were better than composite resin (Z250), when Prompt L – Pop had been used as an adhesive material. These differences were not meaningful. Some comparative studies on microleakage and bonding efficacy of composite resins and compomers to teeth have been reported. Some investigators who used one bottle adhesives and non rinsing adhesives as adhesive systems, found that compomers and composite resins exhibited statistically similar bond strengths[11, 12, 13]. Also in some studies similar microleakage results have been reported between composite resins and compomers[14]. In some other studies, in contrast to present study, composite resins showed statistically significant higher bonding efficacy in comparison to compomers[15], [16], [17] and composite resins revealed less adhesive failure[17]. Also better microleakage results for composites have been reported[18].

An explanation for improving bonding efficacy and microleakage results of compomer in present study, would be the fact that Prompt L-Pop is a solution consistency of matacrylated phosphates and water in a unique application[19] and so is a water based material, and therefore chemically more compatible with restorative materials with enhanced hydrophilic properties, such as compomers, than with more hydrophobic resto- rative materials such as composites[20, 21].

In the present investigation that in which Promp L-Pop had been used as an adhesive system, compomer showed better bonding efficacy in comparison to other studies in which other adhesives had been used. Also better microleakage results have been obtained for promp L- Pop compared with other adhesive systems. With the respect that conditioning the dentin with phosphoric acid causes forming hybrid layer and increasing bond strength of compomer to dentin[22], a viable explanation would be the presence of phosphoric esters in Prompt L- Pop[19] and low pH of this adhesive that could completely dissolve smear layer and smear plug and form hybrid layers with a thickness approaching those of phosphoric acid conditioned dentin[2]. The other reasons might be the hydrophilic nature of Prompt L–Pop and it,s compatibility with compomer (F2000), as mentioned above, and also might be the fact that the commercial brands of compomer material and dentin adhesive which have been tested in this study, were recommended by the manufactures to use with each other.

There were no significant differences between microleakage scores and shear bond strengths of composite and compomer bonded with Prompt L-Pop adhesive system in this study. So, in situation in which Prompt L-Pop is used as an adhesive system, the decision between using composite versus compomer as the restorative material, might be on the base of other properties of these materials, such as their wear resistivity, fluoride releasing, hydrophilic nature, and esthetics quality.

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