

# Microleakage in class V gingiva-shaded composite resin restorations

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## Summary

The purpose of this study was to evaluate the microleakage in Class V cavities restored with a new gingiva-shaded microhybrid composite resin and with a conventional microhybrid composite resin using three different dentin bonding systems (DBS). Class V cavities were prepared in sixty freshly extracted human teeth with the incisal margin in enamel and the apical margin in dentin/cementum. Restored specimens, after thermocycling, were placed in 2% methylene blue solution for 24 hours. Longitudinal sections were obtained and studied with a stereomicroscope for assessment of the microleakage according to degree of dye penetration (scale 0-3). Data were analyzed with Kruskal-Wallis test and with Mann-Whitney U-test.

In this study there was no leakage in enamel: all the cavities showed no dye penetration at the incisal margins (located in enamel). None of the DBS used eliminated microleakage in apical margins (located in dentin or cementum): three-step total-etch and single-step self-etch were more effective in reducing microleakage in dentin margins when compared with two-step total-etch. This in vitro study concluded that microleakage in Class V cavities restored with the composite resins tested is similar.

**Key words:** gingiva-shaded composite resin, dentin bonding systems, microleakage.

## Introduction

Cervical lesions are frequently found in daily practice. Degenerative processes and gingival recession, as result of chronic periodontal inflammation or aggressive periodontal therapy, expose root dentin predominantly in older patients (1). The aetiology of cervical lesions is multifactorial (2). Non-carious cervical lesions are characterized by the loss of dental hard tissue at cementum-enamel junction as a result of abrasive or erosive effects (3); additionally cuspal flexure and tensile stresses in cervical region of the teeth are hypothesized to cause disruption of the bonds among the hydroxyapatite crystals, leading to cracks and loss of enamel and underlying dentin (4). Food acids and inappropriate tooth brushing procedures promote the development of saucer- or wedge-shaped lesions in the cervical area of the teeth (1). In such patients, low dental care and non-effective preventive programs lead to rapid development of caries. The treatment regimen depends on the individual cause of the cervical lesion (5). Instructions for adequate oral hygiene, dietary advices, occlusal adjustment and restoration of the defect are recommended (6). Small non-carious cervical defects with no hypersensitivity, especially in the posterior region, may require only dietary consulting and oral hygiene instruction in order to avoid further progression (1,5). Pain-associated or caries-affected Class V lesions need to be restored. Particular attention is required in anterior teeth, both for small non-carious and for big carious lesions, where aesthetic reasons are predominant. Glass ionomer cements, compomers and composite resins are being mostly used to restore class V defects (1,3,6-8). Amalgam and gold restoration were used in the past but today the increased demand for aesthetic decreased their utilization. Composite resins combined with dentin bonding systems have already substituted glass ionomer cements and compomers in Class V restorations because of their excellent aesthetics, superior mechanical and physical properties and higher bond strength to enamel and dentin (1,9,10). The complex morphology of Class V defects with margins partly in enamel as well as in root dentin presents challenging task for the restorative material (1). Bond strength and sealing ability of adhesive systems to dentin is still inferior compared to enamel cavity segments (11). In Class V the polymerization of composite resins competes with the bond strength of the adhesive systems and challenges marginal integrity and sealing ability especially in dentin segments. Marginal gap formation leads to leakage, responsible for marginal discoloration, secondary caries and partial or total loss of the restoration (6,12). However, newly formulated improved bonding systems provide a better adhesion of the composite resin to dentin, although this is an unresolved problem. The exposed and frequently worn cervical areas of teeth often lack a pleasing appearance

when restored with conventional materials such as glass ionomer cements or tooth coloured composite resins, especially when associated with aging and loss of gingiva. Today the interest is directed toward the development of new restorative materials that permit chair side gingival shade matching, in order to restore aesthetic and function of cervical areas exposed after gingival recession (discoloured or hypersensitive necks of teeth) and cervical V-shaped defects (13).

The purpose of this *in vitro* study was to investigate the microleakage in Class V cavities restored with a new gingiva-shaded microhybrid composite resin (Amaris Gingiva) and with a conventional microhybrid composite resin (Amaris) using three different dentin bonding systems (three-step total-etch, two-step total-etch and single-step self-etch). The null hypothesis of the study was that there is no significant difference in microleakage scores among the various groups.

## Materials and methods

### Specimen preparation

Sixty caries-free vital human teeth freshly extracted for periodontic or orthodontic reasons were used in this study. The teeth were cleaned with dental scalers, polished with pumice and stored in a 0.25% mixture of sodium azide in Ringer solution until the date of use. In each tooth two standardized Class V cavities (on buccal and on lingual surfaces) were prepared with a round-nosed no.245 carbide bur (Dentsply/Caulk, Milford, DE, USA) at high-speed with air/water spray, according to procedure described in Corona et al. (14): the cavities were prepared with the incisal margin located in enamel and the apical margin located in dentin/cementum (3 mm beyond the cementum-enamel junction); the dimensions of Class V cavities were similar, with mesiodistal width, incisal-apical measure and depth of 4 mm. The same trained operator prepared all the cavities. The teeth were randomly assigned to six experimental groups (of 10 specimens and 20 cavities each); Class V cavities were filled with two composite resins and with three dentin bonding systems (DBS) as follows: group 1: Solobond Plus + Amaris Gingiva, group 2: Solobond Plus + Amaris, group 3: Solobond M + Amaris Gingiva, group 4: Solobond M + Amaris, group 5: Futurabond NR + Amaris Gingiva, group 6: Futurabond NR + Amaris.

The same manufacturer (Voco GmbH, Cuxhaven, Germany) prepared the composite resins and the DBS. DBS tested are shown in Table 1.

Solobond M	0949326	two-step total-etching	etch for 20 sec with 37% orthophosphoric acid, rinse with water, apply DBS, gently dry and light cure for 20 sec
Futurabond M	0940451	single-step self-etching	apply DBS for 20 sec, dry with air for 5-10 sec to evaporate solvents and light cure for 20 sec

Table 1 - Dentin bonding systems (DBS) used in this study.

After application of DBS (according to Manufacturers' instructions) cavities were restored with composite resin in three increments. Each increment of composite resin was light-cured for 40 seconds with a curing light in softstart-polymerization mode (Celalux 2 High-Power LED curing-light, Voco GmbH, Cuxhaven, Germany). The restorations were finished and polished with finishing/polishing disks (Sof-Lex Pop-On, 3M ESPE, St. Paul, MN, USA) in decreasing granulation. All teeth were coated with two layers of nail varnish up to 1 mm from the restorations margins, while the apical part was sealed with wax. The restored teeth were then subjected to artificial aging by thermocycling. All specimens were immersed alternately in water baths at 5 and 60°C for 1000 cycles, with at dwell time of 60 seconds in each bath and a transfer time of 15 seconds. After thermocycling, the specimens were immersed in a 2% methylene blue dye solution and incubated at 37°C for 24 hours.

### Microleakage analysis

The teeth were rinsed with distilled water, dried for 10 minutes, and sectioned longitudinally in a buccolingual direction with a low-speed water-cooled diamond cutter. All specimens were examined at 25 $\times$  in a stereomicroscope (Inspective 4Geek, Serravalle, RSM) and standardized digital images were obtained. Two observers scored each section blindly; consensus was forced if disagreements occurred. An ordinal scale from 0 to 3 was used to score microleakage separately at incisal (enamel) and apical (dentin/cementum) margins of each section based on the following criteria, as described in Osorio et al.(15) and in Moldes et al.(16): 0 = no leakage visible at tooth/restoration interface, 1 = dye penetration along the interface up to one-half of the cavity depth, 2 = dye penetration greater than one-half of the cavity depth, 3 = dye penetration to and along axial wall.

### Statistical analysis

The results of microleakage evaluation were submitted to statistical analysis using "Stata 7.0" computer software (Stata Corp., Station College, TX). A Kruskal-Wallis test and a Mann-Whitney U-test were performed. Significance was predetermined at  $p < 0.05$ .

## Results

Representative photographs revealing dye penetration of sectioned specimens are shown in Figures 1-6. Microleakage scores values at incisal margins (in enamel) are presented in Table 2 and microleakage scores values at apical margins (in dentin/cementum) are presented in Table 3. The results of the Kruskal-Wallis test indicated the presence of significant differences among the microleakage values of the various groups ( $P < 0.05$ ). *Post-hoc* Mann-Whitney's Test showed no significant difference in microleakage scores between gingival-shaded (groups 1, 3, and 5) and conventional (groups 2, 4, and 6) composite resins both for occlusal and gingival margins ( $P > 0.05$ ). Moreover, when evaluating



Figure 1. Representative stereomicroscopic photograph of group 1 (Solobond Plus + Amaris Gingiva) original magnification 25x.

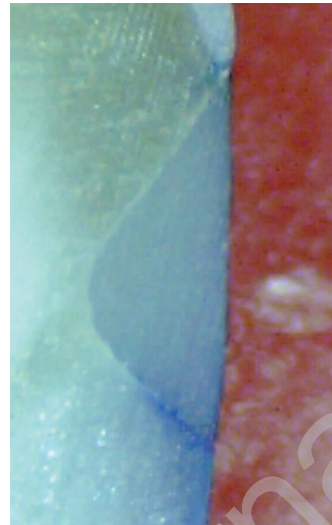


Figure 4. Representative stereomicroscopic photograph of group 4 (Solobond M + Amaris) original magnification 25x.



Figure 2. Representative stereomicroscopic photograph of group 2 (Solobond Plus+Amaris) original magnification 25x.



Figure 5. Representative stereomicroscopic photograph of group 5 (Futurabond NR+Amaris Gingiva) original magnification 25x.



Figure 3. Representative stereomicroscopic photograph of group 3 (Solobond M+Amaris Gingiva) original magnification 25x.



Figure 6. Representative stereomicroscopic photograph of group 6 (Futurabond NR+Amaris) original magnification 25x.

groups	Score 0	Score 1	Score 2	Score 3
1	18 (90%)	2 (10%)	0 (0%)	0 (0%)
2	19 (95%)	1 (5%)	0 (0%)	0 (0%)
3	17 (85%)	2 (10%)	1 (5%)	0 (0%)
4	17 (85%)	3 (15%)	0 (0%)	0 (0%)
5	17 (85%)	3 (15%)	0 (0%)	0 (0%)
6	16 (80%)	3 (15%)	1 (5%)	0 (0%)

Table 2 - Occlusal margin-microleakage scores obtained for each experimental group (n=20).

groups	Score 0	Score 1	Score 2	Score 3
1	13 (65%)	5 (25%)	2 (10%)	0 (0%)
2	12 (60%)	7 (35%)	1 (5%)	0 (0%)
3	3 (15%)	9 (45%)	5 (25%)	3 (15%)
4	2 (10%)	11 (55%)	6 (30%)	1 (5%)
5	14 (70%)	4 (20%)	2 (10%)	0 (0%)
6	12 (60%)	5 (25%)	3 (15%)	0 (0%)

Table 3 - Gingival margin-microleakage scores obtained for each experimental group (n=20).

occlusal margin scores, no significant differences were showed among the three different adhesives tested ( $p>0.05$ ). On the other hand, when analyzing gingival margin scores, groups 3 and 4 showed significant higher frequency of microleakage scores of "1" ( $P<0.05$ ) than the other groups, that both showed higher frequency of score "0".

## Discussion

The null hypothesis of the study was partially rejected. The results of the present investigation showed no significant differences in microleakage values among the gingiva-shaded microhybrid composite resin (Amaris Gingiva) and the conventional microhybrid composite resin (Amaris). The microleakage of the DBS tested in enamel is significantly reduced or null. The results of this study are in agreement with findings in Literature (14,15,17,20): all the specimens showed less dye penetration at incisal margins (in enamel), with no differences emerging between the different adhesive systems. On the other side, the results revealed that none of the DBS used eliminated microleakage in margins located in dentin or cementum of any teeth, as confirmed by other studies (14,21-23). Bonding agents require etching of enamel and decalcifying of dentin to promote micromechanical bonding; for several years phosphoric acid has been used to treat enamel and dentin substrates before adhesive application: this total-etching technique remove smear layer, open dentinal tubules and increase dentinal permeability (24). In attempt to simplify clinical procedures, DBS were developed consisting of a lower number of passages. DBS are currently available as three-step, two-step and single-step systems (17,25,26): three-step systems are traditional adhesives, which involve the etching,

the priming and the bonding steps (also defined total-etch systems); two-step systems include self-priming adhesives (that require a separate etching step) or self-etching primers (that require a separate bonding step); finally, the recently introduced single-step (self-etching) adhesives combine all bonding procedures in a single application, consisting of a mixture of acid monomers that etch enamel and dentin as well as primers that permits penetration of resin into the demineralized dentin (27). No DBS currently available achieved a perfect seal in dentin/cementum (15,19,20,28,30-34). The causes of microleakage are usually associated with the composite resin used, the occlusal load, the location of the prepared margins and the polymerization shrinkage (23): DBS have the aim to minimize those effects. The restoration of cavities with margins located in dentin/cementum is an unresolved problem in operative dentistry; microleakage has clinical effects and causes failure of resin restorations. The reason for this difference between apical and incisal leakage scores is that bonding to dentin/cementum is much more technique-sensitive and substrate-sensitive than bonding to enamel (25,30-34).

## Conclusion

This study showed no differences between the microleakage in class V cavities restored with the composite resins tested: Amaris Gingiva (gingiva-shaded microhybrid composite resin) and Amaris (conventional microhybrid composite resin). Within the limitations of this study it may be concluded that microleakage among two composite resins tested is similar. The microleakage of all DBS tested in enamel is significantly reduced or null, but three-step total-etch and single-step self-etch were more effective in reducing microleakage in dentin/cementum margins when compared with a two-step total-etch.

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