# Effect of Enamel Bevel on the Clinical Performance of Resin Composite Restorations Placed in Non-carious Cervical Lesions

THAYS REGINA FERREIRA DA COSTA, DDS, MS\*, ALESSANDRO DOURADO LOGUERCIO, DDS, MS, PhD<sup>†</sup>, ALESSANDRA REIS, DDS, PhD<sup>†</sup>

## ABSTRACT

*Statement of the Problem:* Laboratory testing of enamel bevel reports many advantages; however clinical studies on this topic are scarce and controversial.

*Purpose of the Study:* To evaluate the effect of enamel bevel on the retention rates of composite restorations placed in non-carious cervical lesions (NCCLs).

*Materials and Methods:* Forty-two patients with more than 20 teeth in occlusion and having at least two NCCLs participated in this study. The cavities were divided into non-beveled (control) and beveled (short bevel [45°, 1–2 mm long] prepared with a diamond bur) groups. The NCCLs were restored with the 2-step etch-and-rinse adhesive ExciTE and the resin composite 4 Seasons (lvoclar Vivadent). Eight-four restorations were placed and evaluated at baseline, after 6 and 12 months according to the modified U.S. Public Health Service criteria.

**Results:** The 12-month retention rates (95% confidence interval) for the beveled (91% [77–97%]) and non-beveled [88% (73–95%)] groups were similar. No significant differences were detected between groups in other criteria (Fisher test, p > 0.05). No significant differences were detected in the same group compared across different recall times (McNemar test, p > 0.05).

*Conclusion:* Enamel beveling may not be clinically relevant for the retention of composite restorations in NCCLs after 12 months.

## **CLINICAL SIGNIFICANCE**

Beveling enamel margins may not be necessary in NCCL restorations restored with the 2-step etch-and-rinse systems.

## INTRODUCTION

With the rapid rise in the elderly population, the prevalence and severity of non-carious cervical lesions (NCCLs) has increased, and more attention has been given to these lesions.<sup>1,2</sup> In most cases, these lesions are treated by controlling the etiological factor and, when indicated, restoring the missing tooth structure.<sup>3,4</sup> Indications for the restoration of NCCLs include

protection against further loss of tooth structure, esthetics, elimination of tooth sensitivity, and the need to use the affected tooth for a removable partial denture abutment.<sup>3–5</sup>

However, restoring NCCLs is still a challenge. Dentin in NCCLs is usually sclerotic, with partial or total obliteration of dentin tubules,<sup>6</sup> which is an unfavorable factor for dentin bonding.<sup>7,8</sup> Furthermore, these lesions

\*PhD student, School of Dentistry, State University of Ponta Grossa, Av. General Carlos Cavalcanti, 4748, Ponta Grossa, Paraná, CEP 84030-900, Brazil <sup>†</sup>Adjunctive Professors, Department of Restorative Dentistry, School of Dentistry, State University of Ponta Grossa, Av. General Carlos Cavalcanti, 4748, Ponta Grossa, Paraná, CEP 84030-900, Brazil are not retentive, and the presence of dentin or cementum at the cervical margin facilitates the occurrence of microleakage.<sup>9</sup>

Some alternatives have been proposed to improve the bonding to dentin in NCCLs, such as increasing the phosphoric acid etching time,<sup>10</sup> citric acid etching for 30 seconds,<sup>11</sup> removal of superficial sclerotic dentin with diamond burs,<sup>12,13</sup> and an additional application of a 17% EDTA solution for 60 seconds, prior to acid etching with phosphoric acid.<sup>12</sup> Although all these techniques improve bond strengths, they are all focused on the dentin substrate. Considering bonding to enamel, performing a bevel on the enamel margin may be a good option, taking into consideration that laboratory studies have shown that microleakage can be prevented if the cervical margin is in enamel.<sup>9</sup>

Laboratory studies have shown that the placement of a bevel in NCCLs can reduce marginal microleakage,<sup>14–16</sup> reduce the risk of fracture in the marginal enamel,<sup>17</sup> result in better adhesion,<sup>17,18</sup> and yield to improved esthetics.<sup>19</sup> However, despite these positive laboratorial findings, few clinical studies<sup>20–23</sup> have been published on the effect of bevel on the retention and performance of class V restorations in NCCLs.

While some researchers consider the bevel a solution to improve the bonding of some etch-and-rinse<sup>20-22</sup> and self-etch adhesive systems,<sup>20–22</sup> other authors have stated that the bevel improves retention only during the first 6-months<sup>23</sup> with no advantage over the non-beveled group after longer periods.<sup>23</sup> One study evaluated the performance of a 2-step etch-and-rinse adhesive placed in beveled and non-beveled NCCLs without significant differences at any recall periods up to 3 years.<sup>23</sup> However, the material evaluated in this study (One Step, Bisco, Schaumburg, IL, USA) has shown poor performance in several previous clinical studies after short-term and long-term clinical function.<sup>23–27</sup> Therefore, the similarity between beveled and non-beveled groups may be due unacceptable bonding provided by this adhesive material.

As a result, more studies with different adhesive systems should be carried out in order to test whether or not enamel bevel can improve the retention of bonded resin composite restorations in NCCLs. Thus, the purpose of this paired-tooth clinical trial was to evaluate the influence of enamel beveling on the retention of composite restorations placed in NCCLs with a 2-step etch-and-rinse system. In this study, we used ExciTE (Ivoclar Vivadent, Schaan, Liechtenstein), a 2-step etch-and-rinse adhesive. A previous study reported that ExciTE exhibited a retention rate 78.8% in a 2-year clinical trial in NCCLs,<sup>28</sup> and this adhesive system performed satisfactorily over a 4-year observation period in Class I and II restorations.<sup>29</sup> The null hypothesis tested is that the retention rate will not be influenced by enamel beveling.

# MATERIALS AND METHODS

#### Trial Design

The Committee on Investigations Involving Human Subjects of the State University of Ponta Grossa, Paraná, Brazil, reviewed and approved the protocol and informed consent form for this study. This research was a double-blind randomized clinical trial and followed the CONSORT guidelines.<sup>30</sup>

#### Participant Selection

Forty two participants in clinical attendance at the School of Dentistry from the State University of Ponta Grossa (PR, Brazil), who met the inclusion and exclusion criteria, were consecutively enrolled in this study.

Participants had to be healthy and should be at least 18 years old. They should have an acceptable oral hygiene level and present at least 20 teeth under occlusion. They were required to have at least two NCCLs to be restored in two different teeth. These lesions had to be non-carious, non-retentive, at least 1 mm deep, and involve both enamel and dentin of vital teeth without mobility. The cavosurface margin could not involve

Characteristic	Number of lesions		Characteristic	Number of lesions	
	Bevel	Control		Bevel	Control
Shape (degree of angle)			Post-operative sensitivity		
<45°	6	7	Yes	0	0
45–90°	10	8	No	42	42
90–135°	3	14	Attrition facet		
>135°	3	13	Yes	23	21
Cervicoincisal height (mm)			No	19	21
<1,5	5	3	Enamel in cervical margin		
1,5–2,5	12	15	<25%	I	I
>2,5	25	24	25–50%	41	41
Score on Dentin Sclerosis Scale*			Tooth distribution		
I	30	28	Incisor	4	7
2	8	9	Canine	10	5
3	4	4	Premolar	23	27
4	0	I	Molar	5	3
Pre-operative sensitivity			Arch distribution		
Yes	21	21	Maxillary	16	20
No	21	21	Mandibular	26	22

TABLE I. Distribution of non-carious cervical lesions (NCCLs) according to some characteristics

\*Based on a dentin sclerosis scale.31-33

1 (No sclerosis present; dentin is light yellowish or whitish, with little discoloration; dentin is opaque, with little translucency or transparence).

2 (More sclerosis than in category I but less than halfway between categories I and 4).

3 (Less sclerosis than in category 4 but more than halfway between categories 1 and 4).

4 (Significant sclerosis present; dentin is dark yellow or even discolored [brownish]; dentin has a glassy appearance, with significant translucency or transparency evident).

more that 50% of enamel.<sup>31</sup> All participants had to sign a written consent form before being enrolled in this clinical trial. Participants with a compromised medical history, a severe or active periodontal or carious disease or with a poor oral hygiene were excluded from the study.

## Interventions: Restorative Procedure

Restorative procedures were carried out by a single and trained calibrated dental Operative Dentistry resident with 4 years of clinical practice, who screened patients and performed pretreatment selection of teeth with NCCLs by means of visual and/or tactile means. Prior to placing the restorations, some features of the NCCLs were evaluated. The degree of dentin sclerosis<sup>31–33</sup> was evaluated according to the description in Table 1. The cavity dimensions in mm (height, width and depth) and the geometry of the cavity (evaluated by photograph profile and labeled at <45°,  $45^{\circ}$ -90°, 90°–135°, >135°) was also recorded (Figures 1 and 2). Other features such as the presence of cervical margin in dentin; the presence or absence of occlusal wear facets; presence or absence of preoperative tooth sensitivity to stimuli (spontaneous, the water spray, air blast, and the pressure from the explorer) were also evaluated (Table 1).



**FIGURE I.** Measurement of the cavity dimensions of a non-carious cervical lesions (NCCLs) (A) in millimeters. The cavity height (B), width (C), and depth (D) was recorded with a probe millimeter.



**FIGURE 2.** Definition of the cavity geometry of the non-carious cervical lesions (NCCLs). (A) < 45°, (B)  $45^{\circ}$ -90°, (C)  $90^{\circ}$ -135°, (D) > 135°.

The interventions were standardized by a detailed protocol, which is briefly summarized below. A preliminary cleaning of the tooth surface with pumice and water aimed at removing the salivary pellicle and any residual dental plaque, followed by rinsing and drying. The proper shade of composite was then determined by means of comparison with a shade guide (Vita Lumin, Vita Zahnfabrik, Bad Säckingen, Germany). Local anesthesia was used if needed to prevent participant discomfort during intervention. All restorations (42 in each group) were placed under rubber dam isolation prior to restoration intervention.

In the non-beveled group, the adhesive (ExciTE, Ivoclar Vivadent) was applied according to manufacturer's instructions (Table 2): the cavity and 1 mm beyond the margins were etched with 35% phosphoric acid (Total Etch, Ivoclar Vivadent) for 15 seconds, then rinsed with water from an air-water syringe for 15 seconds, and the cavity was left visibly moist. The adhesive was applied for 10 seconds by brushing the dentin/enamel surface; an air spray was then applied on the adhesive for 3 seconds; a second layer of adhesive was applied like the first one and the adhesive was light cured (Optilux 500, SDS Kerr, Middleton, Wisconsin, USA) for 10 seconds at 600 mW/cm<sup>2</sup>. In the beveled group, a short enamel bevel (45°, 1–2 mm) was prepared with a diamond bur (#3118F—KG Sorensen, Barueri, SP, Brazil) under water refrigeration and then the adhesive was applied following the same protocol described earlier.

The cervical tooth anatomy was restored by applying three increments of resin composite (4 Seasons, Ivoclar Vivadent). Each increment was light cured for 40 seconds. Restorations were sculpted and polished using fine-grit diamond burs (#3195F and #3195FF, KG Sorensen) and aluminum-oxide flexible disks (Diamond Pro, FGM Produtos Odontológicos, Joinville, SC, Brazil).

## Outcomes: Evaluation Criteria and Procedure

Restorations were evaluated at baseline and after 6 and 12 months of clinical service by two other examiners that were trained and calibrated to evaluate the modified US Public Health Service criteria.<sup>31,32,34</sup> These experienced examiners (specialized in Operative Dentistry and with more than 15 years of clinical practice) were not involved in the placement of the restorations and were blinded to the experimental groups.

The primary clinical endpoint was restoration retention but the following secondary endpoints were also evaluated: marginal adaptation, marginal discoloration, caries adjacent to restorations and post-operative sensitivity. These variables were ranked in the following scores: alpha (no defect clinically detectable, just needing to be polished), bravo (clinically acceptable, but repair is necessary) and charlie (clinically inacceptable, needs restoration substitution).

## Sample Size

Considering the mean retention rate simplified etch-and-rinse adhesives of a systematic review<sup>35</sup> as

Material (manufacture/batch number)	Composition*	Application process
Total Etch (Ivoclar Vivadent/N05612)	Phosphoric acid (37 wt.% in water), silica and color pigments	Apply on enamel and subsequently on dentin; Allow a reaction time of 15 seconds; Thoroughly rinse off the etchant with water spray; Dry the tooth surfaces but avoid excessive drying of the dentin.
Excite Adhesive System (Ivoclar Vivadent/LI I 777)	Phosphonic acid acrylate, hydroxyethyl methacrylate, Bis-GMA, dimethacrylate, highly dispersed silica, ethanol, catalysts, and stabilizers	Apply one coat gently brushed for 10 seconds; Evaporation of the alcohol solvent for 3 seconds; Apply a second coat gently brushed for 10 seconds; Evaporation of the alcohol solvent for 3 seconds; Light cure for 10 seconds.
4 Seasons Composite Resin (Ivoclar Vivadent/H10754 [A3,5 Dentin], H15451 [A4 Dentin], H12935 [Clear])	Bis-GMA, TEGDMA, UDMA 76wt% of barium glass filler, trifluor terbium, Ba-AI fluor silicate glass and dispersed silica with filler particles sized 0.04–3.0 $\mu$ m, and filler average size of 0.6 $\mu$ m	Shade determination; Apply in layers (1.5–2 mm max) and adapt with suitable instruments; Light cure each layer for 20 seconds/600 mW/cm <sup>2</sup> .

#### TABLE 2. Materials used: composition and application process

Bis-GMA = bisphenol-glycidyl methacrylate; TEGDMA = triethylene glycol dimethacrylate; UDMA = 1,6-bis(methacrylethyloxycarbonylamino)trimethyl hexane.

being 75% after 24 months, using an alpha of 5% and a power of 80%, the minimal sample size to detect a difference of 20% among the groups was 40 restorations for each group. Thus, we selected 42 participants of both genders in attendance at the Clinic of Dentistry at State University of Ponta Grossa (PR, Brazil) to be enrolled in this study.

#### Randomization

All participants received one restoration from each group, in different teeth, with similar characteristics, such as deep, shape, dentin sclerosis, and others. To determine which lesion would receive the bevel, a coin was tossed immediately before the restoration placement.

#### Implementation and Blinding

Just one dentist participating in the study enrolled participants who met the inclusion criteria and assigned their teeth to one of the groups.

The operator was not blinded to group assignment when administering interventions; however examiners who carried out all evaluations concerning the restorations were blinded to the group assignments. All parameters during evaluation were recorded using a standardized paper case report form. The evaluation paper had to be sent after each observation to the study's clinical research associate, so that evaluators were blinded to group assignment during follow-up recalls.

#### Statistical Analysis

Descriptive statistics were used to demonstrate the frequency distribution of the evaluated criteria. In each group, the differences between the different recall times (baseline versus 6 months, baseline versus 12 months, and 6 month versus 12 month) for each criterion were compared using the McNemar's test (alpha = 0.05). For each recall time, the groups were compared using the Fisher's exact test (alpha = 0.05). The agreement among examiners was assessed by Cohen's Kappa statistics. Only participants who attended the recalls were included in the data analyses.

## RESULTS

The non-beveled and beveled protocols were implemented exactly as planned, and no



**FIGURE 3.** Flow diagram of the study participants in the different study phases. Np = number of patients, Nr = number of restorations.

modification was done. Inclusion started in August in 2009 and ended in August 2010. Follow-up started in February 2010 and ended in February 2012.

#### **Baseline Data**

Participants selected for this study were 19 women and 23 men. The mean age of participants was  $49 \pm 10$  years. Eighty-four restorations were placed, 36 in the maxillary arch and 48 in the mandibular arch. Approximately, 69% of the restorations were placed in premolars and molars and 31% in anterior teeth. Other features can also be observed in Table 1. A homogeneity of these characteristics between the study groups is clearly seen (Table 1). All restorations received the optimal score (alpha) for all evaluated endpoints at baseline.

#### Numbers Analyzed

Out of the 42 patients included, the analysis for the primary endpoint concerned 38 participants at the 6-month recall (Figure 3). Due to two losses of retention in the non-beveled group at the 6-month recall, 36 patients were analyzed for secondary outcomes in this group. At the 12-month recall, just 34 participants were analyzed for the primary endpoint. In the beveled and non-beveled groups, three and four restorations were lost, leaving 31 and 30 restorations, respectively to be analyzed for secondary outcomes (Figure 3).

#### Outcomes and Estimation

The recall rate was 90% and 81% at 6-month and 12-month recalls, respectively. Reasons for not attending the recall examination were not related to

**TABLE 3.** Number of evaluated restorations in each experimental group for each item of the United States Public Health Service criteria

United States Public Health Service criterion*		Baseline	Baseline		6 months		12 months	
		Bevel	Control	Bevel	Control	Bevel	Control	
Retention	А	42	42	38	36	31	30	
	С	_	_	_	02	03	04	
Fracture	А	42	42	36	33	28	24	
-	В	_	-	02	01	03	02	
-	С	-	-	_	-	-	_	
Marginal discoloration	А	42	42	37	34	31	25	
-	В	-	-	01	-	-	01	
-	С	-	-	_	-	-	_	
Marginal adaptation	А	42	42	35	33	25	25	
	В	-	-	03	01	03	01	
-	С	_	-	-	_	-	_	
Caries adjacent to restorations	А	42	42	38	34	28	26	
	С	_	-	-	_	-	_	
Post-operative sensitivity	А	42	42	38	34	28	26	
	С	_	_	-	_	-	-	
*A=alpha; B=bravo; C=charlie.								

the treatment or to the negative appreciation of the participant concerning the restoration (Figure 3). The clinical data for the primary outcome and the retention rate are summarized in Table 3.

At the 12-month evaluation, four restorations in the non-beveled group and three in beveled group were lost, resulting in retention rates (95% confidence interval) of 88% (73–95%) and 91% (77–97%), respectively. The relative risk was 1.03 (95% CI 0.87–1.21). The examiners did not find caries adjacent to restorations, and no post-operative sensitivity was reported by the participants (Table 3).

At the 6-month recall, three restorations showed fractures (one in the non-beveled group and two in the

beveled group). At the 12-month recall, five restorations had fractures (three in the beveled group and two in the non-beveled groups). Two restorations (one in the beveled group after 6 months and one in the non-beveled group after 12 months) showed marginal discoloration, and four showed lack of adaptation (three in the beveled group and one in non-beveled group) in both periods of assessment (Table 3), receiving a bravo score for these evaluated endpoints.

No significant differences were detected for any criteria when the beveled and non-beveled groups were compared at each assessment time (Fisher's exact test, p > 0.05). No significant difference was detected when the same group was compared at different periods of assessment (baseline versus 6 months, baseline versus 12 months, and 6 months versus 12 months; McNemar test, p > 0.05).

## DISCUSSION

The retention rate is the most important criterion in studies of NCCLs to determine how a material or technique is suitable in terms of bonding for clinical use. In this trial, no significant difference in retention rate was detected between the two groups after 12 months of clinical service. The beveled group showed a retention rate of 91% versus 88% for the non-beveled group which agrees with the study of Santiago and others<sup>28</sup> that evaluated the retention rate of the same adhesive employed in this study in non-beveled NCCLs.

The majority of studies that evaluated the effect of bevel in NCCLs and found significant differences between beveled versus non-beveled group followed up restorations for periods longer than 24 months<sup>20–22</sup> except one study,<sup>23</sup> which employed a two-step etch-and-rinse adhesive. Significant differences between the beveled versus non-beveled groups in the present and in an earlier investigation<sup>36</sup> (that tested a two-step self-etch system) might have been detected if periods longer than 12 to 18 months were evaluated. Although it has been reported that the retention rates of class V restorations seems to be time dependent,<sup>37–39</sup> the effect of bevel in the retention rates of NCCLs in periods longer than 3 years of clinical service has not been evaluated so far.

Another important issue related to the restorative procedure should be mentioned. All restorations from the non-beveled group were performed, finished, and polished as butt joint in an aim to avoid composite overlapping over the enamel margin; however, this is not easily controlled during the restorative procedure. During placement and composite smoothing with a flat instrument or brush, resin composite easily overlaps unground enamel adjacent to the cavity margin. Scanning electron microscopy (SEM) evaluation of recently placed composite restorations in NCCLs was able to identify the presence of composite overhangs;<sup>40</sup> however, SEM evaluation was not carried out in any of the clinical studies that have evaluated the effect of enamel beveling, including the present one. This shortcoming should not be taken as crucial as there is

evidence from clinical studies<sup>41</sup> that the microscopic analysis in the laboratory does not seem to have clinical relevance.

Thus, one may hypothesize that that the lack of differences between beveled and non-beveled groups could be attributed to the fact that an additional retention may be present in the non-beveled groups. An extended 2-mm bevel showed better fracture resistance in class IV resin composite restorations in comparison with 1-mm bevel.<sup>42,43</sup> In most clinical trials involving enamel beveling, including the present one, a short enamel bevel, ranging from 0.5 to 2.0 mm, was performed, which represents a small fraction of the whole enamel buccal area. Therefore, we cannot rule out that this may be the reason why this procedure did not result in superior retention rate compared to the non-beveled group. As there are many differences in the configuration design of class IV and V preparations, further studies should focus on the size of the bevel in order to rule out a positive effect of this procedure on the retention of Class V restorations.

A poor marginal sealing can result in post-operative sensitivity, marginal discoloration and caries adjacent to the restoration, which are the most common symptoms associated with clinical failure of adhesive restorations.<sup>44</sup> Laboratory studies have found that an enamel beveling favors the marginal sealing and reduces microleakage.<sup>9,14–16</sup> Therefore, intuitively, we would expect a lower rate of marginal discoloration or marginal adaptation in the beveled group, which was not observed in the present study, since both groups had similar performance.

Marginal discoloration is probably caused by accumulation of stains into marginal defects, such as a chip fracture of a slight flash of material covering unground and/or non-treated tooth surface. This problems, especially marginal discoloration, takes longer to appear in adhesive restorations performed with etch-and-rinse adhesives,<sup>33,45–49</sup> which may explain the similarity between the groups in the present investigation. According to Peumans and others<sup>49</sup> after 13 years of clinical service, bond degradation is mainly characterized by a further increase in the presence of small but clinically acceptable marginal defects and superficial marginal discoloration.

After 12 months of clinical service, no caries adjacent to restorations were found, which is in agreement with other clinical trials.<sup>22,23,36</sup> In addition, no participant in this study presented post-operative sensitivity at any recall period for both groups, which is also in accordance with other articles.<sup>23,50</sup> However, this does not seem to be consensual in the literature. For instance, although Van Meerbeek and others<sup>22</sup> reported a prevalence of tooth sensitivity of 3% for one adhesive tested, Perdigão and others<sup>36</sup> found a post-operative tooth sensitivity ranging from 43 to 87%, depending on the group and evaluation time. This discrepancy between studies is probably due to different adhesive systems used, restorative materials, techniques employed, and methodology in quantifying the tooth sensitivity.

In regard to the prevalence of fractures, only the study of Van Meerbeek and others<sup>22</sup> evaluated this criterion. They reported no fractures for any of the groups studied at the different assessment times. In our study, 10% of the restorations in beveled group and 4% in non-beveled group showed microfractures, being classified as a bravo. This difference is likely due to differences in the restorative material and polymerization techniques employed.

Finally, it is worth mentioning the study limitations. This study has not evaluated other benefits of enamel beveling such as esthetics. Therefore, the study conclusions are limited to the ability of enamel bevel to improve retention. Although the sample size was calculated to find a difference of at least 20%, differences between the groups could have been detected if the planned sample size had been larger. Furthermore, the evaluation period of this study was short, consequently longer follow-up times should be employed to exclude the possibility of a beneficial effect of the bevel on retention rate of resin composite restorations in NCCLs. Additionally, the intervention and control groups were implemented in participants from both genders older than 18 years old. Therefore, the results of the present trial apply to the adult population having NCCLs with features similar to the ones selected to be included in this clinical trial.

# CONCLUSIONS

After testing the effect of enamel beveling on the clinical retention of composite restorations placed in NCCLs with a 2-step etch-and-rinse adhesive, this study concluded that bevel is not necessary after 12 months of clinical service.

# DISCLOSURE AND ACKNOWLEDGMENTS

The authors do not have any financial interest in the companies whose materials are included in this article. This study was not funded by any sponsoring company.

This study was performed by Thays Regina Ferreira da Costa as partial fulfillment of her MS degree at the State University of Ponta Grossa (UEPG), Ponta Grossa, PR, Brazil. This study was partially supported by the National Council for Scientific and Technological Development under grants 301937/2009-5; 301891/2010-9 and 301291/2010-1.

# REFERENCES

- Miller WD. Experiments and observations on the wasting of tooth tissue variously designated as erosion, abrasion, chemical abrasion denudation, etc. Dent Cosmos 1907;49:1–23.
- 2. Grippo JO. Abfractions: a new classification of hard tissue lesions of teeth. J Esthet Dent 1991;3:14–9.
- Browning WD, Brackett WW, Gilpatrick RO. Retention of microfilled and hybrid resin-based composite in non-carious class 5 lesions: a double-blind, randomized clinical trial. Oper Dent 1999;24:26–30.
- Levitch LC, Bader JD, Shugars DA, Heymann HO. Non-carious cervical lesions. J Dent 1994;22:195–207.
- Hand JS, Hunt RJ, Reinhardt JW. The prevalence and treatment implications of cervical abrasion in the elderly. Gerodontics 1986;2:167–70.

- Sakoolnamarka R, Burrow MF, Prawer S, Tyas MJ. Micromorphological investigation of noncarious cervical lesions treated with demineralizing agents. J Adhes Dent 2000;2:279–87.
- Kwong SM, Cheung GS, Kei LH, et al. Micro-tensile bond strengths to sclerotic dentin using a self-etching and a total-etching technique. Dent Mater 2002;18:359–69.
- Karakaya S, Unlu N, Say EC, et al. Bond strengths of three different dentin adhesive systems to sclerotic dentin. Dent Mater J 2008;27:471–9.
- Retief DH, Woods BS, Jamison HC. Effect of cavosurface treatment on marginal leakage in Class V composite resin restoration. J Prosthet Dent 1982;47:496–501.
- Lopes GC, Baratieri CM, Baratieri LN, et al. Bonding to cervical sclerotic dentin: effect of acid etching time. J Adhes Dent 2004;6:19–23.
- Marshall GW Jr, Chang YJ, Saeki K, et al. Citric acid etching of cervical sclerotic dentin lesions: an AFM study. J Biomed Mater Res 2000;49:338–44.
- 12. Camargo MA, Roda MI, Marques MM, de Cara AA. Micro-tensile bond strength to bovine sclerotic dentine: influence of surface treatment. J Dent 2008;36:922–7.
- Eliguzeloglu E, Omurlu H, Eskitascioglu G, Belli S. Effect of surface treatments and different adhesives on the hybrid layer thickness of non-carious cervical lesions. Oper Dent 2008;33:338–45.
- Eriksen HM, Buonocore MG. Marginal leakage with different composite restorative materials in vitro. Effect of cavity design. J Oral Rehabil 1976;3: 315–22.
- Swanson TK, Feigal RJ, Tantbirojn D, Hodges JS. Effect of adhesive systems and bevel on enamel margin integrity in primary and permanent teeth. Pediatr Dent 2008;30:134–40.
- Mazhari F, Mehrabkhani M, Sadeghi S, Malekabadi KS. Effect of bevelling on marginal microleakage of buccal-surface fissure sealants in permanent teeth. Eur Arch Paediatr Dent 2009;10:241–3.
- 17. Oilo G, Jorgensen KD. Effect of bevelling on the occurrence of fractures in the enamel surrounding composite resin fillings. J Oral Rehabil 1977;4:305–9.
- Ikeda T, Uno S, Tanaka T, et al. Relation of enamel prism orientation to microtensile bond strength. Am J Dent 2002;15:109–13.
- Baratieri LN, Ritter AV. Critical appraisal. To bevel or not in anterior composites. J Esthet Restor Dent 2005;17:264–9.
- Van Meerbeek B, Braem M, Lambrechts P, Vanherle G. Evaluation of two dentin adhesives in cervical lesions. J Prosthet Dent 1993;70:308–14.
- Van Meerbeek B, Peumans M, Verschueren M, et al. Clinical status of ten dentin adhesive systems. J Dent Res 1994;73:1690–702.

- Van Meerbeek B, Peumans M, Gladys S, et al. Three-year clinical effectiveness of four total-etch dentinal adhesive systems in cervical lesions. Quintessence Int 1996;27:775–84.
- Baratieri LN, Canabarro S, Lopes GC, Ritter AV. Effect of resin viscosity and enamel beveling on the clinical performance of Class V composite restorations: three-year results. Oper Dent 2003;28: 482–7.
- 24. Van Dijken JW. Clinical evaluation of three adhesive systems in class V non-carious lesions. Dent Mater 2000;16:285–91.
- Tyas MJ, Burrow MF. Three-year clinical evaluation of one-step in non-carious cervical lesions. Am J Dent 2002;15:309–11.
- Loguercio AD, Reis A. Application of a dental adhesive using the self-etch and etch-and-rinse approaches: an 18-month clinical evaluation. J Am Dent Assoc 2008;139:53–61.
- Reis A, Loguercio AD. A 36-month clinical evaluation of ethanol/water and acetone-based etch-and-rinse adhesives in non-carious cervical lesions. Oper Dent 2009;34:384–91.
- 28. Santiago SL, Passos VF, Vieira AH, et al. Two-year clinical evaluation of resinous restorative systems in non-carious cervical lesions. Braz Dent J 2010;21:229–34.
- 29. Boeckler A, Boeckler L, Eppendorf K, et al. A prospective, randomized clinical trial of a two-step self-etching vs two-step etch-and-rinse adhesive and SEM margin analysis: four-year results. J Adhes Dent 2012;14:585–92.
- Schulz KF, Altman DG, Moher D, CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. Int J Surg 2011;9:672–7.
- Loguercio AD, Reis A, Barbosa AN, Roulet JF. Five-year double-blind randomized clinical evaluation of a resin-modified glass ionomer and a polyacidmodified resin in noncarious cervical lesions. J Adhes Dent 2003;5:323–32.
- Zander-Grande C, Ferreira SQ, da Costa TR, et al. Application of etch-and-rinse adhesives on dry and rewet dentin under rubbing action: a 24-month clinical evaluation. J Am Dent Assoc 2011;142:828–35.
- Ritter AV, Swift EJ Jr, Heymann HO, et al. An eight-year clinical evaluation of filled and unfilled one-bottle dental adhesives. J Am Dent Assoc 2009;140:28–37.
- Barnes DM, Blank LW, Gingell JC, Gilner PP. A clinical evaluation of a resin-modified. Glass ionomer restorative material. J Am Dent Assoc 1995;126: 1245–53.
- 35. Peumans M, Kanumilli P, De Munck J, et al. Clinical effectiveness of contemporary adhesives: a systematic

review of current clinical trials. Dent Mater 2005;21:864–81.

- Perdigão J, Carmo AR, Anauate-Netto C, et al. Clinical performance of a self-etching adhesive at 18 months. Am J Dent 2005;18:135–40.
- Duke ES, Robbins JW, Snyder DS. Clinical evaluation of a dentinal adhesive system: three-year results. Quintessence Int 1991;22:889–95.
- Duke ES. Clinical studies of adhesive systems. Oper Dent 1992;5:103–10.
- Heymann HO, Sturdevant JR, Bayne S, et al. Examining tooth flexure effects on cervical restorations: a two-year clinical study. J Am Dent Assoc 1991;122:41–7.
- 40. Roulet JF, Reich T, Blunck U, Noack M. Quantitative margin analysis in the scanning electron microscope. Scanning Microsc 1989;3:147–58.
- Hickel R, Roulet JF, Bayne S, et al. Recommendations for conducting controlled clinical studies of dental restorative materials. Int Dent J 2007;57: 300–2.
- Eid H, White GE. Class IV preparations for fractured anterior teeth restored with composite resin restorations. J Clin Pediatr Dent 2003;27:201–11.
- Xu H, Jiang Z, Xiao X, et al. Influence of cavity design on the biomechanics of direct composite resin restorations in Class IV preparations. Eur J Oral Sci 2012;120:161–7.
- 44. Heintze SD. Systematic reviews: I. The correlation between laboratory tests on marginal quality and bond strength. II. The correlation between marginal quality and clinical outcome. J Adhes Dent 2007;9:77–106.

- 45. Kubo S, Kawasaki K, Yokota H, Hayashi Y. Five-year clinical evaluation of two adhesive systems in non-carious cervical lesions. J Dent 2006;34:97–105.
- Peumans M, De Munck J, Van Landuyt KL, et al. Restoring cervical lesions with flexible composites. Dent Mater 2007;23:749–54.
- Wilder AD Jr, Swift EJ Jr, Heymann HO, et al. A 12-year clinical evaluation of a three-step dentin adhesive in noncarious cervical lesions. J Am Dent Assoc 2009;140:526–35.
- Peumans M, De Munck J, Van Landuyt KL, et al. Eight-year clinical evaluation of a 2-step self-etch adhesive with and without selective enamel etching. Dent Mater 2010;26:1176–84.
- Peumans M, De Munck J, Van Landuyt KL, et al. A 13-year clinical evaluation of two three-step etch-and-rinse adhesives in non-carious class-V lesions. Clin Oral Investig 2012;16:129–37.
- Fron H, Vergnes JN, Moussally C, et al. Effectiveness of a new one-step self-etch adhesive in the restoration of non-carious cervical lesions: 2-year results of a randomized controlled practice-based study. Dent Mater 2011;27:304–12.

Reprint requests: Alessandra Reis, DDS, PhD, Faculdade de Odontologia, Universidade Estadual de Ponta Grossa, Av. General Carlos Cavalcanti, 4748, Bloco M, sala 64, Ponta Grossa 84030-900, Brazil; email: reis\_ale@hotmail.com

This article is accompanied by commentary "Effect of Enamel Bevel on the Clinical Performance of Resin Composite Restorations Placed in Non-carious Cervical Lesions," Guilherme Carpena Lopes, DDS, MS, PhD, DOI 10.1111/jerd.12043. Copyright of Journal of Esthetic & Restorative Dentistry is the property of Wiley-Blackwell and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.