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Role of non-carious cervical lesions multicausality in the behavior of respective restorations

Juan Fernando Ordóñez-Aguilera [a,1], Karin Landmayer [a], Carlos Alberto Kenji Shimokawa [a], Giovanni Aguirra Liberatti [a], Anderson Zanardi de Freitas [b], Míriam Lacalle Turbino [a], Heitor Marques Honório [c], Luciana Fávaro Francisconi-dos-Rios [a,*]

[a] *Department of Operative Dentistry, University of São Paulo, School of Dentistry, São Paulo-SP/Brazil, Avenida Professor Lineu Prestes, 2227, São Paulo, SP - 05508-000, Brazil*

[b] *Optical Coherence Tomography Laboratory, University of São Paulo, Institute for Energy and Nuclear Research (IPEN/CNEN), São Paulo-SP/Brazil, Av. Prof. Lineu Prestes, 2242, São Paulo/SP, 05508-000, Brazil*

[c] *Department of Pediatric Dentistry, Orthodontics and Public Health, University of São Paulo, Bauru School of Dentistry, Bauru-SP/Brazil, Alameda Octávio Pinheiro Brisolla, 9-75, Bauru, SP - 17012-901, Brazil*

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ABSTRACT

Objectives: To evaluate biocorrosion and eccentric occlusal loading interplay in marginal quality of cervical restorations.

Methods: Cervical wedge-shaped cavities were prepared in extracted premolars and restored with a composite. Premolars underwent either an erosive challenge (E: 1% citric acid/10 min), eccentric occlusal loading (EOL: 150 N/2.5 Hz/10^6 cycles), E before EOL (E + EOL), E intermediate to EOL (EOL/E/EOL), E after EOL (EOL + E), or no E or EOL (C: control). Marginal quality was analyzed based on a series of Optical Coherence Tomography images. Each of the margins was assigned a gap score (0, 1, 2, or 3) and measurement (μm). For each margin, scores data were analyzed with Kruskall Wallis and Dunn tests, and μm data, with Kruskall Wallis. Overall and for each group, the different margins were compared using Wilcoxon signed-rank test, and the correlation between scores and μm, Spearman's correlation coefficient ($\alpha = 0.05$).

Results: E and EOL, even if associated, did not influence enamel marginal quality. EOL/E/EOL impaired dentin/cementum marginal quality only in the case of scores and compared to E. E + EOL, EOL + E or EOL and even C, without differences between each other, did not influence results differently from E or EOL/E/EOL. Margins in dentin/cementum always showed lengthier gaps. Except for C, E and EOL + E cervical margin, there was a strong positive correlation between scores and μm.

Conclusions: Eccentric occlusal loading and/or biocorrosion cannot be assumed as causes of marginal failure of cervical restorations in wedge-shaped cavities. A relevant concern may still be the establishment of adhesive interfaces in dentin/cementum.

Clinical significance: Although non-carious cervical lesions are strongly being recognized multifactorial and their respective restorations not always behave as expected, biocorrosion and eccentric occlusal loading interplay cannot serve as an explanation for marginal gaps they often present.

1. Introduction

The theory of tooth abfraction suggests that – particularly eccentric – occlusal loading is one of the causes of wedge-shaped non-carious cervical lesions (NCCLs) (Grippo, 1991; Grippo et al., 2012; Lee et al., 2002; Rees et al., 2003). Similarly, such loading seems to contribute to the failure of respective restorations (Francisconi et al., 2009; Pongprueksa et al., 2007; Sawlani et al., 2016; Senawongse et al., 2010;

* **Corresponding author.** Department of Operative Dentistry/University of São Paulo, School of Dentistry, Avenida Professor Lineu Prestes, 2227, 05508-000, São Paulo, SP, Brazil.

E-mail addresses: jfernando.ordoneza@ucuenca.edu.ec (J.F. Ordóñez-Aguilera), karin.landmayer@usp.br (K. Landmayer), carlos.shimokawa@usp.br (C.A.K. Shimokawa), giovanni.liberatti@gmail.com (G.A. Liberatti), miturbin@usp.br (M.L. Turbino), luff@usp.br (L.F. Francisconi-dos-Rios).

[1] University of Cuenca, School of Dentistry, Cuenca/Ecuador 32Q5+HFF, Cuenca, Ecuador.

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Yazici et al., 2003).

It has already been advocated that a single etiological factor would be the responsible for the wear, but numerous observations point to the multicausality (Daley et al., 2009; Grippo et al., 2013; Palamara et al., 2001; Sawlani et al., 2016). Wedge-shaped NCCLs would be primarily caused by stresses arising from chewing and parafunctional habits: they would make the tooth to deflect, resulting in the concentration of tensile stresses on its cervical bulge and in the progressive breakdown of enamel (Bartlett and Shah, 2006; Grippo, 1991; Grippo et al., 2012; Guimarães et al., 2014; Lee and Eakle, 1984; McCoy, 1982; Rees et al., 2003). Abrasion and especially biocorrosion (tooth erosion) secondary role had been considered though, since the early 1980s (Lee and Eakle, 1984).

By studying stress corrosion cracking of enamel, Whitehead et al. (1999) have reported the incidental formation of wedge-shaped cervical lesions in extracted premolars. A 5-day axial occlusal loading associated with a 10% aqueous sulfuric acid solution, followed by a 7-day water immersion, resulted in the lesions. Abfraction concept has been reformulated accordingly: in an acidic environment, toothpaste abrasion would favor the wear associated with tensile stresses concentrated in the cervical region of the teeth (Grippo et al., 2004). Further evidences support this reformulation (Bartlett et al., 1999; Romeed et al., 2012), also validating the application of eccentric occlusal loading have not previously influenced marginal quality of cervical restorations, regardless of the restorative material, or their association (Anhesini et al., 2019).

Factors other than occlusal loading seen to have to contribute to the onset of a NCCL (Sawlani et al., 2016), even though it could be responsible for its progression (Takehara et al., 2008). Something like that may also be true for marginal gaps, already conceivable when tensile stresses, alone, concentrate in large cervical restorations (Zeola et al., 2016). Enamel demineralization in NCCLs is significantly greater in the presence of tensile stresses, due to the greater gaps between the enamel and dentin, to stress corrosion cracking and to the increased enamel permeability to acid (Leal et al., 2017). It is thus possible that biocorrosion be the initial factor causing NCCLs, and the eccentric occlusal loading, the supporting one.

Since any therapy must be performed taking into account the cause (s) of the lesion, in order to prevent it from reappearing or the restoration to fail (Ichim et al., 2007), the aim of this this study is to evaluate role of an erosive challenge and eccentric occlusal loading, even associated in different ways, in the marginal quality of cervical composite restorations. Null hypotheses are the following: biocorrosion and eccentric occlusal loading, or their interplay, would not influence 1) marginal quality of cervical restorations, evaluated by scoring (0–3) the gaps; 2) marginal quality of cervical restorations, evaluated by measuring (μm) the gaps; or 3) occlusal margins, determined in enamel, differently from cervical margins, determined in dentin/cementum. Besides, 4) there would not be a correlation between marginal quality evaluated by scoring and by measuring the gaps.

2. Materials and methods

2.1. Experimental design (Fig. 1)

This in vitro study evaluated the marginal quality of cervical restorations in wedge-shaped cavities, prepared in extracted human single-rooted upper premolars, considering the association of an erosive challenge (1% citric acid, 10 min: E) and eccentric occlusal loading (150 N, 2.5 Hz and 10^6 cycles: EOL), in 6 levels: E only (E); EOL only (EOL); E before EOL (E + EOL); E intermediate to EOL (EOL/E/EOL); E after EOL (EOL + E); and no E or EOL (C/Control).

Margins were analyzed by means of Optical Coherence Tomography (OCT) imaging (Bortolotto et al., 2015; Shimada et al., 2015), considering as the response variable, for each of the margins (O: occlusal or C: cervical), the length of the marginal gaps, classified by scores or measured in μm, using Image J.

2.2. Specimens preparation

The Biobank (Human Teeth Division) of the main author's institution committed to providing eighty human upper single-rooted premolars, healthy and extracted, for study conduction, after research protocol approval by the Committee for Ethics in Research on Human Beings (CAAE 94334818.4.0000.0075; Research Project Approval: assents #2.798.897 and #2.943.894; Final Report/Results Approval: assents #4.251.082 and #4.251.089). From the total number, sixty premolars were selected according to cervico-occlusal, mesio-distal and bucco-lingual ratios, as well as cusp height (buccal and lingual) and root length. They were measured using a digital caliper (AOS CD-6″ ASX-B, Mitutoyo Digmatic Caliper, Mitutoyo Sul Americana, Suzano/SP-Brazil) and statistically analyzed (Shapiro-Wilk and Brown-Forsythe tests plus one-way ANOVA, $\alpha = 0.05$), to establish six experimental groups ($n = 10$) similar to each other ($p < 0.05$ in each measure).

Standardized wedge-shaped cavities, located in enamel (occlusal margin) and dentin/cementum (cervical margin), were prepared in the cervical area of the premolars using a water-cooled, high-speed handpiece and straight edge cylindrical diamond burs #3100 (KG Sorensen Indústria e Comércio, Barueri/SP-Brazil), replaced every five preparations, as per Francisconi et al. (2009). The bur edge was placed at 45° to the buccal surface of the teeth, over the cementoenamel junction, and its entire diameter pressed in the described position, before being advanced horizontally, from the medial dental line, 2 mm mesially and 2 mm distally. Derived cavities thus presented standardized dimensions of 1.2 mm deep, and 2.5 and 4.0 mm wide occlusocervically and mesiodistally. Cavity walls were finished with hand instruments (Duflex 8/9, SS White Artigos Dentários, Rio de Janeiro/RJ-Brazil).

They were acid-etched (37% phosphoric acid/20 s), rinsed (40 s) and gently dried with absorbent paper. Adper Single Bond 2 (3M ESPE Division, St. Paul/MN-USA) was applied following the manufacturer's instructions and photopolymerized (20 s, Radii-cal, SDI Limited, Bayswater/Vic. - Australia). Filtek Z250 XT (3M ESPE) was taken to the cavity in two increments; the inner was photopolymerized for 20 s and the outer, for 40 s.

Teeth were stored in distilled water at 37 °C for one week, after which, restorations were finished with growing grit flexible discs (Diamond Pro, FGM Produtos Odontológicos, Joinville/SC - Brazil) and polished with felt discs (Diamond Flex, FGM) in association with a diamond paste (Diamond R, FGM).

2.3. Premolars embedment in acrylic resin

Teeth of all EOL groups were embedded in acrylic resin (Jet - Acrílico Autopolimerizante - Artigos Odontológicos Clássico, Mogi Mirim/SP - Brazil) with the long axis lingually inclined (40°) (adapted from Soares et al., 2015). Periodontal ligament was simulated with a medium viscosity impression polyether (Impregum Impression System Materials, 3M ESPE).

2.4. Erosive challenge

Already restored, and if applicable temporarily removed from the acrylic resin, premolars were either solely, before, intermediate to, or after EOL, submitted to an erosive challenge. Groups of 5 teeth were mounted into a silicone (Optosil/Xantopren, Kulzer GmbH., Hanau - Germany) matrix, and immersed in 50 ml of 1% citric acid (pH ~2.3), for 10 min, followed by washing with distilled water for 1 min (Ganss et al., 2001; João-Souza et al., 2015).

2.5. Occlusal loading

Occlusal loading was performed at a frequency of 2.5 Hz for 10^6 cycles at 150 N in 37 °C distilled water, as already deliberated before (Francisconi et al., 2009). Force was applied obliquely (40° to the long axis of the tooth) at a small seating prepared closest to the center of the buccal cusp ridge of the lingual cusp of each premolar (Pereira et al., 2016; Soares et al., 2015), using stainless steel torpedo-shaped tips (alloy 304, elastic modulus 193 GPa/28 10^6psi, Poisson's ratio 0.30, Ø6.35 mm × 55 mm, torpedo-shaped end 11.31° x Ø4 mm x 12 mm), in a pneumatic mechanical cycler (Biocycle; Biopdi, São Carlos/SP-Brazil).

Teeth of the C and E groups spent only stored in distilled water at 37 °C as much time as that of the EOL groups spent undergoing mechanical cycling (~115 h).

2.6. Marginal defects assessment

Teeth were positioned with the surface of the restoration perpendicular to the light beam on an analyzer table of Spectral Domain Optical Coherence Tomography system (SD OCT, OCP930RS, Thorlabs Inc., Newton, NJ, USA) operating with a super luminescent light-emitting diode, wavelength of 930 nm, 2 mW power, lateral and longitudinal resolutions of 6.2 μm, and capable of displaying up to 8 images per second. Five cross-sectional 2D images (B-scan), 800 μm in depth, containing both margins of the restoration, and then other five images of each the occlusal and the cervical margins of the restoration, were obtained from each tooth: one from the middle of the restoration, two every 500 μm of the first, in the mesial direction, and two, in the distal direction. Images were extracted from the equipment using *Rescale* software (not registered, by Dr. Anderson Zanardi de Freitas) since they are originally generated with different resolutions, in pixels, between height and width, but must be resized in a 1:1 ratio for analysis in any image evaluation program. Hence they were properly organized by specimen, in a.pptx file (Microsoft PowerPoint 2016; Microsoft Informática Ltda., São Paulo/SP - Brazil), and analyzed by two calibrated evaluators (for both the occlusal and the cervical margin, intra-examiner, for both examiners, and inter-examiner Kappa coefficients revealed always 1.0) according to the length of marginal gaps, determined in scores (0, 1, 2, or 3, corresponding to no gaps or gaps up to the external, the middle or the inner third of the cavity wall, Figs. 2 and 3). In the event of disagreement between the evaluators, they reached to a consensus.

Gaps were also measured, from the cavosurface angle up to its limit towards the bottom of the cavity, in μm, using Image J™ 1.50e (Image J, NIH, Bethesda/MD - USA). Three measurements were taken for each gap, and the average of these measurements was attributed to that margin of the specimen. The lengthier gap (white dots resulting from areas of greatest light scattering) identified on each margin of a given tooth was considered.

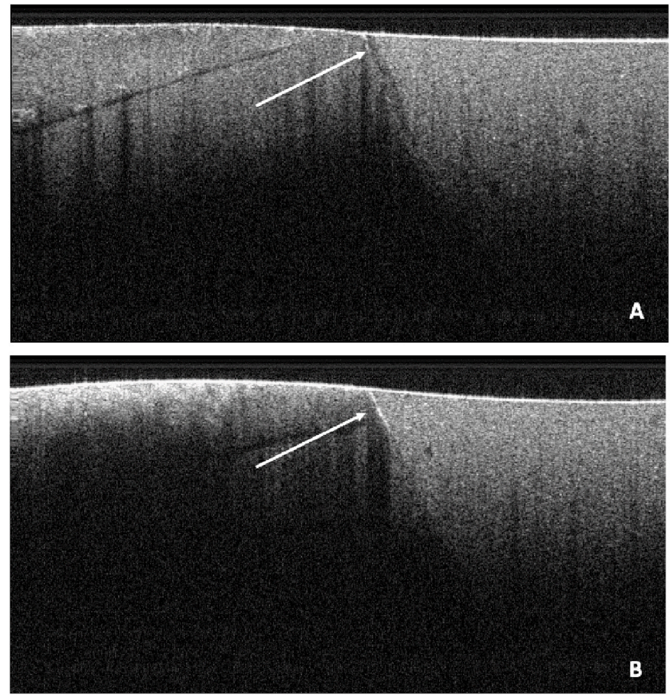

Fig. 2. Representative OCT images of margins in enamel assigned the scores 0 (A) and 1 (B). Scores 2 and 3 were not assigned for any margins in enamel.

2.7. Statistical analysis

Analysis of nominal qualitative data, determined in scores, considering each margin (O or C) separately, was performed by means of a non-parametric analysis of variance (Kruskall Wallis) and by Dunn's multiple comparison test, necessary in the case of the cervical margin. Analysis of continuous numerical quantitative data, determined in μm, was performed by means of Kruskall Wallis non-parametric analysis of variance, since they did not show, for any of the margins (O or C), a normal distribution (Shapiro-Wilk, O: Failed $p < 0.05$; C: Failed $p < 0.05$). SigmaPlot 12.0 was the statistical program used (Systat Software, Inc., San Jose/CA - USA).

Overall and for each level of the factor under study, the different cavity margins were compared using Wilcoxon signed-rank test, and the possible correlation between the analysis by scores or μm, Spearman's

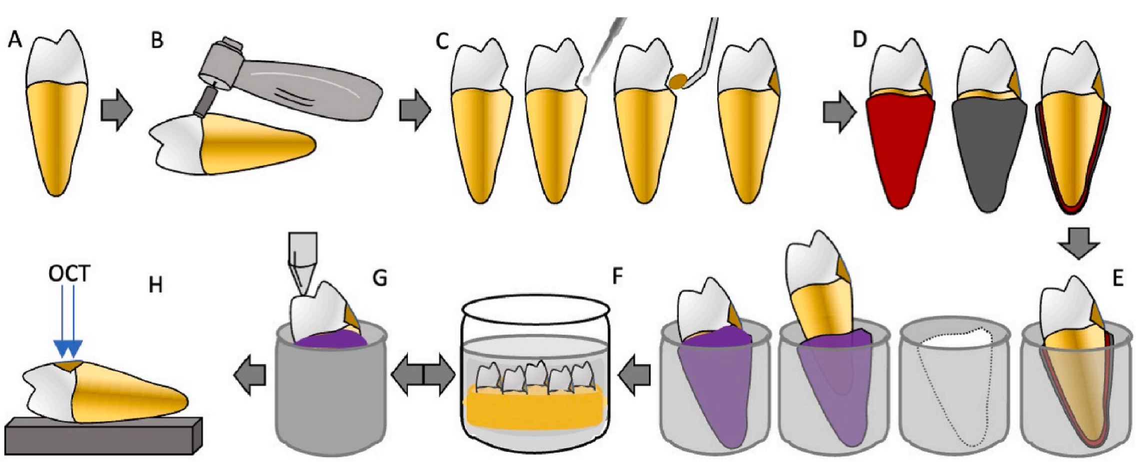

Fig. 1. Study flowchart – A. Human upper single-rooted premolars; B. Wedge-shaped cavities preparation using a straight edge cylindrical diamond bur #3100; C. Adhesive system application (Adper Single Bond 2) and resin composite restoration; D.and E. Periodontal ligament simulation with a medium viscosity impression polyether and teeth embedment in acrylic resin (with the long axis lingually inclined - 40°); F. Erosive challenge; G. Occlusal loading; their different interplays; and H. Marginal quality evaluation via Optical Coherence Tomography (OCT) Imaging.

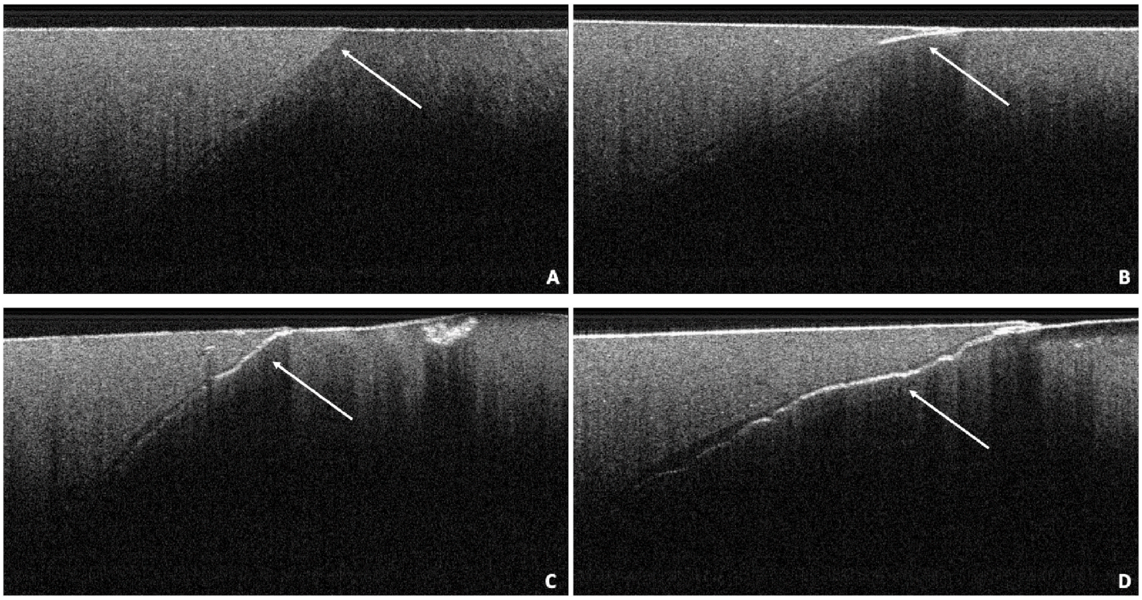

Fig. 3. Representative OCT images of margins in dentin assigned the scores 0 (A), 1 (B), 2 (C), and 3 (D).

correlation coefficient. OriginPro 2017 was the statistical program used (OriginLab Corporation, Northampton/MA - USA).

A significance level of 0.05 was always adopted.

3. Results

When assigning each of the margins a gap score, factor under study did not influence enamel marginal quality ($p = 0.892$), but influenced dentin/cementum marginal quality ($p = 0.004$). E and EOL, even if associated, did not impaired enamel marginal quality (Fig. 4). EOL/E/EOL only impaired dentin/cementum marginal quality and compared to E alone. E + EOL, EOL + E or EOL and even C, without differences between each other, did not influence results differently from E or EOL/E/EOL (Fig. 5).

When marginal gaps were measured (μm), E and EOL, or any kind of their interplay, did not influence both enamel ($p = 0.856$, Fig. 6) and dentin/cementum marginal quality ($p = 0.100$, Fig. 7).

Margins in dentin/cementum always showed lengthier gaps than margins in enamel, both when assigned a score and when measured (μm), overall ($p < 0.001$, Fig. 8; $p < 0.001$, Fig. 9) and for each group (C $p = 0.008$, $p = 0.002$; E $p = 0.031$, $p = 0.004$; EOL $p = 0.016$, $p = 0.004$; EOL + E $p = 0.002$,$p = 0.002$; EOL/E/EOL $p = 0.004$, $p = 0.002$; E + EOL $p = 0.004$, $p = 0.004$).

Overall and for both margins, there was a strong positive correlation between scores and μm (Table 1). The same revealed for each group, except for cervical margin of C, in which there was a moderate positive correlation, and of E and COE + E, in which there was no correlation (Table 2).

4. Discussion

Based upon the results, null hypotheses must be 1, 3, and 4) rejected and 2) not rejected. Although the unfavorable aspect of the erosive challenge intermediate to eccentric occlusal loading may not be irrelevant, compared to the erosive challenge only, one or the other, or even their interplay, cannot be assumed as causes of marginal failure of cervical composite restorations in wedge-shaped cavities, particularly if marginal gaps are measured, in μm.

This is in agreement to what has been advocated concerning wedge-shaped NCCLs themselves (Grippo, 1996; Grippo et al., 2012; Palamara

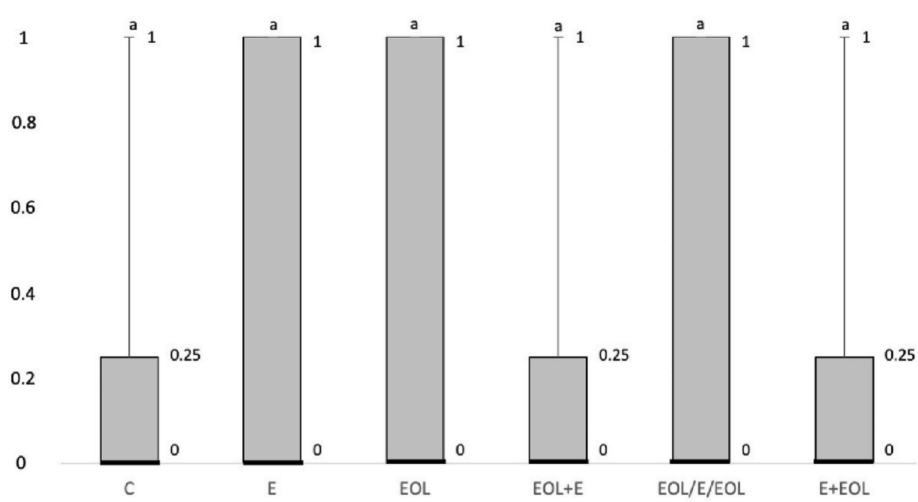

Fig. 4. Scores data (25%/median/75%) of the gaps identified in the occlusal margin (O, in enamel) in each experimental group (C; E; EOL; EOL + E; EOL/E/EOL; E + EOL). Different letters indicate statistically significant differences.

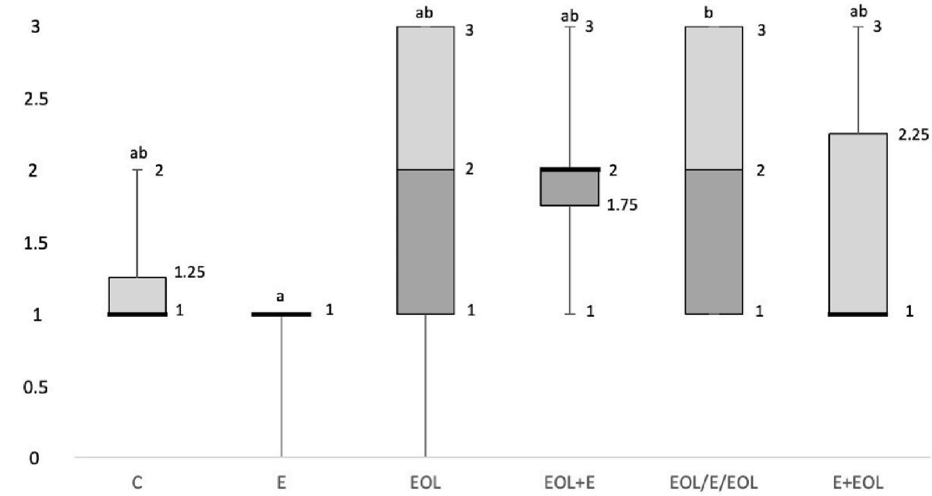

Fig. 5. Scores data (25%/median/75%) of the gaps identified in the cervical margin (C, in dentin/cementum) in each experimental group (C; E; EOL; EOL + E; EOL/E/EOL; E + EOL). Different letters indicate statistically significant differences.

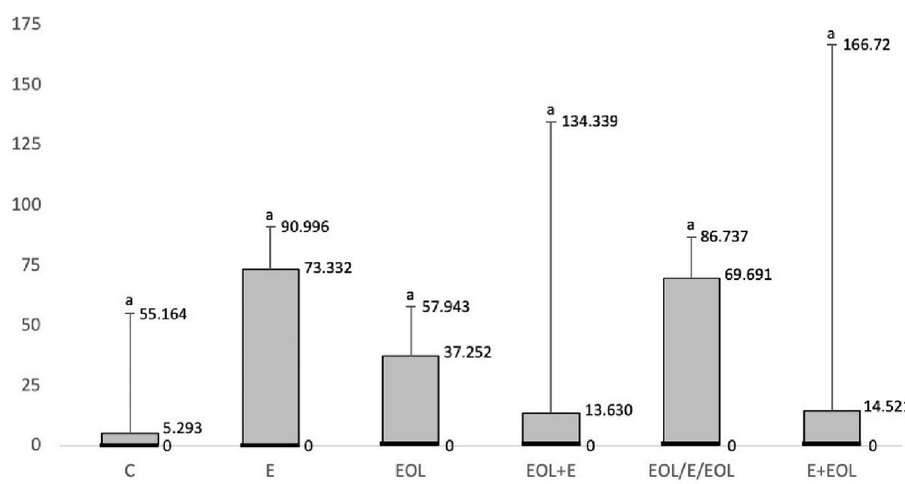

Fig. 6. μm data (25%/median/75%) of the gaps identified in the occlusal margin (O, in enamel) in each experimental group (C; E; EOL; EOL + E; EOL/E/EOL; E + EOL). Different letters indicate statistically significant differences.

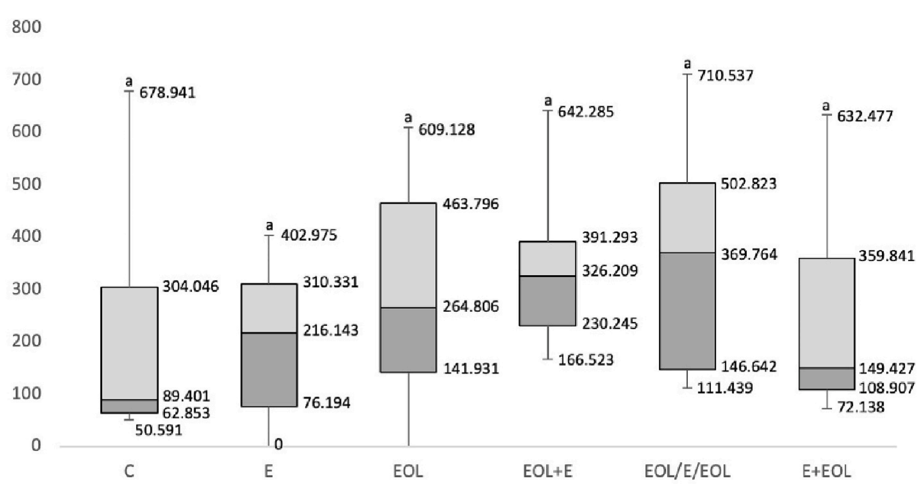

Fig. 7. μm data (25%/median/75%) of the gaps identified in the cervical margin (C, in dentin/cementum) in each experimental group (C; E; EOL; EOL + E; EOL/E/EOL; E + EOL). Different letters indicate statistically significant differences.

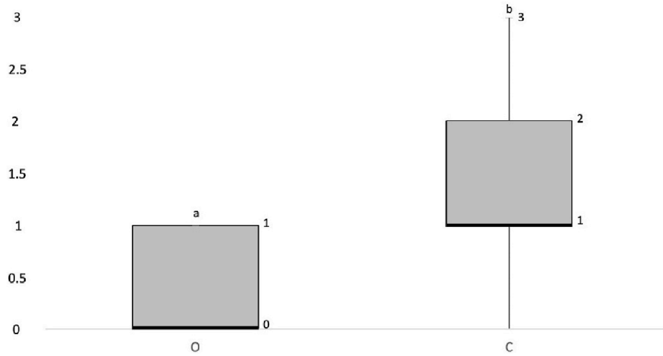

Fig. 8. Scores data (25%/median/75%), of the gaps identified in the occlusal margin (O, in enamel), compared to that in the cervical margin (C, in dentin/cementum). Different letters indicate statistically significant differences between margins.

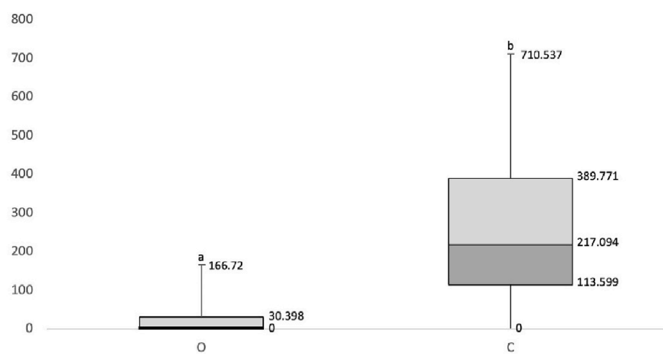

Fig. 9. µm data (25%/median/75%), of the gaps identified in the occlusal margin (O, in enamel), compared to that in the cervical margin (C, in dentin/cementum). Different letters indicate statistically significant differences between margins.

et al., 2001): erosive challenges, alone, or even before or after eccentric occlusal loading, seem not to be accountable for the defects; they may play a significant role only when being intermediate to the occlusal loading.

Wedge-shaped NCCLs did not result from teeth immersion in a 10% sulfuric acid solution only, but became a fact when teeth, immersed in that solution, underwent an – axial – occlusal loading (Whitehead et al., 1999). An exacerbation of the effects of tensile stresses concentrated at the cervical region of teeth also connected to cyclic loading simultaneously to soaking in a buffered (pH 4.5) 1% lactic acid solution: loaded teeth showed a ten times greater enamel loss than the non-loaded (Palamara et al., 2001). Stresses by their own, even if of a tensile sort, are not capable of prompting tooth wear, nor enamel and/or dentin microcracks: they can actually corroborate biocorrosion effects (Leal et al., 2017).

In parallel, regarding marginal quality of wedge-shaped cervical restorations, perhaps for the margins in dentin/cementum, where sealing is far from perfect (bonding is not really predictable, satisfactory and lasting (Arisu et al., 2008; Ben-Amar et al., 2005)), occlusal loading may favor arising of gaps, more gaps or lengthier, transient, gaps. They would thus be acid permeate (in the event of the erosive challenge intermediate to occlusal loading, or maybe concomitantly), furthering stress corrosion cracking (with the sequel occlusal loading). Even though this is a reasonable explanation for the onset of wedge-shaped NCCLs in extracted teeth, they only showed in 8% of those loaded while immersed in an acidic environment (Whitehead et al., 1999).

Indeed, abfraction theory is still very controversial (Bartlett and Shah, 2006; Estafan et al., 2005; Grippo, 2010; Khan et al., 1999; Litonjua, 2010; Litonjua et al., 2004); it undoubtedly lacks more scientific support, especially derived from clinical trials (Bartlett and Shah, 2006; Estafan et al., 2005; Khan et al., 1999). Role of NCCLs restoration with a composite also remain debatable: some believe it prevents stresses from being concentrated in the defect (Guimarães et al., 2014; Soares et al., 2015), minimizing deterioration of remaining structure (Eliguzeloglu et al., 2011; Grippo, 1992; Soares et al., 2015). Micromechanical bonding of resinous materials to dental substrates appears to allow the interface to withstand also tensile stresses, what would happen naturally for compression stresses (Grippo, 1992). From another point of view, even if loading lingual cusp of premolars ends up concentrating higher tensile stresses at their buccal bulge, compared to loading buccal or both cusps (Soares et al., 2015), compressive stresses, which prompt an occluso-cervical reduction, are the kind that seem to favor marginal defects and failure of cervical restorations (Vasudeva et al., 2011).

As for the consequences of acids contacting composites, they tend to be irrelevant compared to those seen for glass ionomer cements (El-Badrawy and McComb, 1998; Honório et al., 2008; Turssi et al., 2002) and, mostly, for the surrounding enamel (Francisconi et al., 2008; Honório et al., 2008). As regards that of erosive and erosive-abrasive challenges on adhesive interfaces, they have been barely studied so far (Assunção et al., 2018). In advanced stages, erosive tooth wear leads to marginal degradation and elevated isles of restorative material (Carvalho et al., 2015). Otherwise, marginal microleakage resulting from one or another seems not to differ from controls (Amaral et al., 2001; Amarante de Camargo et al., 2006; Pilo and Ben-Amar, 1999; Toledano et al., 2012), similarly to what was now shown.

Limitations of in vitro models to study role of non-carious cervical lesions multicausality in the behavior of respective restorations should finally be taken into account. It is possible that simulating the periodontal ligament, or even preparing the small seating to make the loading torpedo-shaped tips steady, may have contributed to a lower concentration of stresses in the cervical region of the teeth (Heintze and Cavalleri, 2006). Perhaps the occlusal loading itself, due to the adopted parameters, have not been capable of significantly influencing marginal quality of studied restorations, even though those, and others of lesser magnitude, have done it before (Arisu et al., 2008;Francisconi et al., 2009; Machado et al., 2017; Soares et al., 2015).

Possibly no differences between control and other conditions is also justified by carrying this in vitro study with sound extracted teeth, in which wedge-shaped NCCLs were simulated. It is clinically complex to successfully restore NCCLs not only because of their complex morphology, the lack of mechanical retention and the unfavorable location (with the cervical margin typically located in dentin/cementum) (Santos et al., 2014; Sooraparaju et al., 2014), but also due to difficulties related to moisture control and to the presence of sclerotic, eroded, abrasive, i.e., highly modified, not sound, dentin as the substrate (Daley et al., 2009; Grippo et al., 2012; Pecie et al., 2011; Perez et al.,

Table 1
Mean values and standard deviations (sd), in scores and in µm, of the gaps identified in the occlusal margin (O, in enamel), compared to that in the cervical margin (C, in dentin/cementum), and respective statistical inferences.

	O				C			
	Mean	sd	Corr.	p	Mean	sd	Corr.	p
Score	1.55	0.790	0.721	0.047	1.55	0.7903	0.782	<0.001
µm	19.339	37.207			268.116	185.749		

Table 2
Mean values and standard deviations (sd), in scores and in μm, of the gaps identified in each experimental group (C; E; EOL; EOL + E; EOL/E/EOL; E + EOL), in the occlusal margin (O, in enamel), compared to that in the cervical margin (C, in dentin/cementum), and respective statistical inferences.

		O				C			
		Mean	sd	Corr.	p	Mean	sd	Corr.	p
C	Score	0.2	0.422	0.994	<0.001	1.2	0.422	0.696	0.025
	μm	7.634	17.977			202.571	220.112		
E	Score	0.3	0.483	0.981	<0.001	0.9	0.316	0.522	0.122
	μm	24.930	40.641			197.978	136.619		
EOL	Score	0.3	0.483	0.981	<0.001	1.8	1.033	0.925	<0.001
	μm	14.000	23.282			295.882	199.956		
EOL + E	Score	0.2	0.4216	0.994	<0.001	1.9	0.568	0.405	0.246
	μm	18.886	44.036			335.739	133.457		
EOL/E/EOL	Score	0.4	0.5164	0.961	<0.001	2	0.817	0.809	0.005
	μm	28.101	37.445			350.369	208.237		
E + EOL	Score	0.2	0.422	0.994	<0.001	1.5	0.850	0.787	0.007
	μm	22.480	53.868			226.161	179.620		

$p < 0.05$ indicates that there was a correlation between the variables; negative Corr. values indicate a negative correlation between the two variables (if one increases, the other always decreases), and positive Corr. values, a positive correlation between the two variables (if one increases, the other also increases); the intervals 0–0.29, 0.3–0.49, 0.5–0.69, 0.7–0.89, 0.9–0.99 and exact 1.0, for more or for less, indicate, respectively, negligible, weak, moderate, strong, very strong and perfect correlation.

2012; Peumans et al., 2014; van Meerbeek et al., 1994).

Gaps found in teeth of the control group, and their considerable dimensions, may explain no differences from those submitted to the erosive challenge and/or the eccentric occlusal loading. Such defects must have originated from technical artifacts, from stresses related to the polymerization contraction of resinous materials, or from vibrations intrinsic to finishing and polishing (Dionysopoulos et al., 2014; Grippo, 2010). Even if analyzed immediately after its careful achievement, no restoration is completely free of interfacial defects (Bakhsh et al., 2011).

Anyway, mathematical simulations of teeth under occlusal loading have revealed gaps in NCCLs restorations more often at the cervical margin, in accordance with most of the defects observed clinically (Ichim et al., 2007). In fact, marginal gaps are invariably more often for margins in dentin, compared to that in enamel, regardless of occlusal loading performing or not (Fruits et al., 2002).

It seems recognizable, therefore, there is much more to be studied concerning not only NCCLs, but also the failure of respective restorations indeed. Reasons why an erosive challenge intermediate to eccentric occlusal loading proved to be capable of impairing marginal quality of cervical restorations compared to that challenge alone, but not to any of their interplays, or the loading alone, or even no challenge or loading, must be clarified. Besides, since this difference was found only when scoring, not measuring (μm), marginal gaps, it deserves attention.

5. Conclusions

Tooth abfraction, although aided, in different ways, by biocorrosion, cannot be assumed a reasonable explanation for marginal gaps cervical restorations in wedge-shaped cavities often present. A relevant concern, even for restoring NCCLs, may still be, more than the persistence of the etiological factors of the tooth wear, the establishment of adhesive interfaces in dentin/cementum.

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CRediT authorship contribution statement

Juan Fernando Ordóñez-Aguilera: Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Karin Landmayer:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Carlos Alberto Kenji Shimokawa:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Giovanni Aguirra Liberatti:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Anderson Zanardi de Freitas:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Míriam Lacalle Turbino:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Heitor Marques Honório:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Luciana Fávaro Francisconi-dos-Rios:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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