Effect of Polyacrylic Acid on the Interface and Bond Strength of Self-adhesive Resin Cements to Dentin

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Purpose: To examine the influence of 11.5% polyacrylic acid pretreatment on the interface and bond strength of self-adhesive resin cements (Maxcem Elite, RelyX Unicem, SeT) to dentin.

Materials and Methods: Fifty-six third molars were randomly divided into seven groups: RelyX ARC as control (ARC), RelyX Unicem (RLXU), Maxcem Elite (MCE), SeT (ST), polyacrylic acid+RelyX Unicem (RLXU-P), polyacrylic acid+Maxcem Elite (MCE-P), and polyacrylic acid+SeT (ST-P). Resin composite blocks were luted to flat dentin. After storage in distilled water for 24 h, sticks with a cross-sectional area of ca 0.80 mm^2 were obtained (n = 24 per group) and submitted to a microtensile bond strength (μTBS) test in a universal testing machine at a cross-head speed of 0.5 mm/min. Two sets from each group were sectioned mesiodistally in the center of the crown and observed with a scanning electron microscope at 4000X magnification.

Results: The mean results of the μTBS test (MPa) followed by the same letter do not differ statistically significantly according to ANOVA and Tukey's post-hoc test ($p < 0.05$): ARC = 24.19 (± 6.90)[a], RLXU-P = 23.12 (± 6.18)[a], MCE-P = 13.09 (± 5.87)[b], RLXU = 10.23 (± 2.88)[b,c], and MCE = 8.14 (± 4.63)[c]. All SeT specimens failed during the cutting procedure. The hybrid layer was not observed for the self-adhesive resin cements, and resin tags were observed for RelyX Unicem and Maxem Elite when dentin was pretreated with polyacrylic acid.

Conclusion: Pretreatment with 11.5% polyacrylic acid was effective for bonding RelyX Unicem and Maxcem Elite to dentin.

Keywords: dentin, bond strength, resin cement, polyacrylic acid, self-adhesive resin cement.

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The use of resin cements has become widespread in recent years, due to better mechanical properties and esthetics than conventional cements, as well as the ability to bond to restorative materials when suitable pretreatment is applied.[5] A new category of resin cements, the self-adhesive resin cements, has gained popularity with clinicians because they are easy to use and the luting procedure takes less time compared with resin cements that require the application of an adhesive system. Without the adhesive system, part of the technique sensitivity is eliminated.[1,5] Despite being easier to apply, it is important that these self-adhesive materials are capable of bonding adequately to both dental tissues and the restorative material.

Self-adhesive resin cements interact superficially with dental hard tissues.[7,20] These materials have lower bond strength to enamel than do resin cements requiring an adhesive system.[1,12] In relation to dentin, studies showed that self-adhesive resin cements perform comparably to multi-step systems on coronal dentin.[1,2,7,12,15] In contrast, other studies showed significantly lower bond strengths of these materials to dentin.[6,18,27] To improve the bond, enamel etching with phosphoric acid has been suggested;[8,15] however, on dentin, this etching diminishes the effectiveness of the bond, which is probably due to inadequate resin cement infiltration into the collagen fiber network.[7]

The application of weak acids – for example, polyacrylic acid – has been suggested[3,23] with the objective of par-

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Table 1 Materials used in the study

Material	Composition	Batch no.	Manufacturer
RelyX ARC (ARC)	Bis-GMA, tri-ethyleneglycol dimethacrylate, zircon/silica filler, photoinitiators, amine, benzoic peroxide, pigments	GW9JJ	3M ESPE; St Paul, MN, USA
RelyX Unicem (RLXU)	Methacrylate monomers containing phosphoric acid groups; methacrylate monomers, silanated fillers, initiator components, stabilizers	395667	3M ESPE
Maxcem Elite (MCE)	GPDM, monomers, nonhazardous inert mineral fillers, ytterbium fluoride, activators, stabilizers, and colorants	3200650	Kerr; Orange, CA, USA
SeT (ST)	Acidic monomer, camphorquinone, fluoroaluminosilicate glass, urethane dimethacrylate	S0907083	SDI; Bayswater, VIC, Australia
Vidrion	11.5% polyacrylic acid	0050808	SS White; Rio de Janeiro, RJ, BR
Adper Single Bond 2	Adhesive: bis-GMA, HEMA, dimethacrylates, silica nanofiller, polyalquenoic acid copolymer, initiators, water and ethanol	9YXBR	3M ESPE

Bis-GMA: bisphenol-A-glycidyl methacrylate; HEMA: 2-hydroxyethylmethacrylate; GPDM: glycerol phosphate dimethacrylate.

tially removing the smear layer, leaving the mineral phase of dentin and increasing the chemical reaction between the material and substrate.[17] Few studies, however, have verified the effectiveness of this treatment in the bond between self-adhesive resin cements and dentin.

The purpose of this study was to evaluate the influence of polyacrylic acid pretreatment on the microtensile bond strength (μTBS) in vitro and on the morphology of the bond interface of self-adhesive resin cements to dentin, using the conventional resin cement RelyX ARC as a control. This study was conducted under the null hypothesis that dentin pretreatment with polyacrylic acid does not improve the μTBS of self-adhesive resin cements to this substrate and does not cause any change in the morphology of the bonded interface.

MATERIALS AND METHODS

Fifty-six unerupted human third molars, extracted for therapeutic reasons, were obtained from the tooth bank after the approval of the Ethics Committee of the Pontifical Catholic University of Rio Grande do Sul (PUCRS). The teeth were cleaned of gross debris and stored in distilled water at 4°C. The water was changed every week, and the teeth were used within 6 months. The roots were mounted in self-curing acrylic resin, and the occlusal enamel surface was removed with a diamond disk mounted in a low-speed laboratory cutting machine (Labcut 1010, Extec; London, UK) under water cooling. The rest of the enamel was removed with wet 400-grit silicon carbide abrasive paper in a polishing machine (DPU-10, Panambra; São Paulo, SP, Brazil). The superficial dentin was exposed and finished with 600-grit silicon carbide abrasive paper in the polishing machine, and a flat dentin surface was obtained. After polishing, the teeth were randomly divided into seven groups according to the materials used (Table 1) and the treatment of the dentin (Table 2). The self-adhesive resin cements tested were Maxcem Elite (Kerr; Orange, CA, USA), RelyX Unicem (3M ESPE; St Paul, MN, USA), and SeT (SDI; Bayswater, Victoria, Australia). RelyX ARC (3M ESPE) served as a control. In each group, six teeth were used for the bond strength test, and two teeth were used for the interfacial analysis.

A stainless steel mold with an inner diameter of 10 mm and a height of 5 mm was used to build resin composite blocks of Amelogen Plus (Ultradent; South Jordan, UT, USA). Three equal increments were inserted into the mold, and each increment was light cured for 40 s with a quartz-tungsten-halogen light-curing unit (Optilux Plus, Gnatus; Ribeirão Preto, SP, Brazil). The surface of the resin composite block was air-borne particle abraded with 50-μm aluminum oxide for 5 s at a pressure of 4 bar, and a layer of silane (Ceramic Primer, 3M ESPE; St Paul, MN, USA) was applied. For all groups, the resin cements were applied on dentin at a thickness of approximately 1 mm, and the composite resin block was luted to the tooth under a 1-kg load by means of a metallic tool for 2 min. The excess resin cement was removed, followed by light curing for 40 s on each side (mesial, distal, buccal, lingual, and occlusal) with the curing unit Optilux Plus. The light intensity was controlled with a radiometer (model 100, Demetron/Kerr; Danbury, CT, USA) to remain between 450 and 500 mW/cm^2. The specimens were stored for 24 h at 37°C in distilled water.

Microtensile Bond Strength

Six teeth per group were sectioned perpendicular to the bonding surface using a Labcut 1010 laboratory cutting machine at a speed of 400 rpm with a diamond disk under water cooling. The specimens presented a transverse section of approximately 0.90 x 0.90 mm as measured with a digital caliper (Mitutoyo Sul Americana; Suzano, SP, Brazil). Four beams from the central region of each tooth were used and examined with a stereomi-

Table 2 Group definitions and treatment

Group	Treatment
Group 1: RelyX ARC – control (ARC)	35% phosphoric acid for 15 s; rinsed for 30 s; excess water removed with a cotton pellet; application of two consecutive coats of Adper Single Bond 2; gentle air drying for 5 s; light curing for 10 s. Equal lengths of base and catalyst paste of RelyX ARC were mixed for 15 s and applied on dentin.
Group 2: RelyX Unicem (RLXU)	Equal lengths of base and catalyst paste were mixed for 15 s and applied on dentin.
Group 3: Maxcem Elite (MCE)	Material applied on dentin with the syringe supplied by the manufacturer.
Group 4: SeT (ST)	The capsule was activated and mixed in a high frequency oscillator for 10 s and the material was applied on dentin.
Group 5: Polyacrylic acid + RelyX Unicem (RLXU-P)	11.5% polyacrylic acid was applied on dentin with a microbrush for 10 s; rinsed for 30 s; the excess water was removed with cotton pellet, followed by the resin cement as described for group 2.
Group 6: Polyacrylic acid + Maxcem Elite (MCE-P)	11.5% polyacrylic acid as described for group 5 plus application of the resin cement as described for group 3.
Group 7: Polyacrylic acid + SeT (ST-P)	11.5% polyacrylic acid as described for group 5 plus the application of the resin cement as described for group 4.

croscope (Olympus; Tokyo, Japan) at 25X magnification to analyze the adhesive area. The specimens presenting defects such as bubbles, lack of material, or irregular areas were discarded. Twenty-four specimens were selected for each group.

The specimens were then fitted to the microtensile testing device for study. This device has two stainless steel grips with an area of 8 x 10 mm as well as sliding shafts that prevent torsion movements during the tests. The sliding shafts possess a fixing screw which prevents the specimen from moving during bonding. The specimens were fixed with cyanoacrylate glue (Loctite; São Paulo, SP, Brazil), associated with the Zip Kicker accelerator (Pacer Technology; Rancho Cucamonga, CA, USA), and stressed at a crosshead speed of 0.5 mm/min until failure in a universal testing machine (EMIC DL-2000; São José dos Pinhais, PR, Brazil) using a cell load of 50 N. The μTBS was expressed in MPa, which was calculated by dividing the applied force (N) at the time of fracture by the bond area (mm^2).

The fractured surfaces of all specimens were observed with scanning electron microscopy (SEM) (Philips XL 30, Philips Electronic Instruments; Mahwah, NJ, USA). The failures were classified as adhesive (failure between dentin and adhesive for group 1 and between dentin and resin cement for the other groups), cohesive in adhesive (failure inside the adhesive only for group 1), cohesive in dentin (dental substrate failure), cohesive in resin cement (failure inside the resin cement), and mixed (two or more types of failure).

Bonded Interface Analysis

Two tooth/resin composite sets were sectioned in the center of the crowns in the mesiodistal direction with a diamond disk mounted in a low-speed laboratory cutting machine (Labcut 1010, Extec) under water cooling.

The bonded interfaces were polished wet with 400-, 600-, 1000-, and 1200-grit silicone carbide abrasive papers using manual pressure and rotating movements. The interfaces were then polished with 6-, 3-, 1- and 0.25-μm grit diamond pastes on a felt disk, also with manual pressure. All of the specimens were ultrasonically cleaned in distilled water for 10 min to remove the residues from polishing. The specimens were then immersed in a hydrochloric acid solution (6 M HCl) for 2 min and then washed with distilled water. Shortly thereafter, the samples were deproteinized in a 1% sodium hypochlorite solution (NaOCl) for 10 min and washed in distilled water. The specimens were dried at room temperature for 24 h and molded with a low-viscosity polyvinyl siloxane material (Express, 3M ESPE). The molds were poured with epoxy resin (Embed 812-Kit, EMS; Hatfield, PA, USA), gold sputter coated (Bal-Tec; Balzers, Liechtenstein), and observed with SEM (Philips XL 30). The bonded interfaces of all the specimens were observed at 4000X magnification. Representative images of each group were recorded and used to qualitatively describe the topography of the dentin/adhesive interface.

Statistical Analysis

μTBS values were analyzed using one-way ANOVA and Tukey's post-hoc multiple comparisons test ($p < 0.05$).

RESULTS

The highest mean μTBS values were obtained for RelyX ARC (24.19 MPa) and RelyX Unicem with polyacrylic acid (23.12 MPa; $p < 0.05$), which were in the same statistical group (Table 3). The lowest mean μTBS value was obtained for Maxcem Elite without polyacrylic acid (8.14 MPa), but this value was not statistically different from RelyX Unicem without polyacrylic acid (10.23 MPa). In addition, Maxcem Elite with polyacrylic acid (13.09 MPa) was not significantly different from RelyX Unicem without polyacrylic acid (Table 3). All specimens of SeT failed during the cutting procedure; therefore, groups 4

Table 3 Mean, standard deviations (SD) and coefficients of variation (%) of bond strength (MPa) for each group

Group	n	Mean (MPa)	SD	Coefficient of variation (%)
ARC	24	24.19[a]	6.90	25.13
RLXU-P	24	23.12[a]	6.18	22.64
MCE-P	24	13.09[b]	5.87	22.99
RLXU	24	10.23[b,c]	2.88	9.96
MCE	24	8.14[c]	4.63	14.42

*Different superscript letters indicate statistically different means according to Tukey's test ($p < 0.05$). See Table 2 for explanation of group abbreviations.

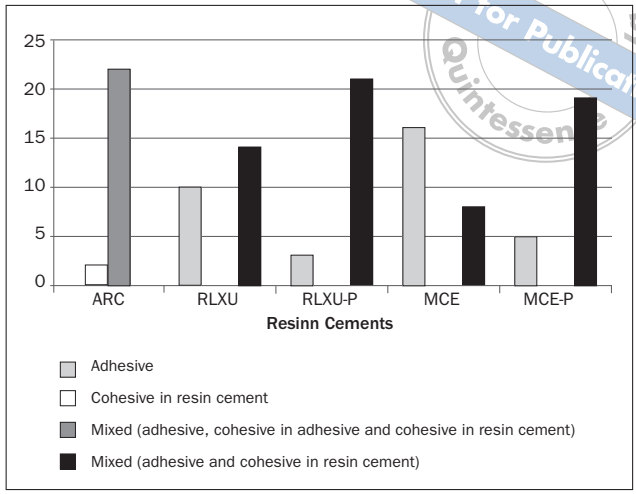

Fig 1 Failure mode analysis.

and 7 were not included in the statistical or the failure mode analyses.

Figure 1 shows the failure mode analysis. Most failures were mixed for RelyX ARC. For RelyX Unicem without polyacrylic acid and Maxcem Elite without polyacrylic acid, adhesive and mixed failures were observed. Most failures were mixed for RelyX Unicem with polyacrylic acid and Maxcem Elite with polyacrylic acid.

Regarding the bonded interface observed with SEM, there was evidence of hybrid layer formation and many tags for RelyX ARC (Fig 2A). For RelyX Unicem without polyacrylic acid, there was no hybrid layer, but there were some resin tags (Fig 2B). For RelyX Unicem with polyacrylic acid, there was no hybrid layer; however, more resin tags were observed (Fig 2C). For Maxcem Elite without polyacrylic acid, there was no hybrid layer formation or resin tags (Fig 2D). When polyacrylic acid was applied, however, a few short resin tags were observed (Fig 2E). Finally, with or without polyacrylic acid, SeT showed no hybrid layer or resin tags (Figs 2F and 2G).

DISCUSSION

In this study, the μTBS was increased with polyacrylic acid pretreatment for the self-adhesive resin cements RelyX Unicem and Maxcem Elite. In addition, the morphology of the bonded interface was changed for these cements. Therefore, the null hypothesis was rejected.

In general, self-adhesive resin cements have a limited capacity to demineralize dental hard tissues,[7,12,20] and various explanations for these findings have been proposed: (1) the pH of these cements, which is approximately 2,[1,20] is not low enough; (2) the high viscosity of the cement prevents adequate infiltration;[7] (3) neutralization may occur during mixture due to the chemical reaction that releases water or alkaline particles, which may increase the pH.[20]

Studies have confirmed the low bond strength of RelyX Unicem to enamel.[1,12,15] This material, however, has better results in dentin.[1,15] One means of increasing the bond strength of RelyX Unicem was to phosphoric-acid etch the enamel.[7,8,15] When phosphoric-acid etching was performed in dentin, however, there was a reduction in the bond strength.[7,15] Escribano and Macorra[10] reported statistical differences in the mean bond strength when they compared Panavia F (Kuraray Medical; Tokyo, Japan) and Multilink (Ivoclar Vivadent; Schaan, Liechtenstein) cements with RelyX Unicem. They found that the lower mean bond strength presented by RelyX Unicem could be related to the lack of acid etching of the remaining tooth structures.

As an alternative, pretreatment with 11.5% polyacrylic acid on dentin before the application of self-adhesive resin cements was evaluated in this study. For RelyX Unicem and Maxcem Elite, polyacrylic acid pretreatment increased the bond strength to dentin.

The bond mechanism of RelyX Unicem to dentin appears to be more chemical than micromechanical in nature.[11] This bond is established by the specific multifunctional phosphoric-acid methacrylates, which are ionized at the time of mixing and which react with the hydroxyapatite of the mineral tissues of the tooth.[11] According to the manufacturer's information, Maxcem Elite also contains an acid monomer, glycerol dimethacrylate dihydrogen phosphate (GPDM), which is partly responsible for the effect of etching and adhesion to the dental structure.

Despite the ability of RelyX Unicem to partially demineralize and infiltrate the smear layer to interact superficially with the underlying dentin,[7] the pretreatment was important, as shown by the statistically similar results between RelyX Unicem + polyacrylic acid and RelyX ARC. The presence of the smear layer has been recognized as the weak link in bonding of glass ionomers to dentin,[25] and this may also be the case with self-adhesive cements.[2] A possible explanation for the increased bond strength is that the 11.5% polyacrylic acid, applied for 10 s, removed the smear layer in quantities sufficient to favor greater interaction of the RelyX Unicem and Maxcem Elite directly with the dentin. The smear layer contains

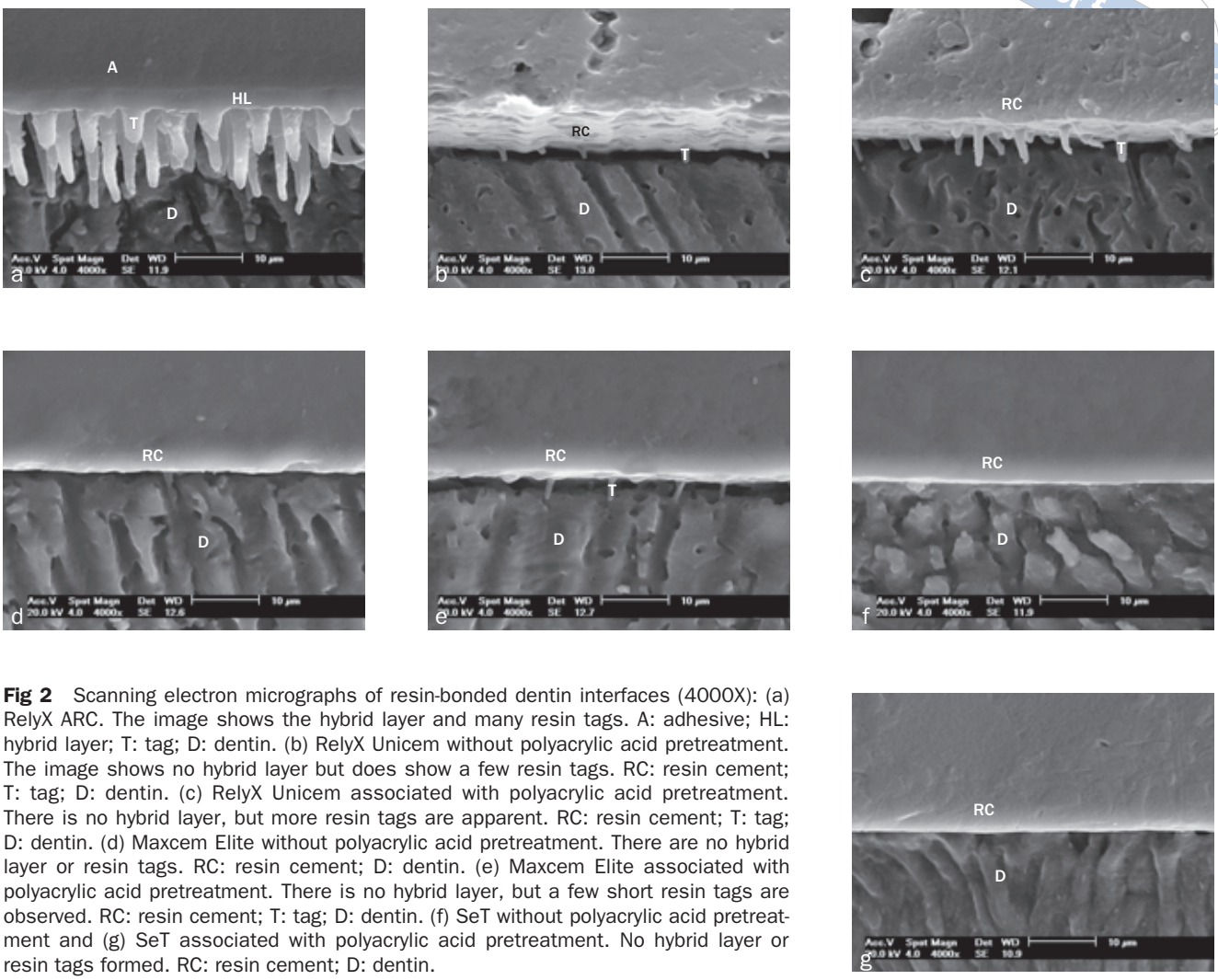

Fig 2 Scanning electron micrographs of resin-bonded dentin interfaces (4000X): (a) RelyX ARC. The image shows the hybrid layer and many resin tags. A: adhesive; HL: hybrid layer; T: tag; D: dentin. (b) RelyX Unicem without polyacrylic acid pretreatment. The image shows no hybrid layer but does show a few resin tags. RC: resin cement; T: tag; D: dentin. (c) RelyX Unicem associated with polyacrylic acid pretreatment. There is no hybrid layer, but more resin tags are apparent. RC: resin cement; T: tag; D: dentin. (d) Maxcem Elite without polyacrylic acid pretreatment. There are no hybrid layer or resin tags. RC: resin cement; D: dentin. (e) Maxcem Elite associated with polyacrylic acid pretreatment. There is no hybrid layer, but a few short resin tags are observed. RC: resin cement; T: tag; D: dentin. (f) SeT without polyacrylic acid pretreatment and (g) SeT associated with polyacrylic acid pretreatment. No hybrid layer or resin tags formed. RC: resin cement; D: dentin.

dentin-buffering components that may contribute to the neutralization effect during setting of the self-adhesive resin cements.[22] The types of failures obtained for RelyX Unicem and Maxcem Elite corroborate the values of bond strength, as most failures were mixed when polyacrylic acid was applied, suggesting a greater interaction of the resin cement with dentin.

Various factors may influence the bonding ability and adhesion of resin cements to dentin, including chemical composition, viscosity, and pH. Maxcem Elite tends to maintain its low pH (2.2), while the pH of RelyX Unicem increases after 48 h (from 2.8 to 7.0). Although a low pH is necessary for adequate dentin etching, it has been speculated that if the pH is maintained for a long time, as in the case of Maxcem Elite, there could be an adverse effect on the bond between this cement and the dental structure.[14] Therefore, this characteristic of Maxcem Elite pH could be one of the factors that led to this material having a lower bond strength than RelyX Unicem.

The results obtained for RelyX Unicem in the present study corroborate the findings of Pavan et al,[23] who also verified a significant improvement in the bond strength of this resin cement when 25% polyacrylic acid pretreatment was performed for 10 s. In addition, these authors verified that pretreatment with polyacrylic acid prior to Maxcem Elite application did not significantly increase the bond strength. In a different study, Mazzitelli et al[19] found no difference in bond strength when using 10% polyacrylic acid pretreatment for 30 s with RelyX Unicem. This finding could be related to the fact that pulp pressure was simulated. In addition, these authors observed that the 10% polyacrylic acid applied for 30 s was able to demineralize the dentin and expose the collagen fibrils, which RelyX Unicem could not infiltrate due to its high viscosity.

In the present study, an 11.5% concentration was used because it is the only one commercially available in Brazil. Different concentrations have been applied in prior studies, however, varying from 10% to 25%. Polyacrylic acid has been used in association with glass-ionomer cements with the goal of achieving greater interaction of the cement with the dental substrate.[16,17] When 20% polyacrylic

acid was applied for 10 s, it removed the smear layer without completely unplugging the dentin tubules.[3,17] Therefore, this type of etching is milder than that performed with phosphoric acid.[3] The process of dentin etching with weaker acids has also been used by other authors for cleaning purposes or smear layer removal, without excessively demineralizing the dentinal surface.[19,23]

Certainly, different concentrations of polyacrylic acid can influence the results.[9] The pH of the 20% polyacrylic acid was reported to be 1[2,13] and the pH of 10% polyacrylic acid 1.85.[24] According to the study of El-Askary et al,[9] the expected difference in pHs of the two conditioners might be the reason for the inability of 10% polyacrylic acid to completely remove a thin smear layer created with 600-grit SIC compared to 20% polyacrylic acid, in which complete removal of the thin smear layer was observed. It would, however, be interesting to evaluate other polyacrylic acid concentrations and different durations of application on the μTBS of self-adhesive resin cements to dentin.

The self-adhesive resin cement SeT contains an acid monomer that is responsible for etching the tooth surface. It is not known, however, what specific type of acid monomer is used or whether it has a chemical interaction with the tooth. The adhesion of SeT did not withstand the cutting performed to obtain the test specimens (beams), and no studies evaluating this material have been performed to our knowledge. Therefore, it was not possible to verify whether polyacrylic acid influences the strength of SeT. It is necessary to use a traditional bond strength testing protocol using larger bonded areas to avoid subjecting the material to the stresses of the cutting machine. The mere fact that this resin cement did not withstand the cutting procedure, however, shows that this material has less interaction with dentin than do RelyX Unicem and Maxcem Elite. In any case, when applied according to the manufacturer's instructions, neither of the self-adhesive resin cements obtained a bond strength comparable to RelyX ARC.

In the present study, RelyX ARC served as the control group, as it is a resin cement that requires the application of an adhesive system. This material provided a statistically higher bond strength than the self-adhesive resin cements RelyX Unicem and Maxcem Elite without polyacrylic acid pretreatment. This high bond strength is possibly related to the application of 37% phosphoric acid, which results in complete removal of the smear layer, superficial dentin demineralization, exposure of collagen fibers and impregnation by resin monomers, forming a hybrid layer[21,26] and thus providing micromechanical retention.

The SEM images of the bonded interface showed that the self-adhesive resin cements did not cause demineralization of the superficial dentin or hybrid layer formation, which differed from RelyX ARC, which formed a hybrid layer and various resin tags. In studies evaluating the bonded interface of self-adhesive resin cements using SEM,[2,7,20] TEM,[7,28] and light microscopy of specimens stained with Masson's trichrome,[20] formation of a hybrid layer or resin tags was not observed. Nevertheless, in the present study, some resin tags were observed for RelyX Unicem without polyacrylic acid pretreatment. The difference in findings between studies could be related to the smear layer thickness obtained[22] and the cementation pressure used in the present study,[12] which could have favored slight infiltration of the material into the dentinal tubules.

The SEM images of RelyX Unicem resin cement showed more resin tags when polyacrylic acid was applied. The same was observed for Maxcem Elite. This finding shows that the smear layer, irrespective of its thickness, may be considered a barrier that the materials need to cross to effectively reach the subjacent mineralized dentin. When the smear layer was removed by the action of polyacrylic acid, the material was in direct contact with the mineralized dentin, allowing its penetration into the dentinal tubules. Mazzitelli et al[19] verified removal of the smear layer, opening of the dentinal tubules, and the presence of some tags when polyacrylic acid pretreatment was associated with RelyX Unicem.

With regard to the SEM images of SeT, the use of polyacrylic acid pretreatment did not alter the morphological pattern of the bonded interface, and no resin tags were observed, which is in contrast to what happened with RelyX Unicem and Maxcem Elite. Further evidence of the lower interaction of SeT with dentin was the failure of a sample not etched with polyacrylic acid at the time of sectioning the tooth to obtain the two hemifaces for analysis of the interfaces; no failure of samples occurred with the other resin cements.

The use of pretreatment with polyacrylic acid represents an additional step in the application of self-adhesive resin cements, which were expressly developed to simplify the application procedure. To date, the literature has not stipulated the minimum bond strength the material must have to the substrate in order to guarantee the success and longevity of the luting procedure. However, according to the results of the present study, the use of 11.5% polyacrylic acid prior to the application of RelyX Unicem and Maxcem Elite appeared to be an important step to improve its bond strength to dentin.

As a continuation of this research, further studies testing the effect of polyacrylic acid pretreatment on the longevity of bonding effectiveness of self-adhesive resin cements to dentin would be of interest, and clinical studies are needed before making any clinical recommendations.

CONCLUSIONS

Based on the methodology used in this study, it can be concluded that:

1. Dentin pretreatment with 11.5% polyacrylic acid increased the bond strength values of RelyX Unicem and Maxcem Elite.
2. There was no hybrid layer formation with the self-adhesive resin cements, irrespective of the application of polyacrylic acid.
3. Dentin pretreatment with polyacrylic acid allowed the formation of a larger number of resin tags for RelyX Unicem and Maxcem Elite, and there was no alteration at the bonded interface using SeT.

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Clinical relevance: The immediate bond strength of self-adhesive resin cements may be improved by using polyacrylic acid as a pretreatment.