Effect of Sodium Ascorbate and the Time Lapse before Cementation after Internal Bleaching on Bond Strength between Dentin and Ceramic

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Abstract

Purpose: To evaluate the effects of the elapsed time (ET) after nonvital bleaching (NVB) and sodium ascorbate application (10%) (SAA) on the shear bond strength of dentin to ceramic.

Materials and Methods: Bovine incisors were selected, internally bleached (35% carbamide peroxide) for 9 days and submitted to the following treatments (n = 10): G1, G2, G3—luting after 1, 7, and 14 days; G4, G5, and G6—luting after SAA, 1, 7, and 14 days, respectively. G7 and G8 were not bleached: G7—luting 24 hours after access cavity sealing; G8—luting 24 hours after access cavity sealing after SAA. After NVB, the vestibular dentin was exposed and flattened. The SAA was applied to the dentin (G4, G5, G6, G8) for 10 minutes, and it was then washed and dried. The dentin was etched (37% phosphoric acid), and an adhesive system (Single Bond 2) was applied. Feldspathic ceramic discs (VM7; 4-mm diameter, 3-mm thick) were luted with a dual-resin agent (RelyX ARC, 3M ESPE Dental Products, St. Paul, MN). After 24 hours, specimens were submitted to shear test on a universal testing machine. The data (MPa) were submitted to ANOVA and Dunnet's test (5%).

Results: The means ($\pm$ SD) obtained were (MPa): G1 (14 ± 4.5), G2 (14.6 ± 3.1), G3 (14 ± 3.7), G4 (15.5 ± 4.6), G5 (19.87 ± 4.5), G6 (16.5 ± 3.7), G7 (22.8 ± 6.2), and G8 (18.9 ± 5.4). SAA had a significant effect on bond strength ($p = 0.0054$). The effect of ET was not significant ($p = 0.1519$). G5 and G6 presented higher values than the other bleached groups ($p < 0.05$) and similar to G7 and G8 ($p > 0.05$).

Conclusions: After NVB, adhesive luting to dentin is recommended after 7 days if sodium ascorbate has been applied prior to dentin hybridization.

An increasing esthetic demand has made dental bleaching a very popular treatment. The dental procedures for bleaching can include techniques for teeth with or without pulp vitality. The most used substances for these procedures are carbamide peroxide (CP), hydrogen peroxide, and sodium perborate (SP).[1]

Despite the common use of bleaching agents, many studies have shown that they reduce the bond strength of composite to enamel from bovine[2,3] and human teeth[4-7] when bonding is performed immediately after bleaching. It is believed that this reduction in bond strength is due to residual oxygen left by the bleaching agent, promoting inhibition of the polymerization of resin-based materials[6] and morphological,[8] physical,[9,10] and chemical[11] alterations of the dental hard tissues.

Few studies have evaluated the adhesive behavior of composite to dentin when internal bleaching is performed in endodontically treated teeth. Spyrides et al[12] and Shinohara et al[3] used 10% and 37% CP and did not observe a decrease in the dentin bond strength. On the other hand, dentin bleached with SP and 30% hydrogen peroxide solution,[13] 35% hydrogen peroxide,[12,14] and 35% CP[12] presented lower shear bond strengths

Table 1 Products used in this study

Brand	Material type	Composition	Manufacturer	Batch
Sodium ascorbate	Sodium ascorbate	Sodium ascorbate ($C_6H_7NaO_6$)	Sigma-Aldrich, St. Louis, MO	106K0089
Vita VM7	Feldspathic ceramic	Si: 19.6%; Al: 4.9%; K: 4.0%; Na: 2.4%; Ca: 0.7%; C: 25.7%, O: 42.2%.	Vita Zanhfabrik, Bad Sackingen, Germany	15110
Ceramic etching gel	Hydrofluoric acid 10%	Fluoridric acid, water, thickening, stain	Dentsply, Petrópolis, Brazil	634113
Monobond-S	Silane agent	Ethanol, water, silane, acetic acid	Ivoclar Vivadent, Schaan, Liechtenstein	H08177
Condac 37	37% phosphoric acid	Phosphoric acid, water, thickening, stain	FGM Produtos Odontológicos, Joinville, Brazil	030407
Adper Single Bond 2	Adhesive system	HEMA, Bis-GMA, dymethacrylate resins, methacrylate-modified polycarboxylis acid copolymer, water, photo initiator system	3M ESPE Dental Products, St. Paul, MN	7LH
RelyX ARC	Dual-resin cement	Bis-GMA, TEGDMA, silica, zircon particles. Inorganic fillers: 67.5% wt	3M ESPE Dental Products, St. Paul, MN	FCGK

Bis-GMA = bis-phenol-A-glycidylmethacrylate; UDMA = urethane dimethacrylate; TEGMA = triethyleneglycol methacrylate; HEMA = 2-hydroxyethyl methacrylate.

for composite resin than the unbleached dentin. These three last studies applied the bleaching agent directly upon the dentin submitted to the adhesive procedure.

Currently, the scientific literature recommends a 1-day to 3-week delay in performing a restoration following dental bleaching with CP.[1,5,7,15] There is the suggestion of applying some substances, such as catalase and sodium ascorbate, to reverse the effect of the bleaching agents by reducing the residual oxygen.[1] The application of sodium ascorbate after the bleaching treatment effectively reversed the bond strength to dentin[4,14] and enamel to that of the unbleached state.[16]

Therefore, the aim of this study was to evaluate the influence of sodium ascorbate application (SAA) and elapsed time before cementation after internal bleaching in endodontically treated teeth on the shear bond strength of dentin to ceramic, using dual-resin cement as the bonding agent. The null hypothesis was that the bond strength values after internal bleaching are similar whether the cementation is conducted after 1, 7, or 14 days, regardless of the application of sodium ascorbate.

Materials and methods

Brand, composition, manufacturers, and batch numbers of the materials used in this study are presented in Table 1.

Tooth preparation

Eighty freshly extracted lower bovine incisors were selected. The periodontal ligament was removed, and the root sectioned about 5 mm below the cementoenamel junction (CEJ). The pulp chamber was accessed from the lingual surface using a spherical diamond drill (1014, KG Sorensen, Sao Paulo, Brazil) in a high-speed handpiece under water cooling. The pulp was removed with endodontic instruments, and the root was prepared with a #3 Largo drill in a slow-speed handpiece and filled with composite resin (Z100, 3M ESPE Dental Products, St. Paul, MN) to a level of 2 mm below the CEJ.

Experimental design

The teeth were randomly assigned to eight groups (n = 10), two unbleached control groups, and six experimental bleached groups, and stored in distilled water (37°C ± 1°) in individual closed bottles. The experimental groups were divided according to the factors: elapsed time after bleaching and SAA (Table 2). In groups 1, 2, and 3, the luting procedures were performed 1, 7, and 14 days, respectively, after internal bleaching treatment with 35% CP over a period of 9 days. In groups 4, 5, and 6, the luting procedures were performed after the same period of time, but after 10 minutes of SAA. In the negative and positive control groups, unbleached teeth were submitted to cementation 24 hours after pulp cavity sealing, without or with SAA, respectively.

Nonvital bleaching (NVB) procedures

Before the application of 35% CP, the pulp chambers were washed in running distilled water, dried with compressed air,

Table 2 Experimental design considering the elapsed time after bleaching and the application of sodium ascorbate (SAA) before cementation for the experimental and control groups (bleached and unbleached)

	Elapsed time (days)	SAA	Condition	Number of specimens (n)
1	1	Without	Bleached	10
2	7	Without	Bleached	10
3	14	Without	Bleached	10
4	1	With	Bleached	10
5	7	With	Bleached	10
6	14	With	Bleached	10
7 (Negative control)	1	Without	Unbleached	10
8 (Positive control)	1	With	Unbleached	10

etched with ethylenediaminetetraacetic acid (EDTA) under agitation for 3 minutes, washed with 5 ml of distilled water, and dried. The teeth were treated with a 35% CP bleaching agent (Biofórmula, São José dos Campos, Brazil), which was applied inside the pulp chamber. After the placement of a piece of absorbent paper, the access cavity was sealed with glass ionomer cement (Vidrion C, SS White, Rio de Janeiro, Brazil). Each group was then stored in distilled water (37 ± 1°C) in individual closed containers. The bleaching agent was removed and replaced after 3 days. So, during the 9 days of bleaching the CP was replaced three times for each tooth. The control groups did not receive the bleaching agent and were sealed right after the access cavity preparation.

Manufacturing of ceramic cylinders

With the assistance of a metallic matrix, standardized ceramic disks (4-mm diameter, 3-mm thick) (Vita VM7, Shade 2M2, Vita Zanhfabrik, Bad Sackingen, Germany) were made. Sintering of the ceramic was accomplished in an oven (Vacumat, Vita Zahnfabrik). The sintered specimens were coated with additional ceramic and fired until a thickness of 4 mm was achieved to compensate for sintering contraction of the ceramic. The surface to be cemented to dentin was polished with #320, #400, #600, and #1200 grit sandpaper, under water irrigation.

Tooth preparation

After sealing, the teeth were embedded in self-activated acrylic resin into a square-shaped mold (25 × 25 × 25 mm^3). The buccal surface was then polished with #80, #400, and #600 grit sandpaper until 5 to 6 mm diameter of flat dentin was exposed.

Sodium ascorbate application

A 10% sodium ascorbate solution (Sigma-Aldrich, St. Louis, MO; Batch#: 106K0089) was prepared and immediately applied to groups 4, 5, 6, and the positive control group, using a syringe. Two drops of this agent were applied twice and agitated on the dentin surface with a microbrush for 10 minutes total for both applications. The sodium ascorbate solution was then washed off and the specimens gently dried.

Luting procedures

Prior to surface conditioning, all-ceramic cylinders were ultrasonically cleaned (Vitasonic, Vita Zanhfabrik) for 5 minutes using distilled water. The ceramic surfaces were etched with 10% hydrofluoric acid gel (Dentsply Petrópolis, Brazil; Batch#: 634113) for 60 seconds, rinsed with air-water spray for 60 seconds and air-dried. After the etching procedures, the ceramics were ultrasonically cleaned in distilled water for 5 minutes. A silane coupling agent was applied (Monobond-S; Ivoclar Vivadent, Schaan, Liechtenstein; Batch#: H08177) with a clean brush in one layer and was allowed to set for 5 minutes.

The bonding area of each specimen was limited by placing a piece of adhesive tape (Scotch, 3M, Ribeirão Preto, Brazil) with a 5-mm diameter hole over the dentin surface. Acid etching was performed with 37% phosphoric acid for 15 seconds. The acid was rinsed for 15 seconds under running distilled water, and the excess water was removed from the dentin with absorbent paper. Two consecutive coats of an adhesive system (Adper Single Bond 2, 3M ESPE) were applied using a microbrush. After gentle air drying for 5 seconds, the material was light-cured for 20 seconds, according to the manufacturer's instructions, with an LED curing light unit (SmartLite PS, Dentsply, Woodbridge, Canada). The catalyst and base pastes of the resin cement (RelyX ARC, 3M ESPE) were mixed and placed on the silanized surface of the ceramic and were bonded to dentin. A 750-g load was applied to the specimens, and the excess cement was removed with a microbrush. The specimens were light-cured for 20 seconds on each of the opposite sides of the ceramic disks. After removing the load, the specimens were also light-cured for 40 seconds on the facial surface of the ceramic discs. The specimens were stored in distilled water (37°C ± 1°; 24 hours).

Shear bond strength test

The shear bond strength test was performed with a universal testing machine (EMIC, mode DL-1000, Equipments and Systems Ltd., São José dos Pinhais, Brazil), where the load was applied to the dentin/ceramic interface at a constant speed of 1 mm/min and with a 50 KgF loadcell. The fractured surfaces of the specimens were analyzed in a stereomicroscope (STEMY 2000-C, Carl Zeiss, Gottingen, Germany) at 30 × magnification to characterize the failure mode. Scanning electronic microscope observation was performed to illustrate some failures. The failure types were classified as: A) adhesive failure along the interfacial region between the dentin and cement, C1) cohesive failure in the dentin, C2) cohesive failure in the ceramic, C3) cohesive failure in the cement, and M) mixed fracture (adhesive failure between the cement and dentin together with cohesive fracture in dentin and/or ceramic and/or cement layer).

Statistical analysis

Statistical analysis was performed using Minitab (Minitab Inc., version 14, State College, PA). The means of the bond strength from each group were analyzed by 2-way ANOVA. Student's *t*-test was used to compare the two control groups (unbleached teeth and sodium ascorbate unbleached teeth), and the 5% Dunnet's test was used to compare among the test groups and the unbleached control group. *P* values less than 0.05 were considered to be statistically significant in all tests.

Results

The results of the shear bond strength testing of dentin bonded to ceramic are presented in Table 3 and are graphically represented in Figure 1. Two-way ANOVA revealed that the bond values were significantly affected by sodium ascorbate ($p < 0.05$). The difference between the elapsed time before cementation was not statistically significant, and there was no significant interaction between the sodium ascorbate and elapsed time factors.

Unbleached teeth presented the highest shear bond strength values (G7 = 22.8 ± 6.2 MPa; G8 = 18.89 ± 5.4). There was no difference ($p = 0.151$) in the 5% Students' test between the control groups G7 and G8 (unbleached teeth with and without SAA before cementation), which indicates that the SAA has

Table 3 Mean ± standard deviation of shear bond strength values (MPa) for different elapsed times (ET) with and without application of sodium ascorbate (SAA)

	ET		
SAA	1 day	7 days	14 days
Without SAA	14.13 ± 4.52	14.61 ± 3.10	14.07 ± 3.71
With	15.55 ± 4.60	19.87 ± 4.55	16.56 ± 3.75

no effect upon unbleached dentin. Comparing the shear bond strength of the control group (G7) with all bleached groups (G1 to G6), it was observed that groups G5 and G6 presented bond strength similar statistically to the control group (G7), and that groups G1, G2, G3, and G4 presented bond strength statistically lower than the control group (Fig 1).

Fracture analysis of the specimens tested after shear test revealed different patterns of fracture: adhesive failure along the interfacial region between the cement and the dentin (A), cohesive fracture in the dentin (C1), cohesive fracture in ceramic (C2), and mixed failure (M). The pattern of failure was very similar in all groups, and the failures were predominantly of the mixed (M) type, except in group G3, where the fractures were predominantly adhesive (A). The percentages of the types of fractures are presented in Tables 4 and 5. Figure 2 illustrates MEV micrographs of a mixed fracture.

Discussion

Shear, tensile, and microtensile tests have been used for in vitro assessment of bond strength. The shear test presents limitations in measuring adhesive bond strength, such as cohesive failure in the base material of the specimen,[17] especially when this material is ceramic; however, many studies have used the shear test to evaluate bond strength between dentin and composite resin in bleached teeth.[3,12,14,18-21] According to Dagostin and Ferrari,[22] due to the low thickness of dentin on the vestibular surface of the teeth and because of ceramic friability, microtensile or tensile bond strength tests become more complex and make specimen preparation more difficult than for the shear test.

Bovine teeth were used in this study, mainly because of ethical difficulties obtaining human teeth. Bovine teeth have similar properties, such as radiodensity,[23] dentinal morphology,[24] and similar values in adhesive bond testing.[24-27] According to Reis et al[24] bovine enamel and dentin can be used in bond strength studies to simulate conditions that would be applied on human teeth.

This study was designed to evaluate the minimum time needed between the bleaching treatment of endodontically treated teeth and the cementation of the final restoration for a reversion of the effects bleaching on dentin. Many studies have evaluated the effects of bleaching agents on bond strength to enamel,[2-7,15,19] but the bond to dentin is also very important, mainly in crowns and veneers, where there is a great amount of exposed dentin.

In some studies that evaluated the effect of bleaching agents on dentin,[3,12-14] the bleaching agent was applied directly on the dentin surface prior to the cementation procedures; however, those studies did not evaluate the influence of the bleaching agent reaching the pulp cavity, a procedure that is sometimes necessary when a ceramic crown or veneer will be done on a tooth after unsuccessful bleaching. This study simulated this condition.

The current results demonstrate that cementation between 1 and 14 days does not affect the shear strength between dentin and ceramic. Additionally, it was found that SAA has a significant effect on bonding values. Comparing bleached teeth (from 1 to 14 days after bleaching) with the unbleached control group, the original shear bond strength from dentin to ceramic was affected by the bleaching treatment and was not reversed even after 14 days (Fig 1).

Shinohara et al[3] studied the shear strength to enamel and dentin after internal bleaching with SP and CP. The bond strength to enamel was adversely affected by SP and CP, but 37% CP did not affect the dentin bond strength. Toko and Hisamitsu[13] found lower values of composite resin to bleached human dentin with SP and 30% hydrogen peroxide solution when comparing the shear strength with unbleached human dentin, independent of the dentin bonding systems used. Similar results were found by Kaya and Türkün,[14] who observed a decrease in bond strength to dentin after bleaching with 35% hydrogen peroxide. On the other hand, some studies[3,18,21] reported that internal bleaching with 37% CP did not affect the bond strength to dentin. The decrease of bond strength after bleaching can be explained by higher levels of free radical

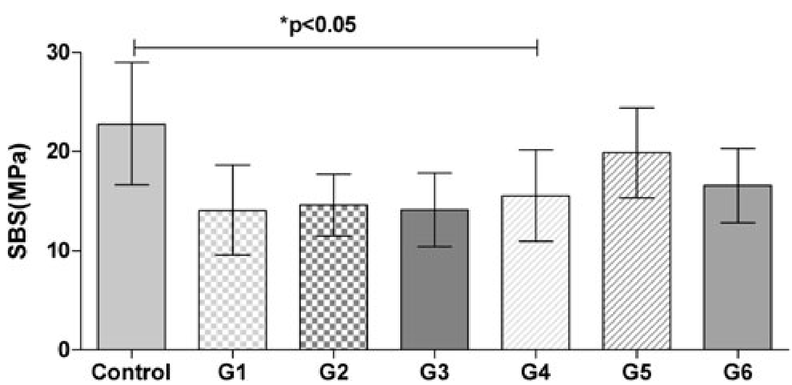

Figure 1 Means ± standard deviations for the experimental groups. Control: unbleached teeth; G1, G2, G3: bleached teeth, 1, 7, and 14 days elapsed time without sodium ascorbate (SA) before cementation; G4, G5, G6: bleached teeth, 1, 7, and 14 days elapsed time with SA before cementation. *Significant difference from control group by 5% Dunnet's test.

Table 4 Failure mode (%) of the groups, after the shear test for different elapsed times without and with application of sodium ascorbate (SAA)

Groups/ failure mode*	Without SAA			With SAA			
	1d	7d	14d	1d	7d	14d	Control
Adhesive	20	20	70	20	20	10	–
Cohesive	20	20	–	30	30	–	10
Mixed	60	60	30	50	50	90	90

*Adhesive failure: between the dentin and cement;

*Cohesive failure: in dentin and/or ceramic and/or cement.

peroxides or oxygen, alone or in combination, at the bond interface, which contaminates the polymerization reaction and reduces bonding strengths. The dentin tubules and dentinal fluid, which are permeable to hydrogen peroxide, would be considered as a reservoir, retaining hydrogen peroxide or oxygen radicals for an undetermined length of time.[7] Liberation of oxygen into the dentin could either interfere with resin infiltration into etched dentin or inhibit polymerization of resins.[28] Additionally, morphological,[8] physical,[9,10] and chemical[11] changes in the dental hard tissues after application of bleaching agent might occur.

According to Spyrides et al,[12] delaying bonding might increase dentin bond strength after bleaching. Those authors verified that delaying bonding for 1 week significantly increased shear bond strengths for groups bleached with 35% hydrogen peroxide and 35% CP. In addition, 10% CP did not decrease the bonding strength to dentin after bleaching, even when immediate bonding was performed. Similar results were found by Shinohara et al.[20] Those authors observed that a delay of 1 week after bleaching decreased the adverse effects of dental bleaching agents on bonding procedures to dentin. In this study, the effect of elapsed time did not significantly influence the bond strength after 14 days. Similar results were found by Teixeira et al[21] after 21 days and by Arcari et al[18] after 14 days for internal bleaching. According to Demarco et al,[29] hydrogen peroxide left on the dentin surface after bleaching loses its activity with time because of its instability. Shinohara et al[20] found various studies where in vitro specimens stored in water or artificial saliva experienced a complete reversal of the reduced enamel bonds.

In this study, the dentin was not in contact with the storage medium; therefore, the release of hydrogen peroxide may have been slower. The residual hydrogen peroxide may have remained enclosed in the dentin during the time before the cementation and affected the adhesive procedure and the bond strength. According to Chng,[9] the effect of the bleaching agent is likely to be more pronounced in the inner dentin and decrease in effect as it approaches the dentin/enamel or dentin/cementum junction. The variation in bleaching agent effect in terms of the dentin location is likely to be related to several factors, such as the pH of the bleaching agents, the buffering capacity of dentin, and the increasing diameter and density of dentinal tubules near the pulp.

According to Zhao et al,[30] the hydroxyl radicals in the apatite lattice are substituted with peroxide ions and produce peroxide-apatite. When peroxide ions decompose, substituted hydroxyl radicals reenter the apatite lattice, resulting in the elimination of the structural changes caused by the incorporation of peroxide ions. According to Lai et al,[31] the inclusion process of peroxide ions might also be reversed by an antioxidant, such as sodium ascorbate.

Sodium ascorbate is a salt of ascorbic acid and is a potent antioxidant, able to quench reactive free radicals in biological systems.[14] It is nontoxic and commonly used in the food industry as an antioxidant. Therefore, it is believed that its use is not hazardous to the oral environment.[14,28,31] By restoring the altered redox potential of the oxidized bonding substrate, sodium ascorbate allows free radical polymerization of the adhesive to proceed without premature termination, reversing the compromised bonding.[28]

Sodium ascorbate has been used in many studies[4,14,16,28,31-33] due to its antioxidant ability. It has helped to partially or completely reverse the effects of sodium hypochlorite, hydrogen peroxide, and CP in enamel and dentin. According to Kaya and Türkün,[14] the application of 10% sodium ascorbate immediately after bleaching treatment effectively reversed the reduced bond strength to dentin to similar values found after waiting for

Table 5 Failure mode of the specimens, after the shear test for different elapsed times without and with SAA

Groups/ specimens	Without SAA			With SAA			
	1d	7d	14d	1d	7d	14d	Control
1	AC1C2	A	A	A	C1	AC1	AC1C3
2	AC1	AC2	A	C1	AC1	A	AC1C2
3	AC3	C3	AC1C3	AC1C2	A	AC2	AC2
4	AC1	AC1C3	A	C1	AC1	AC2	AC2
5	AC1	AC2C3	A	C1	AC1C2	AC2	AC1C2
6	C1	AC2	A	AC1C2	AC1C2	AC2	AC2
7	A	A	A	AC2	C1	AC2	AC2
8	AC2	AC2	A	AC1	C1	AC2	AC1C2
9	A	AC1	AC3	AC1	A	AC2	C1
10	C1	C1	AC1	A	AC1C3	AC2	AC2

A = adhesive failure between dentin and cement; C1 = cohesive failure in the dentin; C2 = cohesive failure in the ceramic; C3 = cohesive failure in the cement.

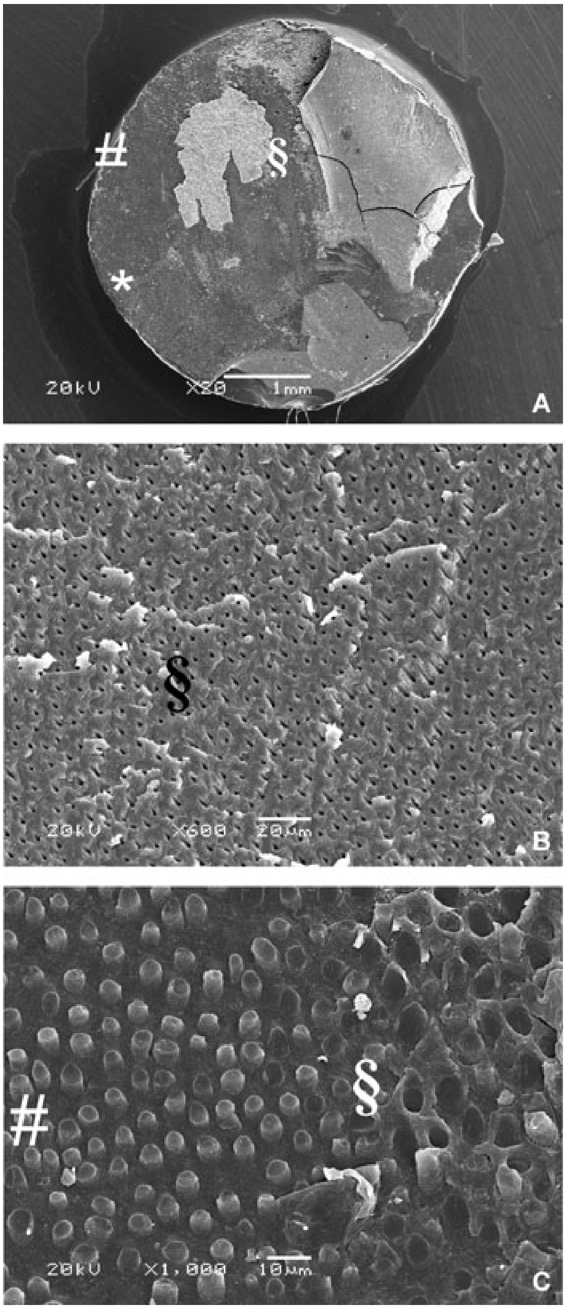

Figure 2 Representative micrographs (A-20×, B-60×, C-1000×) of a mixed fracture (M) between dentin and cement layer of a specimen from G2. * = resin cement; # = adhesive failure on the dentin-resin cement interface; § = dentin.

7 days. Bulut et al[4] realized that orthodontic brackets bonded immediately after bleaching presented significantly lower tensile bond strengths than those bonded to unbleached enamel. Furthermore, no statistically significant differences in tensile bond strength were noted when the delayed-bonding (7 days) and antioxidant-treated groups were compared with the control group (no treatment before bonding). Moreover, Kimyai and Valizadeh[16] found that two forms of ascorbate (hydrogel and solution) can significantly increase the bond strength of resin composite to enamel after bleaching.

In this study, ascorbate was applied immediately before cementation for two reasons: (1) to reduce the remaining peroxide and oxygen radicals in dentin left by the CP and (2) to increase the shear bond strength between ceramic/dentin. The results showed that the SAA significantly increased the bond strength after internal bleaching after 7 and 14 days (Fig 1). When the dentin of the bleached teeth was submitted to the adhesive procedure after 1 day, the sodium ascorbate was not able to reverse the effect of 35% CP. It might be possible to obtain this reversion by increasing the application time and concentration of the sodium ascorbate solution, as observed by Lai et al[30] who applied the ascorbate for 3 hours on bleached teeth prior to performing adhesion procedures and verified that the microtensile bond strength values between enamel/resin were higher after treatment. In other studies,[14,32] 10 minutes of 10% sodium ascorbate treatment for enamel was found to be effective. According to these authors, this short treatment period, including dispensing and continuously agitating of the ascorbate solution, enhanced the effect on the bleached enamel surface and also is a beneficial time for clinical conditions.

The unbleached control group with 10% sodium ascorbate was used to verify other possible actions upon the dentin, other than its reducing action for the residual bleaching agent; however, the results showed that application of ascorbate was not effective upon unbleached teeth, indicating that this substance only acts by reducing the residual oxygen on the bleached teeth. Clinical and in vitro studies should be conducted to evaluate the longevity of the bond strength when sodium ascorbate is applied upon the dentin, as well as to establish an appropriate application protocol.

In this study, there was a high percentage of cohesive dentin, cohesive ceramic, and mixed (adhesive/cohesive) failure. This can occur when the adhesive strength obtained by hybridization and luting is higher than the cohesive strength of the substrates. These strengths are also associated with the limitations of the shear test, such as the incidence of nonparallel forces and point of load application far from the adhesive interface.[17] The findings of this study seem to have important clinical relevance for dentin/ceramic bond strength; however, further in vitro long-term studies using mechanical fatigue tests and prospective clinical studies must be conducted for better statement of the clinical argument.

Conclusions

This study evaluated the effects of elapsed time after NVB and SAA on the bond strength of dentin to ceramic. Based on the results, it can be concluded that:

(1) Bleaching procedures decreased bond strength between dentin and glass ceramic luted adhesively.
(2) Sodium ascorbate 10% application after bleaching increased bond values after an elapsed time of 7 days before adhesive cementation.

(3) Elapsed time before adhesive cementation did not influence bond strength in the absence of the use of 10% sodium ascorbate.
(4) Adhesive luting to dentin is recommended after 7 days if 10% sodium ascorbate has been applied prior to dentin hybridization.

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