Bond Strength of 4 Sealants Using Conventional Etch and a Self-etching Primer

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ABSTRACT

Purpose: The purpose of this study was to determine and compare the shear bond strength of 4 fissure sealant systems (Dyract Seal, Concise, Visio-Seal, Helioseal) to enamel using conventional etch and self-etching primer (Prompt-L-Pop).

Methods: Fifty-six newly extracted noncarious first permanent molars were used and embedded in a Teflon mold (3-mm height, 3-mm internal diameter). Mesial surfaces were exposed to a flattened area of enamel and then dried and washed. The teeth were divided into 8 groups, each consisting of 7 specimens stored in 37°C distilled water for 24 hours. Then specimens were tested in a shear mode (Instron) at a crosshead speed of 0.5 mm/minute. The mean and standard deviations were subjected to an analysis of variance.

Results: The average bond strengths using Prompt-L-Pop were: (1) Dyract Seal=20.61 MPa; (2) Concise=23.42 MPa; (3) Visio-Seal=2.94 MPa; and (4) Helioseal=11.83 MPa. These values were higher than and statistically different from those of Dyract Seal (10.18 MPa) and Concise (9.17 MPa) when the conventional etch system was used (student t test, P<.001).

Conclusion: The bond strengths of Prompt-L-Pop, in conjunction with Dyract Seal and Concise fissure sealant materials, exceeded those of conventional etch. (J Dent Child 2006;73:37-41)

KEYWORDS: SHEAR STRENGTH, FISSURE SEALANT, PROMPT-L-POP

A decrease has been observed in the incidence of caries in children and adolescents in pits and fissures in permanent teeth.[1,2] This phenomenon can be attributed to the fact that this age group population has benefited in recent years from preventive measures, including the use of fissure sealants.[3]

A number of fissure sealant materials have been introduced, and sealants have undergone several modifications to improve ease of application. Resin adhesion to the enamel surface is achieved by acid etching, which affords a mechanical microretention system for ensuring adequate adhesion. The efficacy of applied fissure sealants in prevention of caries depends on retention and resistance to wear.[4] Two important aspects of sealant technique are:

1. bond strength; and
2. the penetration of the sealant into the occlusal fissures previously etched to increase the bonding of the sealant resin to the tooth surface.

New materials have been developed involving use of adhesive agents at the resin-tooth interface with enhanced clinical properties of the sealer resins. These hydrophilic adhesives possess important humectant properties and afford increased penetration into the different structures.[5] The suggestion is that a bonding agent under the sealant as an intermediate layer can increase its bonding strength on moist or saliva-contaminated enamel.[6] Consequently, their use in combination with sealants offers interesting prospects.

The all-in-one adhesive system Prompt-L-Pop combines etching, priming, and adhesive in one solution. The theory behind this new adhesive was that Prompt-L-Pop, when applied on enamel, would dissolve the smear layer by rubbing it in for 15 seconds and, at the same time, etch the enamel surface to create the hydroxyapatite etching pattern.[7] By air-drying the enamel surface, a very thin film of

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Prompt-L-Pop is formed.[7] This enables micromechanical retention of a restorative material, in combination with a chemical bond between this thin Prompt-L-Pop layer and the restorative material.[7]

The purpose of this study was to compare the shear bond strength of 4 fissure sealants using Prompt-L-Pop and phosphoric acid etch.

MATERIALS

For this study, 56 caries-free human first permanent molars—extracted for either periodontal (8) involvement or orthodontic (48) reasons—were used. Proximal mesial or distal surfaces were used because these surfaces have relatively flat enamel, requiring minimum preparation. Materials used were:

1. Helioseal (Ivoclar Vivadent, Inc, Tonawanda, NY);
2. Concise White Sealant System (3M Dental Products, St. Paul, Minn);
3. Dyract Seal (Dentsply DeTrey GmbH, Konstanz, Germany);
4. Visio-Seal (3M ESPE, St. Paul, Minn);
5. 37% phosphoric acid in gel form; and
6. a new-self-etching adhesive Prompt-L-Pop (Meth-acrylated phosphoric esters, ESPE Seefeld, CITY??, Germany).

The 4 sealant materials were selected on the basis of their different compositions. For example, Concise is an unfilled, resin-based sealant, Helioseal is a fluoride releasing, resin-based sealant, and Dyract Seal is a compomer-based sealant that combines the advantages of both composites and glass ionomers. Visio-Seal fissure sealant system was selected because it is relatively new on the market and there is limited information regarding its bond strength.

The mesial or distal surfaces were cleaned with prophy paste (Zircate Prophy Paste, Dentsply International Inc, Milford, Del) then polished with silicon carbide paper to obtain a flat enamel surface. For each surface type, the specimens were randomly divided into 8 treatment groups of 7 specimens each. Teeth were assigned randomly to each group.

For groups 1 to 4, a 37% phosphoric acid etchant was applied to the enamel for 20 seconds, rinsed, and dried with air spray for 20 seconds. Each material was applied to the etched enamel and cured from the top of the sample for 40 seconds. Materials were assigned to each group as follows: (1) group 1–Helioseal; (2) group 2–Concise; (3) group 3–Dyract Seal; and (4) group 4–Visio-Seal.

For Groups 5 to 8, Prompt-L-Pop was activated, as described by the manufacturer, applied onto the tooth surface with a saturated microbrush, and rubbed in for 15 seconds. A thin air stream was applied for 10 seconds, followed by polymerization for 10 seconds. Each material was applied to the prepared enamel and cured as in groups 1 to 4. Materials were assigned to each group as follows: (1) group 5—Helioseal; (2) group 6–Concise; (3) group 7–Dyract Seal; and (4) group 8–Visio-Seal.

A plastic ring of Teflon material 3 mm tall and 3 mm in diameter was placed over each tooth perpendicular to the polished surfaces (Figures 1a and 1b). The enamel surface was divided into 3 parts, and the middle segment was used to standardize the bonding of the specimens. The remaining enamel surface was covered with adhesive tape to prevent overflowing of sealants under the Teflon ring. The test materials were placed in the mold to form a button and cured according to the manufacturer's instructions. Once the materials were light cured, the specimens were stored in 37°C distilled water for 24 hours to avoid dehydration.

The teeth were secured with sticky wax on an acrylic resin cylinder, which was mounted in a metal ring, with treated surfaces parallel to the shearing rod of the Instron testing machine at a crosshead speed of 0.5 mm/minute. The results were recorded in megapascals (MPa). The results were subjected to analysis of variance (ANOVA) followed by Student *t* test for any significant differences.

RESULTS

The mean (±SD) of the shear bond strength of the 4 materials etched with either conventional etch or Prompt-L-Pop in this study are presented in Table 1. Statistical analysis of the

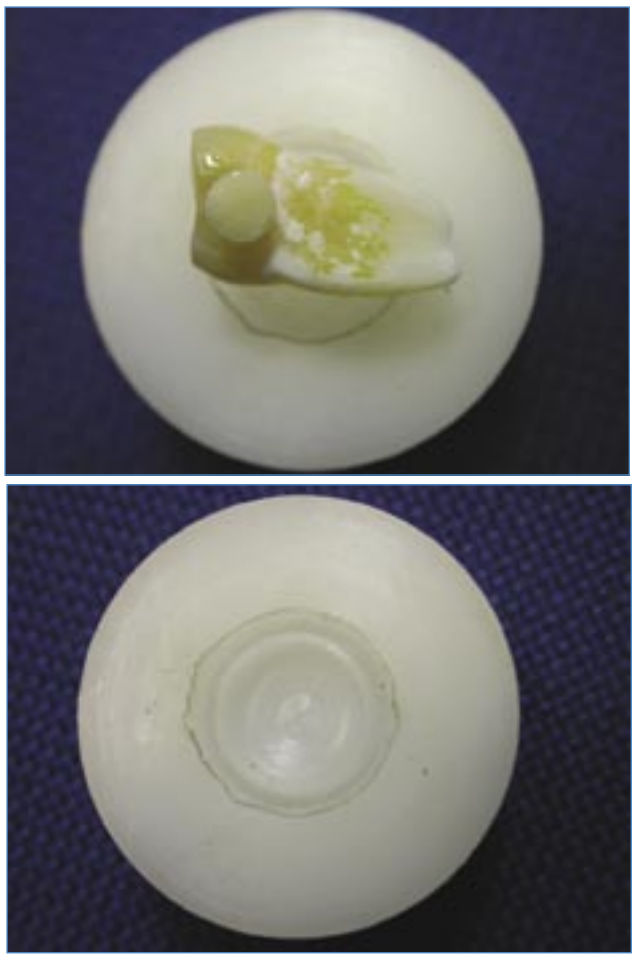
Table 1. Shear Bond Strength (MPa) for 4 Fissure Sealants Etched With Phosphoric Acid or Prompt-L-Pop

	Helioseal		Concise		Dyract Seal		Visio-Seal	
	PA*	Prompt-L-Pop	PA	Prompt-L-Pop	PA	Prompt-L-Pop	PA	Prompt-L-Pop
Mean±SD	10.70±1.07	11.83±3.10	9.17±1.97	23.42±3.10	10.18±3.25	20.61±2.88	2.80±1.19	2.94±0.50

***PA=phosphoric acid.**

Table 2. Analysis of Variance (ANOVA)

Variability source	df	Sum of square	Mean square	F	P value
Fissure sealants	3	1575.581	525.194	89.298	.001
Etching system	1	592.911	592.911	100.812	.001
Interaction between etching and fissure sealants	3	501.951	167.317	28.449	.001
Error	48	282.306	5.881		
Total	55	10331.245			



Figures 1a and 1b. Teflon mold embedded with extracted tooth.

data was accomplished by using 2-way ANOVA, accepting an alpha level of 0.001 for significance (Table 2).

Mean values for strengths of adhesion, depending on the type of etching materials, are listed in Table 1. The highest values for adhesion were observed using either Dyract (20.61 MPa) or Concise (23.42 MPa) when bonded by Prompt-L-Pop. The lowest mean bond values, however, were seen for the Visio-Seal group, whether Prompt-L-Pop (2.94) or phosphoric acid conventional etch (2.80) was used. This was also true for Helioseal.

The statistical analysis revealed that both Dyract and Concise sealant materials showed significant bond strength ($P<.001$) when bonded with Prompt-L-Pop, where the bonding system significantly affected bond strength ($P<.001$).

Statistical analysis showed that there were interactions between fissure sealant materials and etching system at the 0.001 level (Table 2).

For the Dyract Seal, Helioseal, and Concise groups, failure occurred at the sealant-adhesive as well as sealant-enamel interface. For Visio-Seal, however, the failure was at the sealant-enamel interface.

DISCUSSION

Bonding to the enamel's intact natural surface is fundamental to achieve marginal sealing and retention of pit and fissure sealants.[8] The author's hypothesis was that applying Prompt-L-Pop would increase the bond strength of sealant to enamel. In this study, 4 different sealant materials with different compositions were used. The behavior of Prompt-L-Pop on enamel and dentin has been a controversial subject.

Some studies have shown that self-etching systems perform well on enamel and dentin in vitro, whereas others reported insufficient bonding results.[9,10] Prompt-L-Pop has been indicated for bonding composite, compomer, and modified glass ionomer restorations.[11-14] Also, self-etching Prompt-L-Pop was found to mediate shear bond strengths to unground human enamel of the same magnitude as did phosphoric acid etching when used with fissure sealant.[15] Thus, the null hypothesis was accepted.

The results showed an interesting finding—that significantly higher bond strength was achieved for Dyract Seal and Concise to enamel bonded by Prompt-L-Pop, compared to the conventional acid etch technique. When there was no contamination, as in ideal conditions, using the bonding agent under the sealant yielded a significantly stronger bond. The results of Dyract Seal and Concise were in agreement with Friedi et al[16] as well as Issa and Watts,[17] who reported that the use of Prompt-L-Pop under composite as a bonding agent to enamel significantly increased bond strength (35 MPa), compared to those prepared with phosphoric acid (13 MPa).

Furthermore, the data support the clinical finding of Feigal and Quelhas, who found equivalent 2-year retention rates of sealants in permanent molars following application of Prompt-L-Pop as an etching system.[18] This could be explained by the low pH (1) of Prompt-L-Pop that interacts more profoundly with enamel and dentin and creates strong micromechanical interlocking.[18] Also, by applying a stream of air, a very thin film of Prompt-L-Pop is formed on top of the enamel. This enables the micromechanical retention of a fissure sealant in combination with a chemical bond between this thin Prompt-L-Pop layer and the fissure sealant.[19] Dyract Seal is a light curing, self-adhesive compomer with a curing mechanism that is the same for light curing composite and compomers.[20] In vitro, composite materials bonded to enamel with Prompt-L-Pop showed acceptable micromorphology and microtensile bond strength.[21] Concise sealant material is an unfilled sealant with significant retention due to its viscosity.[22]

The present results contradict those of Pashley and Tay, who found that bond strengths of Z100 resin composite to enamel promoted by 3 self-etching adhesives were significantly lower than the bond strength promoted by total-etch adhesive systems.[23] This could be due to less demineralization of enamel by the priming agent, compared to total-etch systems. The more shallow pattern of demineralization associated with Prompt-L-Pop primers could be due to difficulty in penetration of the primer into the enamel or due to some mineral precipitation on the enamel, which could modify the depth of mineralization.[24]

The bond values of Dyract Seal with Prompt-L-Pop were significantly higher than when used with a conventional acid-etch technique. It is interesting to note also that, when Dyract Seal is used with Prompt-L-Pop, shear bond strength values are similar to those of Concise bonded with the same etching technique.

With respect to Helioseal and Viso-Seal results, there were no differences in bond strength obtained with Prompt-L-Pop or phosphoric acid. Fritz et al reported equal bond strength to enamel for Clearfil SE Bond and conventional total-etch system.[25] These previous studies agreed with the present study's results. In another study, Peutzfeldt and Nielsen reported no significant difference in bond strength between phosphoric acid and Prompt-L-Pop groups.[26]

Thus, the results obtained so far are contradictory regarding the efficacy of Prompt-L-Pop on enamel with fissure sealants. The reasons for the differences could be due to incompatibility of Prompt-L-Pop to different sealants types. Also, the shear bond testing with Prompt-L-Pop could be attributed to the polymerization network rather than to the extent of the etching alone.[27] It had been reported that the shear bond strength of 6 different resin composites etched by Prompt-L-Pop ranged between 1 to 13MPa.[28] Thus, the difference in results could be due to different mechanical properties of the resin sealants used in this study.

CONCLUSIONS

Based on this study's results, the following conclusions can be made:

1. The bond strengths of Dyract Seal and Concise fissure sealant materials, following treatment with Prompt-L-Pop, exceeded those of conventional etch.
2. The bond strength of Helioseal was similar for Prompt-L-Pop and conventional etch techniques, but was significantly less than for Dyract Seal and Concise combined with Prompt-L-Pop.
3. Visio-Seal had significantly lower bond strength than all 3 other materials, regardless of the etchant system used.

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