



Microtensile Bond Strength of Prehybridized Dentin: Storage Time and Surface Treatment Effects

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Purpose: This study evaluated the effect of surface treatments of the prepolymerized adhesive layer in the immediate dentin sealing technique (IDS) on the microtensile bond strength of two-step etch-and-rinse adhesive systems.

Materials and Methods: The occlusal dentin surfaces of 60 human third molars were exposed and Adper Single Bond 2 (SB) or Prime & Bond NT (PB) adhesive systems were applied (control groups). Immediately afterwards, the temporary cement RelyXTemp NE was applied on the bonded dentin surface, and the teeth were stored in artificial saliva for 48 h or 4 months. After the storage time, the temporary cement layer was removed and the following surface treatments were applied: aluminum oxide (AO), 37% phosphoric acid (PA), or AO+PA. Next, a second adhesive layer was applied for each adhesive system, and a composite resin block restoration (Z250) was built. The specimens were cut and submitted to microtensile strength (μ TBS) testing. The adhesive layer thickness (ALT) was evaluated in other specimens from all groups by SEM. The fracture pattern was evaluated in all sticks tested by SEM. μ TBS and ALT values were analyzed with two-way ANOVA and Tukey's test ($\alpha = 0.05$).

Results: The highest μ TBS, similar to the control, was obtained with aluminum oxide and phosphoric acid (AO+PA) for both adhesives systems. The use of aluminum oxide alone (AO) or associated with phosphoric acid (AO+PA) showed values close to those of the control groups in relation to the ALT. The failure pattern was the same for control groups and AO +PA groups.

Conclusion: Dentin prehybridization can improve the adhesive bond strength if the bonded surface is treated with airborne aluminum oxide particle abrasion associated with 37% phosphoric acid, followed by application of a second adhesive layer.

Keywords: microtensile bond strength, prehybridized dentin, resin coating technique, storage time.

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Direct composite resin restoration seems to be a good approach to restoring small and medium-sized cavities in posterior teeth.^{5,13,19} However, because of polymerization shrinkage, the direct technique is contraindicated in large cavity preparations.^{5,13} In this situation, indirect restorative procedures with resin composites or ceramics are a good alternative, being more conservative than the full crown. How-

ever, a substantial dentin area remains exposed until the indirect cavity preparation has been fully restored, and thus application of an adhesive system is recommended.^{2,16}

Recently, some authors have recommended the prehybridization procedure, also called immediate dentin sealing (IDS). This technique has advantages such as: the presence of the hybrid layer avoids the risk of contamination;^{2,5,13,16,19} dentin is less sensitive during the days required for making and adjusting the restoration before the definitive luting procedure; bond strength and interfacial adaptation to dentin can be improved due to the second application of the adhesive system in the definitive cementation procedure,^{1,9,15} increasing the adhesive thickness and therefore relieving the stress generated by occlusal load.^{6,20}

Notwithstanding, some points remain unclear in this technique, for example, no surface treatment protocol for adhesive cementation procedures has yet been established. The major problem to consider is that the adhesive bonding substrate is not the dentin but the adhesive surface. Magne et al¹² indicated that the adhesive layer must be meticulously cleaned with alumina microparticle air-

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borne abrasion before the cementation procedure, in order to completely remove the temporary cement. These authors also reported the use of pumice or diamond bur at low speed to create irregular roughness as an alternative technique for prehybridized surface cleaning. However, Stavridakis et al¹⁹ demonstrated that the airborne alumina particle abrasion cleans these surfaces more homogeneously than does pumice.

In indirect restorative procedures, it is necessary to make a provisional restoration to protect the remaining tooth structure and periodontal tissue, and to keep the occlusal load well distributed. The longer this provisional restoration is kept in contact with the previously inserted adhesive, the worse the bond will be to this material in luting procedures, particularly because of the surface contamination and a possible decrease in the surface adhesive capacity.

Therefore, the purpose of the present study was to determine the effects of different surface treatments on prehybridized dentin, examine the influence of the storage time on the microtensile bond strength when temporary cement is used, and assess the failure mode and adhesive layer thickness when the immediate dentin sealing technique (IDS) was used. The null hypothesis tested was that there was no difference in microtensile bond strength when dentin was superficially treated with phosphoric acid and/or aluminum oxide for IDS.

MATERIALS AND METHODS

Tooth Selection and Experimental Design

Seventy-two extracted third molars were cleaned and stored in 0.5% chloramine for 48 h for disinfection. Teeth were embedded in autopolymerizing acrylic resin Jet (Classico; São Paulo, SP, Brazil) and the dentin was exposed using #200- and #600-grit silicon carbide abrasive papers.

Restorative Procedure

Teeth were divided in two groups according to the adhesive used. Adper Single Bond 2 (SB, 3M ESPE; St Paul, MN, USA) and Prime & Bond NT adhesives (PB, Dentsply; Petrópolis, RJ, Brazil) were applied in accordance with the manufacturers' instructions. After acid etching with the respective acids of the different adhesives, the surfaces were rinsed with water for 20 s and air dried, but keeping dentin wet. The adhesives were applied on dentin surfaces. A brush saturated with adhesive was applied to the wet surface and brushed for 10 s, followed by a stream of air for 10 s at a distance of 20 cm. The same procedure was repeated for the second layer. The adhesive was immediately light cured for 10 s using a XL3000 halogen light unit (3M/ESPE; Seefeld, Germany). The adhesives were light polymerized between 450 and 500 mW/cm², measured with an analogical radiometer (Demetron Kerr; Orange, CA, USA).

The teeth were divided into 8 groups as shown in Table 1. In the control groups (no provisional restoration), a com-

posite resin block (Z250, shade A3, 3M ESPE) was built up in three 2-mm increments that were light polymerized for 20 s each. Specimens were stored in artificial saliva at 37°C for 48 h.

The experimental groups (use of provisional restoration; Table 1) were covered with an occlusal coat (2 mm) of eugenol-free temporary cement (RelyX Temp NE, 3M ESPE).

Storage Procedures

The specimens were stored in a culture oven in artificial saliva (Salivan, Aspen Farmacêutica; São Paulo, SP, Brazil) for 48 h or 4 months (Table 1).

Surface Treatment

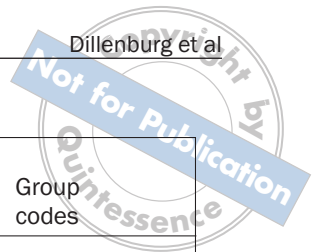
After the storage period, temporary cement excess was removed with a #17 dentin excavator (Hu Friedy; Chicago, IL, USA). Next, the teeth were randomly divided into the following groups.

- Airborne alumina particle abrasion (AO): A micro-etching device (Danville Engineering; Danville, CA, USA) was used to apply the 50- μ alumina particles under a pressure of 80 psi for 10 s. The application distance was standardized at 2 cm using an orthodontic wire positioned on the tip outlet of the airborne microparticle abrasion device. After airborne particle abrasion, teeth were washed with air/water spray for 10 s.
- Phosphoric acid (PA): The surface was etched with 37% phosphoric acid for 15 s and washed with air/water spray for 15 s.
- Aluminum oxide + phosphoric acid (AO + PA): The micro-etching device was used to apply the 50- μ alumina particles under a pressure of 5.51 bars for 10 s as described above. Then, the surface was etched with 37% phosphoric acid for 15 s and washed with air/water spray for 15 s.

After surface treatment, another adhesive coat was applied and light polymerized for all experimental groups. Next, a composite resin block (Z250, shade A3, 3M ESPE) was built up in three 2-mm increments that were light polymerized for 20 s each. Specimens were again stored in artificial saliva at 37°C for 48 h.

Specimen Preparation for Microtensile Bond Strength Testing

Subsequently, 48 teeth ($n = 3$ per group) were mounted in a cutting machine (Labcut 1010, Extec Corp; London, England). Using a 0.35-mm-thick diamond disk (Buehler; Lake Bluff, IL, USA) at a low speed (500 rpm) under constant distilled water cooling, teeth were cut in the x and y directions, perpendicular to the adhesive area, into sections approximately 0.7 mm thick.¹⁸ Resin/dentin sticks were obtained and the adhesive area was measured using a digital caliper with a precision of 0.01 mm (Mitutoyo; São Paulo, SP, Brazil). The adhesive area of the specimens was inspected with a stereoscopic microscope SZ-40 (Olympus;

**Table 1 Experimental design of different groups**

Adhesive/ Batch number	Provisional restoration	Storage time	Surface treatments	Adhesive application	Composite resin	Group codes
Adper Single Bond 2 (SB - 3M ESPE) /OEH	NO (control)	2 days (2 d) 4 months (4 m)	NO	NO	YES	SB control
	YES (experimental)	2 d	Aluminum oxide (AO)	SB	YES	SB AO
		4 m	Phosphoric acid (PA)			SB PA
		2 d				SB AO + PA
		4 m				
Prime & Bond NT (PB - Dentsply) /5215	NO (control)	2 d 4 m	NO	NO	YES	PB control
	YES (experimental)	2 d	AO	PB	YES	PB AO
		4 m	PA			PB PA
		2 d				PB AO + PA
		4 m	AO + PA			

Tokyo, Japan) at 10X magnification before testing to exclude sticks with voids and adhesive failures.

The sticks were individually attached to a microtensile testing device using cyanoacrylate glue (Superbonder Gel, Loctite; São Paulo, SP, Brazil) and the accelerator Zip-Kicker (Pacer; Rancho Cucamonga, CA, USA), with the adhesive area perpendicular to tensile long axis. The test was performed in a universal testing machine (EMIC DL-2000; São José dos Pinhais, PR, Brazil) at a crosshead speed of 0.5 mm/min. No sticks were lost prematurely during the cutting procedure or debonded before the μ TBS test.

The mean μ TBS for every group was expressed as the average of the three teeth used per group. After data collection, the microtensile bond strength test results were submitted to the Kolmogorov-Smirnov normality test. The statistical tests used were ANOVA with two fixed factors (storage time and surface treatments) for each adhesive system tested and Tukey's test ($\alpha = 0.05$) for each adhesive.

SEM Evaluation of Fracture Pattern

After the microtensile bond strength test, the two fractured portions of each stick were fixed on stubs, using a metal strip to keep the interface up. The specimens were immersed in 2.5% glutaraldehyde for 12 h at 4°C for fixation, washed with 20 ml of sodium cacodylate 0.2 M buffer solution (pH 7.4) for 1 h, and washed in distilled water 3 times for 1 min. The specimens were dehydrated by sequential immersion in ethyl alcohol (25% for 20 min, 50%

for 20 min, 75% for 20 min, and 98% for 20 min), and dried at 37°C for 48 h with silica gel drying pearls. The prepared specimens were gold sputtered at 10 mA for 1 min and observed with SEM (Philips; Eindhoven, The Netherlands) at 200X and 2000X magnification.

To evaluate the failure pattern for each group, the area fractions of the failure modes per total fractured surface (%) of all specimens were calculated from SEM photomicrographs using Power Point (Office XP, Microsoft; Redmond, WA, USA) in which a checkered screen with 100 squares was positioned over the photomicrograph. The failure mode was classified as: interfacial (cohesive in top or bottom of hybrid layer, cohesive in adhesive), cohesive in dentin, cohesive in composite resin, or mixed when more than one failure mode was involved. As a quality measurement was made, the data were presented as percentages.

SEM Evaluation of Hybrid Layer Thickness

To evaluate the adhesive layer thickness by SEM, specimens similar to those of the main factor surface treatment for each adhesive were made, but these were sectioned parallel to the tooth long axis leaving the dentin/adhesive interface exposed. Twenty-four teeth ($n = 3$ per group) were used and the adhesive layer was measured at 10 different points of each specimen, from which means and standard deviations were calculated for each group. Each specimen hemi-face was treated as follows: 6N chloride acid immersion for 30 s, distilled water washing for 1 min, 12% NaOCl immersion for 5 min. The drying cycle in 25%,

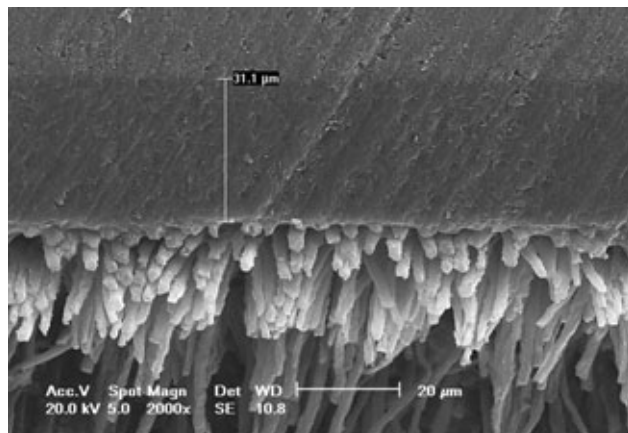
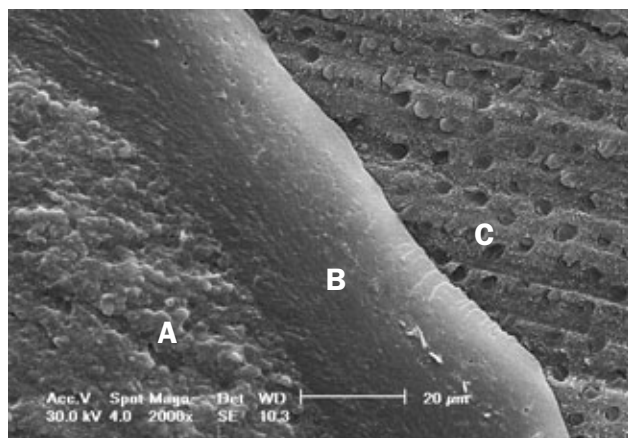


Fig 1 Adhesive layer thickness measurement, in this case 31.1 μm .



50%, 75%, and 98% ethanol was also performed, with each specimen remaining for 20 min in each solution. Specimens remained for 5 min on absorbent paper before being placed in semi-open receptacles that allowed alcohol to evaporate and avoided contact with air impurities. After 24 h, specimens were placed in a desiccator with silica gel drying pearls and then positioned on stubs, gold sputtered at 10 mA for 1 min, and observed by SEM at 1000X and 2000X magnification.

For adhesive layer thickness measurement, the software Image Tool (UTHSCSA; San Antonio, TX, USA) was calibrated for micrometer readings. The measurement was made from the bottom of the adhesive layer to the base of the composite resin (Fig 1). Ten measurements were made for each specimen slice and the means and standard deviations were calculated for each test group. Next, the statistical tests used were ANOVA with two fixed factors (storage time and surface treatments) for each adhesive system tested and Tukey's test ($\alpha = 0.05$). All statistical analyses were performed using SPSS version 11.0 (SPSS; Chicago, IL, USA).

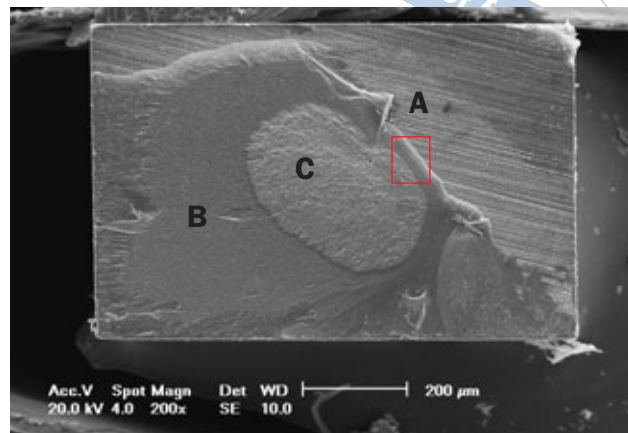


Fig 2 SEM photomicrograph of a stick with mixed failure: A) failure at the top of hybrid layer; B) cohesive failure in adhesive and; C) cohesive failure in composite resin. Area in red box shown at higher magnification in Fig 3.

Fig 3 SEM photomicrograph of the mixed failure: A) cohesive in composite resin; B) cohesive in adhesive and; C) cohesive at the top of hybrid layer.

RESULTS

The overall mean microtensile bond strength and mean cross-sectional area are shown in Table 2. The mean cross-sectional area was similar between groups and no differences among the treatment groups were detected ($p > 0.05$, Table 2).

As regards microtensile bond strength, the interaction of storage time x surface treatment and the main factor storage time were not significant for either of the adhesive systems ($p > 0.05$). Only the main factor surface treatment was significant ($p < 0.001$). The microtensile bond strength means and standard deviations for the mentioned significant interaction are shown in Table 3.

The most effective treatment was the association of aluminum oxide and phosphoric acid for both adhesives systems tested, (see SB and PB, AO + PA groups in Table 3) the results being similar to those of the SB and PB control groups ($p > 0.05$), and both were significantly superior to the other groups ($p < 0.05$). The use of aluminum oxide treatment only (SB and PB, AO groups) or phosphoric acid



Table 2 Mean adhesive area (mm²) and standard deviation (SD), as well as mean microtensile bond strength values (μ TBS) in MPa and SD for each experimental condition

Surface treatment	Storage time	Area (mm ²) \pm SD	μ TBS (MPa) \pm SD
SB control	2 d	0.51 \pm 0.04	41.6 \pm 6.91
	4 m	0.53 \pm 0.07	41.2 \pm 9.32
SB AO	2 d	0.51 \pm 0.08	23.8 \pm 5.92
	4 m	0.52 \pm 0.05	23.9 \pm 5.49
SB PA	2 d	0.50 \pm 0.08	28.5 \pm 6.57
	4 m	0.48 \pm 0.09	27.8 \pm 3.31
SB AO + PA	2 d	0.51 \pm 0.06	44.9 \pm 10.5
	4 m	0.54 \pm 0.05	44.8 \pm 9.07
PB control	2 d	0.51 \pm 0.06	40.2 \pm 10.4
	4 m	0.52 \pm 0.08	41.0 \pm 11.2
PB AO	2 d	0.52 \pm 0.06	19.1 \pm 5.48
	4 m	0.51 \pm 0.05	18.5 \pm 3.95
PB PA	2 d	0.50 \pm 0.04	30.6 \pm 10.1
	4 m	0.52 \pm 0.03	28.3 \pm 10.3
PB AO + PA	2 d	0.49 \pm 0.06	47.2 \pm 10.1
	4 m	0.52 \pm 0.04	46.0 \pm 10.3

Table 3 Mean microtensile bond strength values (MPa) and standard deviation (SD) and mean adhesive layer thickness (ALT in μ m) and standard deviation, for the main factor surface treatment for each adhesive system

Surface Treatment	μ TBS (MPa) \pm SD *	ALT (μ m) \pm SD *
SB control	41.4 \pm 8.2 (A)	28.5 \pm 3.8 (G)
SB AO	23.9 \pm 5.7 (B,C)	31.3 \pm 1.3 (F)
SB PA	28.2 \pm 4.9 (B)	58.3 \pm 6.1 (D)
SB AO + PA	44.6 \pm 9.8 (A)	35.7 \pm 3.3 (E)
PB control	40.6 \pm 10.8 (a)	25.2 \pm 3.8 (g)
PB AO	18.8 \pm 4.7 (c)	28.4 \pm 3.9 (f)
PB PA	29.4 \pm 4.7 (b)	54.4 \pm 4.6 (d)
PB AO + PA	46.6 \pm 10.2 (a)	32.5 \pm 2.5 (e)

* Means followed by the same upper or lower case letter in the same column show no statistical difference according to Tukey's test for each adhesive ($p < 0.05$)

Table 4 Failure percentage by fracture location for main factor surface treatment (*)

Surface treatment	Cohesive resin (%)	Cohesive dentin (%)	Bottom hybrid layer (%)	Interfacial failure Top hybrid layer (%)	Adhesive (%)
SB Control	61.7	5.9	0.9	8.7	22.8
SB AO	13.3	1.0	44.3	26.3	15.1
SB PA	13.2	4.0	5.7	60.4	16.7
SB AO + PA	63.1	2.9	1.3	8.0	24.7
PB Control	52.8	3.9	4.9	14.8	23.6
PB AO	14.7	0.5	43.3	27.1	14.4
PB PA	11.8	0.3	5.1	60.4	22.4
PB AO + PA	62.2	3.4	1.3	8.1	25.0

In **BOLD** most predominant failure pattern

(SB and PB, PA groups) showed the worst and similar microtensile bond strength values for both adhesives (Table 3, $p < 0.05$).

With regard to mean adhesive thickness (Table 3), the interaction of storage time \times surface treatment and the main factor storage time was not significant for either of the adhesive systems ($p > 0.05$), but surface treatment was significant ($p < 0.05$). Table 3 shows that all surface treatments differed significantly compared to the SB and PB control groups ($p < 0.05$). The use of phosphoric acid showed the highest adhesive thickness values for both adhesive systems (see SB and PB, PA groups in Table 3, $p < 0.05$). The use of aluminum oxide alone (SB OA and PB AO groups) or associated with phosphoric acid (SB AO + PA and PB AO + PA) showed values close to those of the SB and PB control groups, but this difference was statistically significant ($p < 0.05$, Table 3).

In Table 4, the failure pattern for each experimental condition is shown. Again, only the main factor surface treatment showed significant differences ($p < 0.05$). Seventy five percent of the fractured surfaces analyzed presented mixed failure, 21% presented interfacial failure, while cohesive failures in composite resin and in dentin represented 3% and 1% of the total, respectively (Table 4).

The failure patterns were similar to those of the SB and PB Control and SB AO + PA and PB AO + PA groups, independently for each adhesive system. For Adper Single Bond 2, 61.7% were cohesive failures in resin in the SB Control group, and 63.1% for the SB AO + PA group. For Prime & Bond NT, 52.8% and 62.2% were cohesive resin fractures in the PB control and PB AO + PA groups, respectively. This was different for phosphoric acid and aluminum oxide groups for both adhesive systems. In these groups, mixed failure was the most common failure mode. When SB or PB AO was used, the most frequent failure pattern was at the bottom of the hybrid layer (44.3% and 43.3% for SB AO and PB AO, respectively); otherwise, for SB and PB PA groups, 60.4% of the failures were found at the top of the hybrid layer for both adhesive systems tested (Figs 2 and 3).

DISCUSSION

Adhesive system prepolymerization in direct restorations is a well-established technique; however, this is not true with regard to indirect restorations. In the classical adhesive cementation technique, a dual adhesive system should be used in order to prevent marginal gaps in restorations, caused by adhesive layer thickness.¹⁹ However, the non-polymerized hybrid layer may collapse, as the result of pressure generated during restoration insertion and fitting. This could decrease the content of resin-impregnated collagen fibers, weakening the already formed hybrid layer.^{7,14} This factor can determine the presence of postoperative sensitivity, lower bond strength, and greater gap formation at the bond interface.^{3,5,16} In IDS, the impression is taken after the adhesive application. To avoid the interaction of adhesive systems with impression materials and temporary material, and to allow a more effective ad-

hesive layer polymerization without oxygen inhibition, the use of water soluble glycerin over the adhesive layer after initial light polymerization is indicated,^{13,19} as used is the present study.

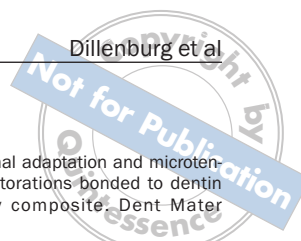
When the indirect procedure is performed, it is necessary to apply temporary cement, and depending on the time this material has to stay in position, it could be difficult to realize the adhesive procedure with a second layer application as called for by the IDS protocol. These results allowed the null hypothesis tested in this study to be accepted with regard to storage time, because there was no significant difference between groups tested after 2 days and 4 months, as was also shown by Magne et al.¹¹

Some authors indicated the adhesive layer should be meticulously cleaned before the IDS technique,^{12,19} however, there is no consensus about the best way to clean the adhesive surface contaminated by temporary cement and saliva before the adhesive procedure and during definitive cementation. The present study results showed that there was a difference between groups tested. Thus, the null hypothesis tested in this study was rejected with regard to surface treatment.

Lower bond strength means were encountered in the groups that received only airborne alumina microparticle abrasion (SB AO and PB AO) (Tables 2 and 3) when compared with the SB and PB control groups. In the case of aluminum oxide (SB AO and PB AO), these lower values can be explained by a possible decrease in adhesive layer thickness and cohesive strength caused by airborne alumina particle abrasion. Note that although two layers of adhesive were applied in this group, the adhesive thickness was similar to that of the control groups (28.5 and 25.2 for SB control and PB control, respectively, vs 31.3 and 28.3 for SB AO and PB AO) (Table 4). Another factor that agrees with this hypothesis is that there was a general change in the fracture pattern in this group in comparison with the control groups, again indicating that the aluminum oxide may have weakened the adhesive layer: the fractures in this group occurred at the bottom of the hybrid layer (see groups SB AO and PB AO, Table 4). This theory is supported by Stavridakis et al,¹⁹ who reported that the airborne particle abrasion generated a decrease in the adhesive layer thickness, and that there was the risk of the adhesive layer being completely removed during the temporary cement cleaning procedure.

The groups in which the temporary cement excess was removed by a scaler, followed by acid etching with phosphoric acid (SB PA and PB PA groups) always presented lower bond strength values than did the controls (Tables 2 and 3). A possible explanation for these low values could be that dentin cleaning was performed with a scaler only, and it may not have been enough for removing all the temporary cement residues.² These cement remainders on the adhesive surface interfere with the hybrid layer structure, lowering the bond strength and promoting a fracture pattern predominantly at the top of the hybrid layer (Table 4).

Moreover, it can be observed that although the bond strength values were lower than those of the SB and PB control group, phosphoric acid (SB PA and PB PA) pre-



sented higher values than did the aluminum oxide groups (SB AO and PB AO). An explanation for this may be that the adhesive layer was not damaged by phosphoric acid application (Table 4). The adhesive layers of groups in which PA was applied were thicker than in those where it was not (see SB PA and PB PA in Table 3).

These factors are also reinforced by the lower adhesive layer thickness found for Prime & Bond NT in the studied groups, probably because of the rapid solvent evaporation (acetone) that leads to thin and irregular adhesive layer formation, as described by Platt et al,¹⁷ in comparison with groups restored with Single Bond 2.

The results of the present study showed that among the experimental groups, the subgroups AO + PA presented the best results (Tables 2 and 3). This occurred because the areas where the adhesive layer was thinned or removed may have been repaired after the renewed etching and adhesive layer application. Moreover, the adhesive thickness was lower in comparison with the PA groups, indicating that the application of aluminum oxide really removed just the adhesive surface; however, the phosphoric acid conditioning improved the interaction of the second adhesive layer with the previously hybridized surface, increasing the bond strength values and re-establishing the fracture pattern observed in the control groups (Table 4).

Hasegawa et al⁸ and Leloup et al¹⁰ reported that the number of substrate cohesive failures (dentin/composite resin) was directly proportional to the bond strength values. In this study, the highest number of cohesive resin failures was found in the groups that presented higher bond strength (control and AO + PA) (Table 4). This result is in agreement with some previously mentioned studies.^{8,10}

Little difference was found between adhesive systems used, although this factor was not submitted to statistical analysis. Groups treated with aluminum oxide and Prime & Bond NT (PB AO) presented statistical differences from the group in which phosphoric acid was used (PB PA; Table 3). With regard to Adper Single Bond 2, these two treatments were similar (Table 3; SB AO and SB PA). This may be related to the adhesive chemical composition, particularly the diluent. The presence of acetone in Prime & Bond NT may lead to a more irregular adhesive layer formation than Single Bond 2, which contains water and ethanol. The acetone evaporates more rapidly, making it difficult for the monomer to penetrate into the substrate, thus creating a thinner adhesive layer.¹⁰ It is possible that this layer becomes more fragile when associated with airborne microparticle abrasion, decreasing its bond strength values.

CONCLUSION

In summary, dentin prehybridization in indirect restorative procedures can improve the adhesive bond strength if the bonded surface is treated with airborne alumina particle abrasion associated with 37% phosphoric acid, followed by a second adhesive layer. Testing of the proposed technique in vivo could clarify the results obtained in this study.

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Clinical relevance: The bond strength in the immediate dentin sealing technique may be improved if the pre-polymerized adhesive layer is cleaned with aluminum oxide (10 s) associated with phosphoric acid (15 s).