

## Effect of Cavosurface Margin Configuration of Class V Cavity Preparations on Microleakage of Composite Resin Restorations

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### Abstract

**Aim:** The aim of this study was to compare the marginal leakage of hybrid and microfilled composite resin in Class V restorations with and without an enamel bevel.

**Methods and Materials:** Fifty-six cavities were prepared on the buccal and lingual surfaces of 28 extracted human molars using a round bur with the dimensions of 3×2×1.5 mm. The specimens were divided into two groups of 28 based on the cavosurface margin configuration (beveled and non-beveled). Each group was then divided into two subgroups (n=14) based on the type of composite resin (microfilled and hybrid) used for restoration. After completing restorative procedure, specimens were thermocycled and immersed in 0.5% basic fuchsin. Samples were embedded in polyester and then sectioned both mesiodistally and buccolingually. Dye penetration was observed with a stereomicroscope at 25x magnification. Statistical nonparametric analysis Kruskal-Wallis and Mann-Whitney tests were performed to compare the data ( $\alpha=0.05$ ).

**Results:** There was no statistically significant difference between the two types of composites and two types of enamel margins with respect to microleakage ( $P>5\%$ ). The degree of microleakage at the gingival margin located in dentin of each group was more than that of the enamel margin ( $P<5\%$ ).

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**Conclusion:** An enamel bevel in a Class V cavity preparation had no effect on the reduction of marginal leakage using either hybrid or microfilled composite resin.

**Keywords:** Class V cavity preparation, bevel, microleakage, composite resin

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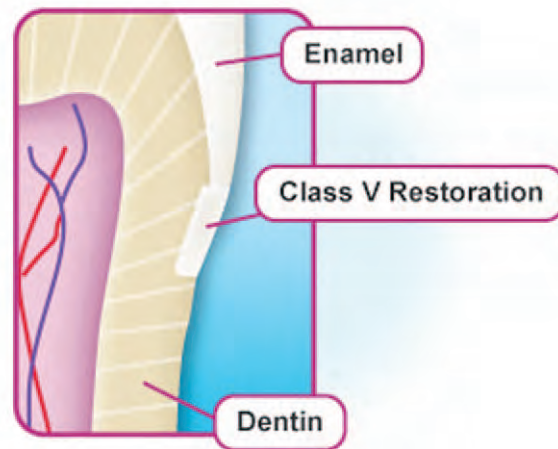
## Introduction

Resin-based restorative materials have been a common choice of dental practitioners for restoring cervical lesions due to their esthetic quality and ability to be bonded to the tooth structure. However, cervical lesions have been a restorative challenge for dentists for many years. The complex morphology of Class V cavities with margins partly in enamel and partly in dentin presents a challenging scenario for the restorative material.<sup>1</sup> The primary problem associated with the restoration of this kind of cavity is leakage at the gingival margin located in dentin.<sup>2,3</sup> Several restorative techniques have been proposed to minimize the polymerization shrinkage consequences and achieve a better marginal adaptation in Class V cavities.<sup>4,5</sup> Because the bond strength to enamel is usually greater than to the dentin, it has been suggested Class V cavities could be restored in multiple layers.<sup>6</sup>

Since the clinical success of procedures relies on approaches for polymerization shrinkage control and establishment of a predictable adhesion, a number of different materials have been advocated as a means to reduce the possibility of microleakage.<sup>7</sup>

The primary rationale behind the use of flowable composites is the formation of an elastic layer that may compensate for polymerization shrinkage stresses.<sup>8</sup> Some studies demonstrated no statistically significant difference between flowable and hybrid composites with respect to microleakage at cervical and occlusal margins.<sup>9</sup> Two recent studies used only hybrid resin composite for the restoration of Class V cavities.<sup>5,10</sup>

The cavosurface margin bevel plays an important role in the reduction of marginal leakage, improved esthetics, and increased adhesion. However, when beveling is needed in a small



sized Class V conventional cavity preparation, it changes the configuration of the cavity in a way that causes reduced retention.<sup>11</sup>

The issue of beveling the cavosurface margin of Class V preparations has been under discussion since the introduction of dentin bonding agents designed to increase the adhesion of composite to dentin. Sunder et al.<sup>12</sup> compared marginal leakage in beveled and non-beveled cavosurface margins of Class V cavity preparations using different second generation dentin bonding agents.

Owens et al.<sup>13</sup> evaluated the microleakage of tooth colored restorative systems in the gingival margins of cavity preparations with and without a bevel. They concluded Class V restorations with a gingival bevel demonstrated greater microleakage.

A clinical trial<sup>14</sup> compared the clinical success of non-carious Class V cavity preparations on the buccal surface of canines and premolars with and without an enamel bevel and restored with a microfilled resin-based composite. The results showed no significant difference in

retention rate between the two groups after two and three years. Moreover, post-operative sensitivity, marginal discoloration, and secondary caries were not affected by enamel beveling and restorative material.

A recent study done by Satini et al.<sup>15</sup> evaluated the marginal leakage of box shaped Class V cavities with and without a marginal bevel and found no significant difference between the groups studied.

The aim of this study was to compare the marginal leakage of hybrid and microfilled composite resin in Class V restorations with and without an enamel bevel.

### Methods and Materials

Twenty-eight caries-free, freshly extracted human molars were selected for this study and stored in physiologic solution for less than three months. A standardized Class V cavity, 3.0 mm wide (mesial-distal), 2.0 mm high (occlusal-gingival), and 1.5 mm deep, was prepared on the buccal and lingual surfaces of each tooth with the occlusal margin located 1.0 mm on enamel and the gingival margin located 1.0 mm on dentin/cementum. This resulted in the creation of a total of 56 Class V cavities (28 buccal and 28 lingual) on the 28 teeth. The preparations were made using #12 diamond round burs (Drendel Zweiling, Diamont GmbH Georzalee, Germany) in a water-cooled, high-speed handpiece. Each bur was used for four preparations and then replaced. The teeth were randomly assigned to two groups of 28 preparations based on the configuration of the enamel cavosurface margin as follows:

- **Group C:** Conventional cavity with no bevel on the enamel.

- **Group B:** Beveled enamel cavosurface margin on a conventional cavity preparation. Cavities in this group were cut with a 0.5 mm bevel in the enamel margin using a flame shaped diamond bur (#3118, KG Sorensen, Sp, Brazil).

Half of all cavity preparations were beveled and half were not beveled. Then each group of 28 cavities was divided into two subgroups (n=14) according to the type of composite resin used for restoration of the preparations. Tetric Flow™, a flowable composite (Ivoclar Vivadent-AG, Schaan, Lichtenstein), and Evo-Ceram™, a hybrid composite (Ivoclar Vivadent –AG Schaan, Lichtenstein), were used to restore the preparations as shown in Table 1.

The total etch technique was performed prior to the establishment of the adhesive layer in all groups. A 35% phosphoric acid (Scotchbond Enchant Gel, 3M-ESPE, St. Paul, MN, USA) was applied initially to the enamel margins and then extended from the superficial to deep dentin for 15 seconds. After application of the acid gel, the substrate was rinsed with an air/water spray for 30 seconds, and the excess moisture was removed with a cotton pellet applied to the dentin while the enamel was gently air dried. A total etch, one-bottle adhesive system (Excite™, Ivoclar Vivadent-AG, Schaan, Lichtenstein) was applied according to the manufacturer's instructions on both the enamel and dentin and thinned after 20 seconds with a light blast of air. The adhesive was then light cured using an Optilux 500 curing unit (Demetron-Kerr, Orange, CA, USA) at 500 mW/cm<sup>2</sup> for 20 seconds.

**Table 1. Description of the specimens and the type of composite resin used.**

Group	Subgroup (n=14)	Preparation Type	Composite
<b>C</b>	Subgroup CF	Conventional, no bevel.	Tetric Flow™, a flowable composite. (Ivoclar Vivadent-AG, Schaan, Lichtenstein)
	Subgroup CH	Conventional, no bevel.	Evo-Ceram™ a hybrid composite. (Ivoclar Vivadent –AG, Schaan, Lichtenstein)
<b>B</b>	Subgroup BF	Conventional, with bevel.	00
	Subgroup BF	Conventional, with bevel.	00

Tetric Flow™ was used in two oblique increments for the restoration of subgroups CF and BF. For the first increment, a small amount of composite material was injected from the gingival wall to the middle of the occlusal wall but not including the enamel margin. The second increment filled the remaining cavity. Each increment was light cured for 40 seconds.

Two subgroups CH and BH were restored with the Evo-Ceram™ hybrid composite resin in two increments as described above.

The group of 28 buccal and lingual cavities were filled with flowable composite in which 14 cavities (7 buccal and 7 lingual) included an enamel margin bevel and 14 cavities (7 buccal and 7 lingual) did not, so that enamel bevels were prepared on both the buccal and lingual cavities. Hybrid composite resin also was used with the same procedure.

After immediate finishing and polishing with sequential discs (Sof-Lex Pop-On™, 3M-ESPE, St. Paul, MN, USA), the teeth were stored in 37°C and 100% humidity for 24 hours. The specimens were then thermocycled for 2000 cycles with baths held between (5°C·2°C) and (55°C·2°C), a dwell time of 30 seconds, and a transfer time of three seconds. All external surfaces of each specimen were isolated with a layer of sticky wax and two layers of nail polish except for an area within 1.0 mm around the restoration. The teeth were then immersed in a 0.5% basic fuchsin solution for 24 hours at room temperature.

The root apices were cut 2 mm beyond the cementoenamel junction (CEJ), and then the specimens were immersed in clear epoxy resin (Aroclite-Ciba-Geigy, Basel, Switzerland). After 24 hours, each tooth was sectioned mesiodistally in the long axis of the tooth with a low speed diamond saw (Isomat, Buchler Ltd, Lake Buff, IL, USA) under a water coolant resulting in two sections (buccal and lingual) for each tooth. Each section was then sectioned longitudinally in a bucco-lingual direction through the center of each restoration. The cut surfaces were examined at the occlusal and gingival margins using a stereo microscope (M9 Wild, Heerbrugg, Switzerland) at 25x magnification. The most extensive degree of

dye penetration at the composite/tooth interface was evaluated for both the occlusal and gingival margins using the following scoring system:

Dye Penetration Scoring System	
0 =	No dye penetration
1 =	Dye penetration less than half the length of the gingival or occlusal wall
2 =	Dye penetration up to the full length of the gingival or occlusal wall
3 =	Dye penetration along the axial wall

The non-parametric data were analyzed using the Kruskal-Wallis analysis of variance test and Mann-Whitney U test by ranks at the significance level of  $p < 0.05$ .

### Results

Distribution of the degree of leakage associated with sections from individual teeth in the four test groups ranged from 0-4. Score frequency for microleakage results are shown in Table 2 and Figure 1.

The Kruskal Wallis test indicated no significant difference among the four experimental groups ( $P > 5\%$ ). The Mann-Whitney U test for comparison of the mean rank of microleakage in enamel and dentin margins of each group showed a significant difference ( $P < 5\%$ ) (Table 2).

### Discussion

Statistical analysis showed no significant difference between the two types of composite resins (hybrid and flowable) and cavosurface configurations (conventional, no bevel and beveled conventional) with regard to microleakage. However, a significant difference between dentin and enamel margins in each group was observed. Microleakage in dentinal margins is not completely preventable. Enamel is a reliable substrate for bonding, but bonding



Table 2. Score frequency and mean rank for microleakage in enamel and dentin margins for each group (n=14).

Composite Resin	Cavosurface Configuration	Margin	Score Frequency				Mean Rank
			0	1	2	3	
Hybrid (Evo-Ceram)	Beveled conventional (BH)	Enamel	14	0	0	0	11.75
		Dentin	2	1	1	10	26.46
	Conventional (CH)	Enamel	13	0	0	1	9.5
		Dentin	4	1	1	8	27.5
Flowable (TetricFlow)	Beveled conventional (BF)	Enamel	12	0	0	2	5.10
		Dentin	2	0	0	12	27
	Conventional (CF)	Enamel	14	0	0	0	11.64
		Dentin	2	0	1	11	26.43

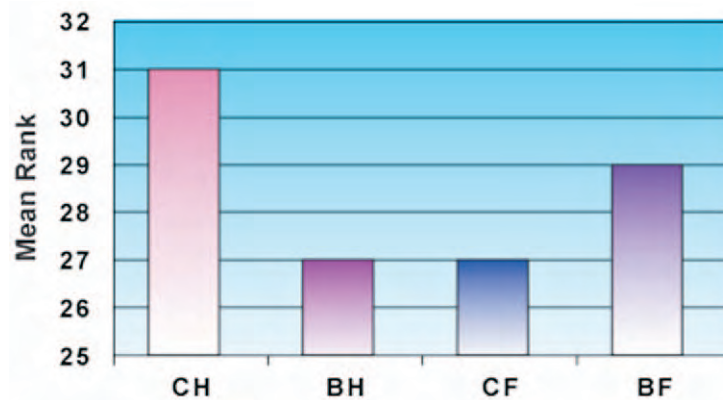


Figure 1. Mean rank of leakage in the four groups.

to dentin is more challenging due to its high organic component, the variation in the degree of mineralization, and the presence of outward fluid movement.<sup>16</sup>

Because leakage is nearly always observed at the cervical margin of Class V resin composite restorations the ability of adhesive systems to bond to hybridized cementum must be questioned.<sup>17</sup> The literature includes only one report of hybrid layer formation in cementum.<sup>18</sup>

Shrinkage stresses generated during the polymerization of resin composite creates a force that competes with the adhesive bond. This may disrupt the bond to cavity walls which is one of the main causes of marginal failure and subsequent microleakage.<sup>7</sup>

The primary rationale behind the use of flowable composites is the formation of an elastic layer that may compensate for polymerization shrinkage stresses. When comparing microleakage using flowable and hybrid composites as a base material, no statistically significant difference was observed. This result is in accordance with several studies that demonstrated a flowable composite did not influence microleakage.<sup>7,19,20</sup> This differs from other studies that demonstrated the use of flowable composite resins results in an improved marginal seal.<sup>8,21</sup>

In the present study the incremental placement technique was used. The application of the bulk placement technique is not indicated for all Class V situations.<sup>7</sup> For large cavities, the incremental

placement technique is recommended when the technique is started at either the enamel or the dentin portion of the cavity because of better polymerization adaptation and placement control compared to forcing a single large increment into the cavity.<sup>22</sup>

The cavosurface bevel has been employed for many years as an accepted modification for composite restorations in permanent anterior teeth. The bevel exposes more enamel rods for bonding. Using the acid etch technique, the resin-enamel bond is stronger with etched transverse sections of enamel prisms than with longitudinal sections.<sup>23</sup>

In Class V cavities enamel margins are beveled based on the notion that beveling decreases marginal leakage, increases adhesion, and improves esthetics.<sup>11</sup> On the other hand, enamel margin beveling in a lower depth Class V cavity preparation leads to a flat cavity configuration; this probably causes an easier displacement of restorative material under flexural loads. This retention hypothesis has been accepted by Baratieri et al.<sup>14</sup> as a result of a clinical trial in which they demonstrated beveling did not affect the retention of restoration in Class V cavity preparations after three years. The present study confirms this finding as well.

In the present study a group of cavity preparations were prepared without an enamel margin bevel in anticipation of finding at least the same degree of leakage as cavity preparations with an enamel margin bevel so the elimination of enamel beveling in Class V cavities could be realized. Cavity preparation with a round bur leaves the cavity with concave walls allowing

the enamel to cover the restorative material instead of the composite resin covering the tooth structure. This enamel covering the composite resin may be undermined but not brittle. It has been shown undermined enamel can be saved.<sup>11</sup>

Satini et al.<sup>15</sup> compared microleakage in Class V cavities prepared with fissure bur to create a 90° cavosurface margin having an enamel bevel. No significant difference in microleakage was found.

Baratieri et al.<sup>14</sup> also compared microleakage of Class V cavities with and without an enamel bevel. The results showed enamel beveling and composite resin viscosity did not affect microleakage.

Results of the studies by Baratieri et al.<sup>14</sup> and Satini et al.<sup>15</sup> are similar to the conclusion of the present study. Although controversy still remains regarding the configuration of Class V cavity margins based on these studies and the present study, the authors believe enamel beveling and the type of restorative material has no effect on microleakage.

### Conclusions

1. There was no statistically significant difference between the two types of composites and two types of enamel margins with respect to microleakage.
2. The degree of microleakage in the gingival margin of each group was more than that found in enamel margins.

### Clinical Significance

There is no need for an enamel bevel in Class V carious lesions after preparation with a round bur.

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