



# Microleakage of Compoglass<sup>®</sup>-F and Dyract<sup>®</sup>-AP compomers in class V preparations after salivary contamination

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## Abstract

**Purpose:** The purpose of this study was to investigate the effect of salivary contamination on the microleakage within Class V preparations of teeth restored with either Compoglass<sup>®</sup>-F/Syntac<sup>®</sup> SC and Dyract<sup>®</sup>-AP/Prime and Bond<sup>®</sup> 2.1.

**Methods:** Class V cavity preparations with occlusal margins in enamel and gingival margins in cementum were prepared on the buccal and lingual surfaces of extracted human permanent molar teeth. Preparations were distributed randomly into 4 treatment groups (N=16) consisting of the two compomers and their respective bonding agents with and without salivary contamination. After treatment, the samples were stored in tap water for 24 hours, thermocycled, stained with dye, sectioned, and scored for microleakage.

**Results:** Salivary contamination had no significant effect on enamel microleakage but significantly increased both linear and penetrating microleakage versus non-contaminated for both compomer/dentin bonding systems.

**Conclusion:** These data indicate salivary contamination adversely affects gingival but not enamel microleakage when Class V restorations are restored with either Compoglass<sup>®</sup> F/Syntac<sup>®</sup> SC or Dyract<sup>®</sup>-AP/Prime and Bond<sup>®</sup> 2.1. (*Pediatr Dent* 21:39-42, 2000)

After many decades of scientific and nonscientific controversy, use of silver amalgam for primary teeth is waning.<sup>1</sup> Alternatives to amalgam and resin composite are becoming increasingly popular. Compomers are a new generation of restorative material developed with the intent of trying to blend the favorable characteristics of glass ionomers—fluoride release, chemical bond to dentin—with the advantages of composite resins to increase toughness, wear resistance, esthetics, polishability, and decrease brittle behavior—all of which are problems with glass-ionomer cements.<sup>2</sup>

From the clinical standpoint, contamination by saliva has always been a problem and can be especially difficult to control in the pediatric patient. Copious amounts of saliva, behavior management issues, very young patients, and rampant caries extending into cervical areas make isolation for placement of suitable restorations difficult. Whether or not the dentist discovers that contamination has taken place can adversely impact the longevity of the restoration and determine its clinical success. Product instruction and accepted clinical technique based on research data clearly state that saliva contamination of newly

etched enamel and dentin require that the surface be re-etched.<sup>3</sup> Dry enamel has traditionally been thought as necessary for good adhesion since it had been shown that an acid-conditioned enamel surface readily absorbs salivary constituents, reducing surface energy and rendering the surface less favorable for bonding.<sup>4,5</sup> These changes had been shown to occur with an exposure period as short as one second and even if an air-water wash was used after the exposure.<sup>3,6</sup> Some studies reported that saliva-contaminated and unwashed enamel provided significantly lower bond strengths of resin composite to enamel.<sup>7,8</sup> However, with the advent of more hydrophilic resins contained in contemporary dentin bond systems, this notion of the sensitivity of saliva contaminated tooth structure to adhesive techniques has been brought into question. Investigations have reported that the use of dentin bonding agents under fissure sealants reduced their sensitivity to saliva contamination and provided bond strengths equivalent to the ones obtained when the sealant was bonded directly to clean etched enamel.<sup>9-12</sup> In one of two recent studies on saliva-contaminated dentin using a limited number of samples, the bond strength of Prime and Bond<sup>®</sup> and Dyract<sup>®</sup> compomer was relatively insensitive to contamination.<sup>13</sup> The other study tested Prime and Bond<sup>®</sup> 2.0 using air drying of dentin and concluded that contamination had no significant effect except when saliva was dried.<sup>14</sup> El-Kalla et al. found that saliva contamination did not affect the shear bond strength to enamel and dentin of Prime and Bond<sup>®</sup> 2.1, One Step,<sup>®</sup> and Tenure<sup>®</sup> Quik.<sup>3</sup>

Bond strength values quoted by manufacturers may not accurately predict the clinical performance of a restorative material.<sup>15</sup> Microleakage performance may be more useful for comparative assessment of materials, because microleakage can result in pulpal irritation, tooth discoloration, secondary caries, and, eventually, loss of the restoration and clinical failure.<sup>16</sup> Microleakage may occur even if the restorative material is still retained by the enamel and dentin.<sup>15</sup>

The purpose of this study was to investigate the effect of salivary contamination on microleakage when Class V preparations were restored using the compomers Compoglass<sup>®</sup>-F and Dyract<sup>®</sup>-AP and their respective dentin bonding systems.

## Materials

Recently extracted human permanent molar teeth stored in deionized water with 0.2% sodium azide were used in this study. Residual tissue tags were scraped and the teeth thor-

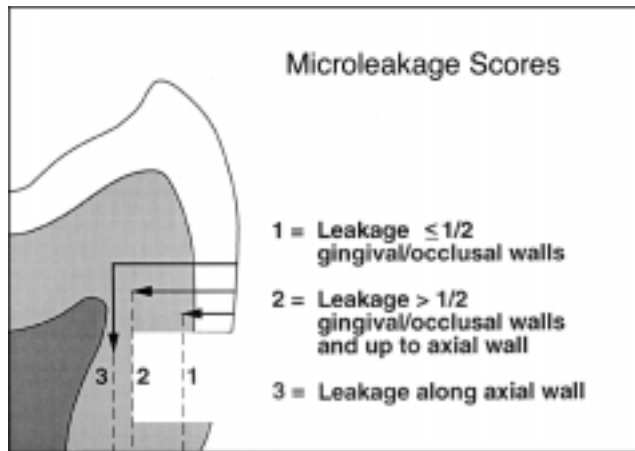


Fig 1. Diagram of microleakage scoring.  
0 = No microleakage

oroughly rinsed under running tap water for 15 minutes to remove the sodium azide solution. Class V cavity preparations were placed on the buccal/lingual or mesial/distal surfaces of each tooth, using a high speed handpiece with air and water spray and a #330 bur. The preparations were 1.5 mm deep, oblong in shape, measuring 2X6 mm, parallel to the cemento-enamel junction (CEJ), and the gingival half of the preparations extended 0.5 mm below the CEJ. Cavosurface walls were finished to a butt joint with a #55 slow-speed bur. The enamel margin was beveled at a 45° angle using a flame shaped finishing bur and the dentin margins were left at a 90° angle or butt joint. Preparations were given a number and the choice of restorative material and treatment order was assigned randomly via a scheme derived from a random number generation program. Fresh unstimulated human saliva was collected from a group of 10 healthy ASA I volunteers who had not eaten or consumed any liquids for 30 minutes and pooled for immediate use. The four test groups were (N=16/group with a study total of N=64):

**Group 1-Dyract®-AP/Prime & Bond® 2.1 (Caulk, Milford, DE) /non-contaminated**

The entire preparation was etched with 37% phosphoric acid for 20 seconds, rinsed with water and gently air-dried to leave the cavity surface “wet” according to the “total-etch wet-bond-

ing” technique.<sup>17</sup> The preparation was saturated with Prime and Bond 2.1 using a disposable brush tip for 20 seconds and the excess solvent was removed with a gentle stream of air and light cured with a visible light unit (Spectrum 800, Caulk, Milford, DE), producing 800 mW/cm<sup>2</sup> of light output, for 10 seconds. A second application of primer-adhesive was done, gently dried, and cured for 10 seconds. The preparation was then filled with Dyract®-AP compomer and cured for 60 seconds and finished using Soflex® discs (3M, St Paul, MN).

**Group 2-Dyract®-AP/Prime& Bond® 2.1/salivary contamination**

Steps were similar to Group 1 except that the etched surface was contaminated with fresh, unstimulated human saliva, left undisturbed for 20 seconds, excess pooled saliva was gently removed to leave a visibly moist surface, the adhesive applied, and the compomer placed and finished.

**Group 3-Compoglass®-F/Syntac® SC (Ivoclar North America, Amherst, NY) /non-contaminated**

The entire preparation was etched with 37% phosphoric acid for 20 seconds, rinsed with water for 20 seconds, and gently air dried to leave a slightly moist surface. Syntac® SC was applied to the etched surface with a brush, scrubbed for 10 seconds, left undisturbed for 20 seconds, then air-dried and light-cured for 20 seconds. A second coat was applied, air-dried, and light-cured for 20 seconds. The preparation was filled with Compoglass®-F compomer, light-cured for 60 seconds, and finished with Soflex® discs (3M, St. Paul, MN).

**Group 4-Compoglass®-F/Syntac® SC/salivary contamination**

The steps were similar to Group 3, except that the etched surface was contaminated with fresh, unstimulated human saliva, which was left undisturbed for 20 seconds, and the excess saliva was gently removed to leave a moist surface and the adhesive applied. The remaining steps were as described for Group 3.

Table 1 lists the composition of the tested compomers and dentin adhesives. After restoration, the samples were stored for 24 hours in distilled water then thermocycled for 1,000 cycles between 5-55°C with a dwell time of 30 seconds. The root apices were sealed with Vitrebond® (3M, St. Paul, MN) glass ionomer cement and the entire tooth surface was painted with

Table 1. Compomers and Enamel-Dentin Bonding Systems Used

Components	Composition	Manufacturer
Dyract®-AP compomer	strontium fluorosilicate glass, UDMA, PENTA, TGDMA,	Caulk, Milford, DE
Prime and Bond® 2.1	Dimethacrylate resins, PENTA, Cetylamine, hydrofluoride, acetone	Caulk, Milford, DE
Compoglass®-F compomer	barium fluorosilicate glass, UDMA, TEGDA, CADCADM, ytterbium trifluoride	Ivoclar/Vivadent Amherst, NY
Syntac® Single Component	Dimethacrylate, modified polyacrylic acid, maleic acid, fluoride compound, water	Ivoclar/Vivadent Amherst, NY

UDMA=urethane dimethacrylate CADCADM=cycloaliphatic dicarboxylic acid dimethacrylate  
PENTA=dipentaerythritol penta acrylate monophosphate TEGDA=tetraethyleneglycol dimethacrylate  
TGDMA=triethylene glycol dimethacrylate

**Table 2. Enamel/Occlusal Microleakage-Tabular Distribution of Microleakage Scores**

Group (N=16)	Microleakage Score <sup>†</sup>				Median	% Penetrating**
	0	1	2	3		
Compoglass®-F/ Syntac® SC	16	0	0	0	0	0
Compoglass®-F/ Syntac® SC*	11	5	0	0	0	0
Dyract®-AP/ P&B® 2.1	16	0	0	0	0	0
Dyract®-AP/ P&B® 2.1*	16	0	0	0	0	0

\*Contaminated with saliva.

\*\* % Penetrating-Percentage of Penetrating Microleakage=# of samples that had penetrating(radiating into tubules) microleakage. Total # of samples that had both linear + penetrating microleakage.

†No significant difference (P<0.05) in enamel microleakage between any of the test groups.

two coats of acid resistant varnish (nail polish) to within 1 mm of the restoration margins. The teeth were immersed in 0.5% basic fuchsin dye for 24 hours. After removal from the dye, the teeth were embedded in orthodontic acrylic, cut serially into two sections using an Isomet Slow Speed Saw (Buehler Corp, Waukegan, IL) with both buccal and lingual restorations included in each cut. Each section was viewed under an Olympus SC 35 stereo microscope at 20x and scored for microleakage by an independent examiner who was blinded as to the identity of the samples. Linear microleakage scores were based on the degree of dye penetration using the following grading system (Fig 1):

0=No dye penetration;

1=Dye penetration up to, but not beyond 1/2 to occlusal or gingival wall;

2=Dye penetration up to, but not contacting, the axial wall, and;

3=Dye penetration along the axial wall.

Both sections of each restoration were read for enamel and gingival margin microleakage and the section for each margin which had the greatest amount of microleakage was recorded as the score for that restoration. Additionally, the presence of penetrating microleakage was recorded. Penetrating microleakage was defined as dye penetration which was radiating along the dentin tubules toward the pulp. Non-penetrating microleakage was dye penetration which was confined to the area along the compomer/dentin interface. Again, as with linear microleakage scoring, both sections of each restoration were to be read and if one of the sections had penetrating microleakage, that was what was recorded for that restoration.

The microleakage scores for the groups were analyzed using appropriate non-parametric tests for ordinal and nominal data. Linear microleakage data (ordinal) was subjected to Kruskal Wallis non-parametric ANOVA and then Dunn multiple comparison test at a significance level of P<0.05. Occlusal versus gingival linear microleakage was tested using Mann Whitney Rank Sum test at a significance level of P<0.05. Penetrating microleakage data(nominal) was subjected to Chi-Square analysis at a significance level of P<0.05.

## Results

Tables 2-3 are summary tables of the microleakage data for the four groups. All groups showed significantly greater gingival microleakage when compared to the occlusal. There was no significant difference between the four groups with respect to enamel/occlusal microleakage (Table 2). Enamel exhibited virtually no microleakage for either material whether or not salivary contamination had occurred.

Comparing the dentin/gingival microleakage (Table 3), there was a significant increase in both linear and penetrating microleakage for both Compoglass®-F/Syntac® SC and Dyract®-AP/Prime & Bond® 2.1 when the preparations were exposed to salivary contamination (Table 3). Dyract®-AP/Prime & Bond® 2.1 had significantly greater linear microleakage than Compoglass®-F/Syntac® SC in both the non-contaminated and salivary contaminated samples.

## Discussion

The results of this study indicate that when Class V preparations are restored with the tested compomers and their dentin bonding systems, salivary contamination does not adversely

**Table 3. Dentin/Gingival Microleakage-Tabular Distribution of Dye Penetration Scores**

Group (N=16)	Microleakage Score				Median	% Penetrating**
	0	1	2	3		
Compoglass®-F/ Syntac® SC †‡	6	9	1	0	1	0
Compoglass®-F/ Syntac® SC* †‡	0	4	10	2	2	81
Dyract®-AP/ P&B® 2.1 †‡	2	3	7	4	2	56
Dyract®-AP/ P&B® 2.1* †‡	0	0	6	10	3	100

\* Contaminated with saliva. \*\* % Penetrating-Percentage of Penetrating Microleakage=# of samples that had penetrating(radiating into tubules) microleakage. Total # of samples that had both linear + penetrating microleakage. Brackets indicate groups that are significantly different (P<0.05) in Penetrating Microleakage

†Significant difference (P<0.05) between groups. ††Significant difference (P<0.05) between groups.

‡Significant difference (P<0.05) between groups. ‡‡Significant difference (P<0.05) between groups.

affect enamel microleakage. This confirms the results of Hitt and Feigal,<sup>12</sup> Fritz et al.,<sup>18</sup> and El-Kalla and Garcia-Godoy.<sup>3</sup> It is hypothesized that salivary contamination affects enamel bonding only if the enamel is dried after contamination has occurred but before the bonding agent is applied. The dried film of salivary protein inhibits penetration of the bonding agent into the hydroxyapatite. This study left the salivary contaminated preparations moist prior to the application of the bonding agent. Presumably, the water present in the saliva facilitated the infiltration of the hydrophilic bonding agents into the enamel.

All of the groups showed significantly more microleakage radiating from the gingival margin even under ideal laboratory conditions. In both materials, salivary contamination significantly increased linear and penetrating microleakage. The protein-absorbing properties of dentin have been previously reported.<sup>19</sup> Compoglass<sup>®</sup> F/Syntac<sup>®</sup> SC performed significantly better in this study than Dyract<sup>®</sup>-AP/Prime & Bond<sup>®</sup> 2.1 with respect to gingival microleakage, whether saliva was present or not. The difference in performance may be explained by the chemical composition of the bonding agents. Syntac<sup>®</sup> SC is primarily water-based, whereas Prime & Bond<sup>®</sup> 2.1 is acetone-based. This difference may allow Syntac<sup>®</sup> SC to be less affected by the presence of salivary proteins than an acetone based Prime and Bond<sup>®</sup> 2.1.

Penetrating microleakage is potentially the most damaging to the pulpal tissue, since with the linear type the dentin still has a sealed layer preventing pulpal migration of the microleakage. Both compomer/dentin bonding systems performed poorly on gingival margins when salivary contamination was present. The significant increase in penetrating microleakage in the presence of saliva can possibly be explained by the reaction of dentin and saliva. The salivary proteins adsorb to the collagen meshwork and could prevent penetration of the bonding agent. Even though the dentin was not dried, these proteins may clog the collagen network and block effective penetration of the dentin bond agent and prevent effective hybridization of this area.

## Conclusions

In this in- vitro study using Compoglass<sup>®</sup>-F/Syntac<sup>®</sup> SC and Dyract<sup>®</sup>-AP/Prime & Bond<sup>®</sup> 2.1, the following conclusions may be drawn:

1. Salivary contamination of enamel did not significantly affect microleakage. Therefore, no alteration in technique is necessary, provided the preparation is not air-dried and left visibly moist.
2. Salivary contamination of dentin significantly increased microleakage. If salivary contamination is inevitable and uncontrollable, using a water-based rather than an acetone-based dentin bonding agent may reduce the amount of linear microleakage.

Whether this data reflects in vivo results is not known at this time and awaits clinical data either refuting or confirming these results.

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