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Resin-Based Materials Protect Against Erosion/Abrasion—a Prolonged *In Situ* Study

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Clinical Relevance

The application of resin-based materials, including resin infiltrants, on previously eroded enamel subjected to prolonged *in situ* erosive and abrasive challenges, was able to arrest enamel loss. This is a promising finding to support conducting clinical trials testing resin infiltration.

SUMMARY

While patient compliance is key to preventive measures related to dental erosion, the application of resin-based materials could serve as an additional treatment to inhibit erosion progression. This *in situ* study evaluated the effect of applying resin-based materials, including resin infiltrant, on previously eroded enamel subjected to prolonged erosive and abrasive challenges. The factors under study were types of treatment (infiltrant [Icon], sealant [Helioseal Clear], adhesive [Adper Scotchbond Multi-Purpose Plus], and control [no treatment]); wear conditions (erosion [ERO] and erosion + abrasion [ERO + ABR]) and challenge time (5 and 20 days) in a single-phase study. The blocks were prepared from bovine enamel, eroded (0.01 M HCl, pH 2.3 for

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30 seconds) and randomized among treatments, wear conditions, and volunteers. The application of resin-based materials followed the manufacturers' recommendations. Twenty-one volunteers wore the palatal intraoral device, in which one row corresponded to ERO and the other to ERO + ABR. In each row, all treatments were represented (2 blocks per treatment). For 20 days, the erosive challenge was performed 4 times/day (immersion in 0.01 M HCl, pH 2.3, for 2 minutes) for the ERO condition. For the ERO + ABR condition, two of the erosive challenges were followed by abrasion for 15 seconds with fluoride dentifrice slurry. Enamel and/or material loss was measured using profilometry (initial, after treatment, and after the end of the fifth and 20th days of *in situ* erosive challenge) and analyzed by ANOVA models and Tukey's test (α=0.05). The results showed that the application of resin-based materials did not cause superficial enamel loss. The infiltrant group showed a thicker layer of material above the enamel compared with the other materials (*p*=0.001). After the erosive challenge, there was no difference between the conditions ERO and ERO + ABR (*p*=0.869). All materials protected the enamel against erosion progression compared with the control group (*p*=0.001). Based on these results, we conclude that the application of resin-based materials results in protection of previously eroded enamel subjected to *in situ* erosive and abrasive challenge for 20 days.

INTRODUCTION

Over recent decades, there has been increased concern regarding erosive tooth wear (ETW).[1,2] Ideal preventive measures might act on ETW etiological factors[3]; however, specific protective products or materials can be applied to erosive lesions to increase treatment effectiveness.[4,5] The application of resin sealant and bonding materials over enamel has been shown to form a physical barrier, preventing contact of the erosive agent with the tooth surface, reducing ETW progression.[5-17]

Another resin-based material that was tested for erosion inhibition is resin infiltrant,[13-15,17] which was originally developed for initial dental caries arrest.[18,19] The infiltrant consists of a special low-viscosity resin that penetrates into the porous body of carious white spot lesions, blocking the diffusion of acids. Results on the effectiveness of resin infiltration on dental erosion are controversial.[13-15,17] In the study of Zhao and others (2017),[17] the use of 15% HCl on enamel for 2 minutes before applying the infiltrant promoted about 15 µm of enamel loss, and no protection against erosion associated with abrasion was observed. In contrast, other studies showed the formation of a 100-µm thickness of infiltrant coating over enamel when similar enamel conditioning was applied.[13,15] Moreover, after the erosive challenge, no enamel was lost.[13,15] Probably the mode of application of the material influences its thickness and its ability to prevent erosion. In addition, it was previously demonstrated that the presence of the resin infiltrant only inside the eroded surface does not inhibit erosion progression, that is, the material must remain on the enamel surface.[15]

There is no method available to measure the ETW lesion clinically, and most of the studies have not been conducted *in vivo*.[20] *In vitro* studies allow researchers to control the experiment and use precise measuring methods, but provide a low level of scientific evidence. Alternatively, *in situ* studies are an intermediate protocol between *in vivo* and *in vitro* that permit exposing the tooth specimens to the oral environment with all its biological variations and contact with saliva.[21] It is known that saliva is the predominant biological factor influencing the development and progression of ETW.[22,23] Taking into account that ETW is a chemical-mechanical process of dental hard tissue loss, with acid as the main cause,[2] the association between chemical and physical insults better resembles the clinical situation. In addition, it is important to clarify the property of a thick layer of infiltrant coating to resist erosion associated with abrasion *in situ*. Therefore, the present *in situ* study evaluated the effects of applying resin-based materials, including resin infiltrant, on previously eroded enamel subjected to prolonged erosive and abrasive challenges. The hypothesis of this study was that the tested infiltrant, sealant, and adhesive materials would protect eroded enamel against ETW (a chemical-mechanical process).

METHODS AND MATERIALS

Experimental Design

This study had a single-blind, single-phase randomized *in situ* design. The factors under study were types of treatment (infiltrant [Icon], sealant [Helioseal Clear], adhesive [Adper Scotchbond Multi-Purpose Plus], and control [no treatment]), wear conditions (erosion [ERO], erosion + abrasion [ERO + ABR]), and challenge time (5 and 20 days). Sample size calculation was based on a pilot *in situ* study with four volunteers. A sample size of 20 volunteers was estimated based on a type I error (α) of 5%, type II error (β) of 20%, 3.8 μm of enamel and/or material loss as the minimum detectable difference in means, and 3.5 μm of enamel and/or material loss as the estimated standard deviation. Considering a possible dropout, 21 subjects were selected. Bovine enamel blocks (n=430) were eroded (HCl for 30 seconds), selected by their hardness (n=336), and randomized among treatments, wear conditions, and volunteers. Each volunteer (n=21) wore an acrylic palatal device with two rows, each containing eight bovine enamel blocks, one row corresponding to ERO and the other to ERO + ABR. In each row, all treatments and control were represented (two blocks per treatment). The erosive cycling procedure consisted of immersing the palatal device extraorally in 0.01 M HCl, pH 2.3, for 2 minutes, four times per day for 20 weekdays. On weekends, the devices were maintained immersed in artificial saliva. On the ERO + ABR condition, the first and third erosive challenges were followed by abrasion for 15 seconds with fluoride dentifrice slurry. The response variable was tissue loss, determined profilometrically after the fifth and twentieth weekday challenges.

Enamel Block Preparation

Four hundred thirty bovine enamel blocks (4 × 4 × 3 mm) were prepared from freshly extracted bovine incisors. The enamel blocks were cut using a cutting machine (Isomet low-speed saw, Buehler Ltd, Lake Bluff, IL, USA) and two diamond disks (Extec Corp, Enfield, CT, USA), which were separated by a 4-mm thick spacer. The block's surface was ground flat with water-cooled silicon carbide discs (320, 600, and 1200 grades of Al_2O_3 papers - Buehler) and polished with felt paper wetted by 1-μm diamond spray (Buehler). The blocks were ultrasonicated in deionized water for 10 minutes (T7 Thornton, Unique Ltda, São Paulo, SP, Brazil) between polishing steps.

The enamel blocks were then marked with a scalpel blade (Embramac, Itapira, SP, Brazil) to define the reference areas at 1.0 mm (border) and the test area at 2.0 mm (center) in width. The initial profile of the blocks was evaluated using a profilometer (Marh; MarSurf GD 25, Göttingen, Germany) and contour software (MarSurf XCR 20). The blocks were fixed to a special holder to standardize their positions. Their locations were recorded to allow their replacement after material application and the *in situ* phase. In each block, five readings were made of the relative position of the block on the *y*-axis at the following distances: 2.25, 2.0, 1.75, 1.5, and 1.25 μm. The profile of each reading was saved individually. Any block that did not present an adequate flat surface was discarded.

Surface hardness was determined by performing five indentations at distances of 100 μm from each other on the test area of the blocks (Knoop diamond, 25 g, 10 seconds, hardness tester from Buehler). The initial mean hardness of the blocks (SHi) was 355 ± 11 KPa/mm^2. The erosion lesion was developed by immersing the blocks in 0.01 M HCl (pH 2.3) for 30 seconds (17.6 mL/block), resulting in surface softening without tissue loss.[24] The surface hardness determination was performed again (SHd) with 5 measurements at a distance of 100 μm in relation to the initial indentations (SHi). Then 336 eroded enamel blocks with Knoop hardness numbers (KHNs) between 205 and 234 (mean surface hardness, 220±11 KPa/mm^2) were selected.

The enamel blocks were sterilized by ethylene oxide gas exposure. The reference areas of the blocks (2/3) were protected by cosmetic nail varnish (Maybelline Colorama, Cosbra Cosmetics Ltda, São Paulo, SP, Brazil).

Materials Application

The resin-based materials were applied on the middle third of the enamel surface, following the manufacturers' instructions (Table 1). Afterward, the nail varnish was removed from the reference areas of the enamel surface. The blocks were repositioned on the special holder on the table of the profilometer according to their position in the baseline measurements. Five readings were performed using the same software (XCR 20, MarSurf GD 25, Göttingen, Germany) and the same measurement parameters described above (initial profilometry). Then, after re-covering the marks and reference area with nail varnish, the samples were subjected to the *in situ* phase.

In Situ Phase

This study was approved by the Local Research Ethics Committee (protocol No. 556258) and conducted in full accordance with the Declaration of Helsinki. Informed consent was obtained from the subjects at the beginning of the study. Twenty-one healthy adult volunteers (aged 20-41 years) participated in this study after satisfying the following inclusion criteria: residing in the same fluoridated area (0.70 mg F/L), physiologically stimulated salivary flow rate >1 mL/min, and adequate oral

Table 1: *Materials, Composition, and Application Steps According to the Manufacturer's Instructions*

Material	Composition	Application Steps
Adper Scotchbond Multi-Purpose Plus Adhesive	Bis-GMA, HEMA (>99wt%)	Etch with 37% H_3PO_4 (30 s), rinse and air-dry, apply adhesive Adper Scotchbond (10 s), and polymerization
Helioseal Clear	Bis-GMA, TEGDMA (>99wt%)	Etch with 37% H_3PO_4 (30 s), rinse and air-dry, apply Helioseal Clear (15 s), and polymerization
Icon	Icon-etch: HCl, pyrogenic silicic acid, surface-active substances Icon-dry: 99% ethanol; Icon-infiltrant: methacrylate-based resin matrix, initiators, and additives	Etch with 15% HCl (120 s), rinse and dry, 95% ethanol-and-air–dry, resin infiltration with a syringe (180 s), polymerization, and infiltrant reapplication (60 s), and polymerization

Abbreviations: Bis-GMA, bisphenol A-diglycidyl ether dimethacrylate; HEMA, 2-hydroxyethyl methacrylate; TEGDMA, triethylene glycol dimethacrylate.

health with no caries, erosive lesions, or significant gingivitis or periodontitis. Exclusion criteria were systemic illness, pregnancy or breastfeeding, under orthodontic intervention, and use of fluoride compounds in the last 2 months.

The palatal appliances were made with acrylic resin on a plaster model. They had two columns, one on the right side and one on the left, with four cavities (10 × 10 × 3 mm) in each column. Two enamel blocks were affixed on each cavity. One column corresponded to ERO and the other to ERO + ABR. In each column, all treatments and the control group were represented (2 blocks per treatment). The enamel blocks were fixed on the appliances with wax. An orthodontic wire was attached to the ends of the cavities, passing over the blocks without touching them on the column corresponding to erosion (Figure 1). This procedure was performed in order to prevent abrasion of the blocks by the tongue. The position of the blocks corresponding to each group was represented in each row. The position of the groups in the rows was randomly determined for each volunteer to ensure that in the role experiment, each row of the appliance had different groups (Figure 1). The positions of the ERO and ERO + ABR columns alternated among participants.

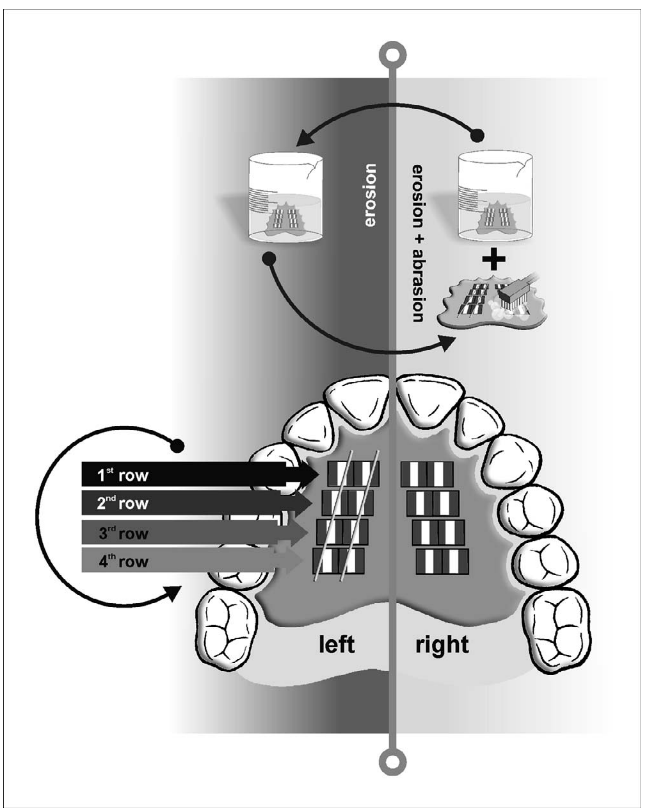

Figure 1. *Schematic illustration of the intraoral appliances.*

Seven days before and throughout the experimental phase, the volunteers brushed their teeth with a standardized toothbrush (Curaprox 5460 Ultrasoft, Curaden Swiss, Switzerland) and fluoride toothpaste (Triple Action, 1450 ppm F as sodium monofluorophosphate, Colgate, São Bernardo do Campo, SP, Brazil) after meals, without the appliances in the mouth. They were requested not to use any other fluoride product. The volunteers were trained to correctly follow the experimental *in situ* procedures. They also received written instructions and a form to register every step they followed in the *in situ* phase.

The subjects wore the intraoral appliance for 20 weekdays and business hours (7:30 AM to 6 PM ; total of 8 hours and 30 minutes of daily use), and removed it for 1 hour 45 minutes during meals[25] and on weekends. The time without the appliance provided for greater comfort of the volunteers. It was important to standardize the acid attack among the participants independently of their individual diet. When not in the mouth, the appliances were kept immersed in artificial saliva, whose composition was 0.33 g KH_2PO_4, 0.34 g Na_2HPO_4, 1.27 g KCl, 0.16 g NaSCN, 0.58 g NaCl, 0.17 g $CaCl_2$, 0.16 g NH_4Cl, 0.2

g urea, 0.03 g glucose, 0.002 g ascorbic acid, 2.7 g mucin, and 1000 mL distilled water at pH 7.0.[26] Tooth erosive challenge was simulated by immersing the appliances into 150 mL 0.01 M HCl, pH 2.3, at room temperature (37°C) for 2 minutes; this was done *ex vivo* to protect the volunteer's teeth from damage. The acid challenge was repeated four times daily at the following schedule: 8 AM, 10 AM, 2 PM, and 4 PM (whereas from 12 PM to 1:45 PM, the appliances remained outside the mouth). For the ERO + ABR condition, after the first and third acid immersion of the appliance, the volunteers applied one drop of fluoride dentifrice slurry 1:3 (Triple Action, 1.450 ppm F, Colgate Palmolive, São Paulo, Brazil) on each enamel block and only on the column corresponding to ERO + ABR, brushing each block for 15 seconds using an electric toothbrush (Oral-B Precision Clean, Procter & Gamble, Rio de Janeiro, Brazil) with a timer. The participants removed the appliances from their mouth to perform the erosive and erosive plus abrasive challenges.

Final Profilometry

At the end of the fifth and last day of the *in situ* phase, the enamel blocks were removed from the appliance and the cosmetic nail varnish was removed from the reference areas. The blocks were repositioned on the special holder on the profilometer table and profilometric analysis (five readings) was performed again at the same sites as the baseline measurements (initial profilometry).

Since the enamel specimens could be precisely repositioned in the profilometer, it was possible to match the baseline with the other profiles.[13] The graphs were superimposed and analyzed using a specific software program (MarSurf XCR 20, Göttingen, Germany). The resin-based material thickness after application and material and/or enamel loss after erosive cycling were quantitatively determined by calculating the average thickness of the materials and the depth of the eroded surface relative to the baseline surface profiles, respectively. The block enamel loss was expressed as the mean of five graphs.

Statistical Analysis

Statistical analysis was performed with SigmaPlot version 12.3 (2011 Systat Software, Erkrath, Germany). For the thickness of the coating layer after placement, two-way repeated measure ANOVA was applied. Three-way repeated measure ANOVA was applied to analyze the thickness of the coating layer and the enamel loss after the *in situ* phase, considering the three factors under study (type of treatment, wear condition, and times of challenge, the last being the repeated measure). The *post hoc* test used was Tukey's. For all cases, the level of significance was set at 5%.

RESULTS

The thickness of the coating layer of the studied materials after application is provided in Table 2, column "After treatment." There was a statistically significant difference among materials ($p<0.001$). Resin infiltrant showed the thickest layer, followed by sealant, which was followed by adhesive. There was no difference between blocks to be eroded vs abraded ($p>0.05$).

After the *in situ* phase, there was a statistically significant difference among the materials ($p<0.001$), between periods of challenge ($p<0.001$), and interaction between these criteria ($p<0.001$) (Table 2). Erosion resulted in a similar alteration of enamel and resin-based materials compared with the erosion associated with abrasion ($p>0.001$). For each material, there was no significant difference in thickness of the coating layer between 5 and 20 days of challenge. All the studied materials provided enamel protection against erosion whether associated or not with abrasion after 5 and 20 days because they differed from the control group. Enamel loss of the control group subjected to 20 days of erosion and/or abrasion was statistically significantly higher than 5 days.

Table 3 shows data on material loss (thickness after treatment minus thickness after *in situ* challenge) compared with enamel loss. There was a statistically significant difference among the materials ($p<0.001$), between challenge periods ($p<0.001$), and interaction between these criteria ($p<0.001$), but no difference was found between wear conditions ($p>0.001$). After 5 days of challenge, loss of material and enamel were statistically similar, while after 20 days, all materials were more resistant than enamel. Considering each material separately, there was no statistically significant difference of material loss between the fifth and twentieth days of challenge. The loss of enamel on the twentieth day of challenge was higher than that on the fifth day.

DISCUSSION

The results of the present study indicate that the application of resin-based materials, including infiltrant, was able to arrest enamel loss when chemical

Table 2: *Mean Material Thickness and/or Enamel Loss (μm±SD) After Treatments and Following In Situ Challenges (Erosion and Erosion Associated with Abrasion) of 5 and 20 Days*[a]

Wear Condition	Type of Treatment	After Treatment	5 Days of Challenge	20 Days of Challenge
Erosion	Adhesive	55.82 ± 26.59 A	53.99 ± 24.56 ab	47.86 ± 27.39 a
	Sealant	92.03 ± 38.74 B	83.59 ± 36.46 bc	78.37 ± 37.62 c
	Infiltrant	110.78 ± 19.67 C	107.28 ± 20.00 d	99.77 ± 20.42 d
	Control	−0.09 ± 0.03	−6.39 ± 4.65 f	−29.28 ± 42.85 e
Erosion + abrasion	Adhesive	66.43 ± 34.09 A	62.68 ± 34.58 ab	56.08 ± 36.57 a
	Sealant	87.06 ± 33.88 B	79.00 ± 27.49 bc	73.99 ± 25.50 c
	Infiltrant	116.87 ± 28.07 C	111.58 ± 28.12 d	107.68 ± 28.50 d
	Control	−0.10 ± 0.04	−11.30 ± 6.26 f	−50.29 ± 53.03 e

[a] *For column "After Treatment," different uppercase letters denote statistically significant differences (two-way repeated measures ANOVA, Tukey's test;* $p<0.05$*), the control group was not considered in this analysis. For columns "5 (20) Days of Challenge" and the lines "Erosion" and "Erosion + Abrasion," different lowercase letters denote statistically significant differences (3-way repeated measures ANOVA, Tukey's test;* $p<0.05$*). Positive and negative values correspond to enamel loss and presence of materials above enamel, respectively.*

and mechanical insults were applied. The mechanism of action of the professional application of resin-based materials on eroded enamel is the formation of a protective coating that inhibits contact of the acids with enamel,[5,27] depending on the coating's duration. Therefore, the materials' resistance to the oral challenges, mainly hydrolysis, acids, and mechanical forces, is very important. The *in situ* protocol of prolonged erosive and abrasive challenge used in this study is closer to the *in vivo* condition than the *in vitro* ones.[21] However, there are limitations that must be taken into account when transposing the results to the clinical situation. The enamel blocks were worn inside intraoral appliances *in situ*, but were eroded and abraded by brushing outside the oral environment for the sake of standardization and minimal risk to the volunteers.[28] This approach cannot adequately simulate the biological factors, such as dilution of the erosive solution by saliva or protection from erosion and abrasion by the natural pellicle, producing a higher amount of wear than in the clinical situation.[28-30] In addition, the use of electric toothbrushes ensures a standardized movement of the brush over the sample surface but also has a higher potential to damage eroded teeth than do manual brushes with the same force.[31] Brushing forces were not controlled, but the volunteers were carefully trained and instructed to brush the blocks with minimal force.

It is difficult to convert experimental characteristics and parameters—even *in situ* studies—into real, everyday situations.[28] In this study, the parameters were chosen to exaggerate clinical conditions so as to test the ability of resin-based materials to protect against ETW in a worst-case scenario. Assuming that in the daily situation, the tooth may be subjected to a maximum of 3 minutes of erosive challenge and 5 seconds of brushing with an electrical toothbrush,[17,28] a total of 160 minutes of acid attack and 120 seconds of brushing *in situ* might represent about 4 months of erosion and abrasion. The studied resin-based materials showed minimal wear (7% to 15%) during this period, and the mechanical toothbrushing forces did not take them away of the enamel. In contrast, clinically measuring palatal tooth wear after coating the dentin with

Table 3: *Mean Material Thickness Loss (Thickness After Treatment Minus Thickness After* In Situ *Challenge) and Enamel Loss (μm±SD) Following* In Situ *Challenges (Erosion and Erosion Associated With Abrasion) of 5 and 20 Days*[a]

Wear Condition	Type of Treatment	5 Days Challenge	20 Days Challenge
Erosion	Adhesive	1.83 ± 17.94 a	7.96 ± 24.79 ab
	Sealant	8.44 ± 8.34 ab	13.65 ± 12.65 b
	Infiltrant	3.50 ± 4.02 a	11.01 ± 9.53 ab
	Control	6.29 ± 4.65 ab	29.19 ± 42.85 c
Erosion + Abrasion	Adhesive	3.75 ± 4.82 a	10.34 ± 9.11 ab
	Sealant	8.06 ± 16.69 ab	13.06 ± 18.51 b
	Infiltrant	5.28 ± 6.32 a	9.18 ± 7.25 ab
	Control	11.20 ± 6.26 ab	50.19 ± 53.03 c

[a] *Different lowercase letters denote statistically significant differences (three-way repeated measures ANOVA, Tukey's test,* $p<0.05$*).*

resin-based materials showed that the preventive effect of the bonding agent lasted only 3 months.[9,10] On the other hand, a fissure sealant had lasted 9 months.[9,10] Not only the resin material's wear resistance can protect the enamel coating, but also retention of the material is of major importance for the acid-protective effect.[13,14] For resin materials' retention, the micromechanical interlocking of tiny polymerized resin tags within porosities of the acid-etched enamel surface provides the main achievable bond mechanism for the dental substrates.[32] The mechanism in dentin is more complex and less predictable because of the intrinsically hydrophilic characteristics associated with the organic matrix and its components.[32] Therefore, better results are expected for the application of acid protective layers on enamel. The differences between dentin and enamel and among commercial brands tested might explain the variation of results.

The measured mean layer of resin material formed on the enamel surface ranged from 57.86 μm (adhesive) to 107.68 μm (infiltrant). There was a great variation among the blocks for each studied material and among different materials. The application of materials was conducted by a single trained dentist (G.C.O.) and, even considering that the application was standardized, variation in *in vitro* thickness was observed. Therefore, this procedure might be subject to much more variation *in vivo*. Despite this variation in adhesive and sealant thickness among the different studies,[13,15-17,33] these materials formed a resin coating over the enamel. However, there is no consensus regarding the coating formation after the application of resin infiltrant.[13,15,17]

Zhao and others found enamel loss after treating enamel previously eroded by 15% hydrochloric acid (HCl) with resin infiltrant, while the formation of a material layer of approximately 4.5 μm was noticed when the enamel was not etched. The application of HCl was intended to remove the superficial, hypermineralized layer of the carious lesion,[34] resulting in tissue loss of approximately 15 μm when used on sound enamel.[34] Considering that eroded lesions have a lower mineral content and a mechanically less stable surface, it is likely that the softened layer of the initial erosive lesion might be removed by HCl. This is a probable side effect of resin infiltration that can be offset by resin coverage. Taking into account the fragility of the enamel etched by HCl, the infiltrant was applied with caution, gently positioning the brush onto the enamel without pressure. This procedure might be the reason for the formation of a thick layer of material in contrast to the occurrence of enamel loss in another study.[17] An alternative for the deleterious effect of HCl is the use of resin infiltration without previous enamel conditioning, which was shown to be sufficient to promote enamel coating against erosion.[15] However, this procedure resulted in less penetration on eroded enamel.[15,16] Another intermediate option that might be tested for eroded enamel is the use of H_3PO_4, which is capable of creating a microretentive surface for successful capillary diffusion and penetration of the infiltrant on sound enamel.[35,36]

There is *in vitro* evidence that eroded enamel is more susceptible to toothbrush abrasion, resulting in higher enamel loss than erosion alone.[37-40] Also for composite resins, erosion associated with abrasion resulted in higher material loss *in vitro*.[41] However, in the present study, no statistically significant difference was observed between erosion and erosion plus abrasion for enamel and the tested resin-based materials. It is hypothesized that in an *in situ* situation, there are biological factors that vary among subjects and influence the degree of wear.[1] Especially on the twentieth day of challenge, the standard deviation indicated a greater variation in enamel loss. At first, it was thought that this variation was due to the absence of brushing force standardization, but when the enamel was subjected only to erosion, a similar variation was observed. Regarding the resin-based materials, the high standard deviation had already been observed after their application.

It is expected that the resistance of the coating materials to the oral environment ensures their acid or mechanical protective effect over time.[42] Overall results of the present study indicate a similar amount of material loss over time, from the fifth to the twentieth day of assessment, with no difference among the materials. Although it was observed that at the end of 5 days of challenge, material and enamel loss were statistically similar; after 20 days, the loss of material was less than that of enamel. The higher enamel loss compared with resin-based materials is in accordance with previous studies.[43,44] This performance is mainly attributed to the composition of the materials. Even considering that the acid attack particularly compromises the polymerized net of the organic portion of materials, their overall resistance to erosion is greater than that of hydroxyapatite.

The susceptibility of resin-based materials to chemical and mechanical challenges is influenced by the type of monomer and filler content. In this case, all tested materials were filler-free, which diminishes their resistance.[45] The composition of infiltrant is based on methacrylate monomers, mainly triethylene glycol dimethacrylate (TEGDMA), that shows a higher penetration coefficient than do resins containing large amounts of bisphenol A-diglycidyl ether dimethacrylate (Bis-GMA) or urethane dimethacrylate.[18] On the other hand, TEGDMA molecules have a greater affinity to water molecules compared with Bis-GMA, which increases the presence of water uptake and the likelihood of hydrolysis.[46,47]

Helioseal Clear (Ivoclar Vivadent, Valencia, CA, USA), as a hydrophobic material based on a combination of Bis-GMA and TEGDMA, is less susceptible to water degradation than is the infiltrant. The bonding agent tested (Adper Scotchbond Multi-Purpose Bond, 3M, St Paul, MN, USA) is composed basically of Bis-GMA and hydroxyethylmethacrylate (HEMA). As it was developed to penetrate a previously etched surface, HEMA was introduced to optimize the wetness to the dental substrate to improve its penetrability. Therefore, its resistance was not expected. Likely, its performance demonstrating less loss might be due to its proper penetration into enamel, resulting in the formation of an initially thin layer on the surface that was resistant over time. Between the weekdays of erosive challenges, the studied blocks were immersed in artificial saliva, which ensures the simulation of hydrolysis challenge.[46,47] However, all studied materials succeeded in preventing enamel wear under the erosive and abrasive protocol compared with the group without protection. In addition, the thicknesses of material loss among the studied resin-based materials, including resin infiltration, were similar.

CONCLUSION

All of the studied resin-based materials can be considered promising in arresting erosive tooth wear, but clinical trials are necessary to confirm this promise.

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Regulatory Statement

This study was conducted in accordance with all the provisions of the local human subjects oversight committee guidelines and policies of the Bauru Dental School. The approval code for this study is 556.258 approval 2/26/2014.

Conflict of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, or company presented in this article.

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