Simultaneous Activation Technique: An Alternative for Bonding Composite Resin to Glass Ionomer

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Abstract

Purpose: The purpose of this study was to evaluate a new simultaneous activation technique (SAT)–for the union between glass ionomer cements and composite resins.
Methods: Forty primary molars were embedded in self-curing acrylic resin. Class I cavity preparations were performed on the dentin surface and the teeth were randomly divided into 4 groups (N=10). Two groups were restored with the SAT and 2 by etching the ionomer surface/sandwich technique (ST). The materials tested were Vidrion F (SS/White), Vitremer (3M), and Z100 (3M). After 24 hours in aqueous solution at 37°C, a tensile test was performed. The microleakage study was also performed by selecting 40 primary molars which were distributed in the same way as in the bond strength test. Furthermore, 1 tooth from each group of the microleakage test was evaluated by means of scanning electron microscopy.
Results: The SAT and ST did not show statistically significant differences in both tests.
Conclusions: The SAT is a less complex, quicker, and feasible alternative for the bonding of glass ionomer cements to composite resins in primary molars. (*Pediatr Dent*. 2003;25:270-274)

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Reduction in the number of operative steps, without a consequent decrease in the acceptability of clinical outcome, would help reduce the time of a dental appointment for the patient and the dentist.

Resin-modified glass ionomer cements such as Vitremer (3M) have the capability of reducing the total number of viable bacteria within affected dentin. This antibacterial potential is complemented by the capability of the ionomer cements to induce dentin remineralization. Thus, these materials may be indicated for procedures where dentin and pulp recovery are indicated.[1] However, as ionomer cements are not fracture resistance, the use of these materials combined with a composite resin is a treatment option.[2]

Today in the Brazilian market, 2 kinds of glass ionomer cements can be found: (1) the conventional cements (chemical-cure cements), and (2) the resin-modified cements (light-cured glass ionomer cements). Among the conventional glass ionomer cements, the market gives great emphases to Vidrion F (SS White). This glass ionomer cement is a chemical-cure ionomer used as lining material. Vidrion F (SS White) shows approximately 22.04 MPa of flexural strength and 4.61 MPa of adhesivity to dentin.[3] Among the resin-modified glass ionomer cements, the authors have Vitremer (light-cured glass ionomer) that presents the following cure process: (1) the acid/base reaction identical to the conventional glass ionomer cement; (2) a light-activated, free-radical polymerization of methacrylate groups of the polymer and HEMA initiated by visible light; and (3) a water-activated redox catalyst reaction which allows the methacrylate cure to proceed in the dark.[4]

The union between the glass ionomer cements to composite resins has been exhaustedly studied, and research shows that the light-curing ionomer cements possess significantly higher bond strength to composite resin than any of the chemically

Table 1. Group Distribution for the Tensile Bond Strength Test

Group	1	2	3	4
GI base	Vidrion F	Vidrion F	Vitremer	Vitremer
Curing time	6 minutes, self-cured	None	10 seconds, light-cured	None
Adhesion technology	E*	SAT†	E*	SAT†
Composite	Z100	Z100	Z100	Z100

*Etching of the ionomer surface + Scotchbond Multi-Purpose.
†Simultaneous activation technique with Scotchbond Multi-Purpose.

curing cements.[5] The sandwich technique (ST), which consists of using glass ionomer cement as a base for the composite resin, combines the favorable properties of the ionomer cement with the advantages of superior wear resistance, greater cohesive strength, and better translucence and esthetics of the composite resin.[4,6] In this technique, after the insertion of the glass ionomer cement in the cavity, it is necessary to wait until the chemical cure or the photoactivation of the material, and only then can the acid etching, rising, and drying be done followed by the application of the bonding agent and the insertion of composite resin. This technique is too complex and too long for children.

The simultaneous activation technique (SAT) is a new alternative for the union between glass ionomer cement and composite resin. With SAT, after insertion of glass ionomer cement into the cavity, the bonding agent is immediately applied and light cured prior to placement of the composite resin. There is no need to wait for the setting of the conventional glass ionomer cement, to light cure the resin-modified glass ionomer cement, or to etch the ionomer surface.

The purpose of this study was to evaluate the behavior in vitro of the SAT on primary teeth using: (1) the tensile bond strength test, (2) the microleakage study, and (3) the scanning electron microscopy analysis.

Methods

Bond strength

Forty primary molars were embedded in self-curing acrylic resin. The occlusal teeth surfaces and the resin were ground with 320 to 600-grit wet sandpaper to obtain flat dentin surfaces. The cavity preparations were performed on the dentin surface by using 1033 (KG Sorensen) inverted-cone, diamond-coated tips, with a diameter of approximately 4 mm and a depth of approximately the active portion of the bur, at high speed. The specimens were randomly divided into 4 groups of 10 teeth each (Table 1).

The conventional glass ionomer cement (Vidrion F) and the composite resin (Z100) were employed in the first group (E–control). The ST is the currently accepted clinical standard and is currently recommended by the material manufacturers. In this group, after inserting glass ionomer cement into the cavity, the latter was allowed to set for 6 minutes before being etched for 15 seconds with 35% phosphoric acid. The Scotchbond Multi-Purpose (3M Dental Products) bonding agent was applied on the ionomer base and light cured for 10 seconds prior to placement of the composite resin.

Table 2. Degree of Microleakage[9]

Score	Criterion
0	No dye penetration
1	Dye penetration up to the middle of the tooth/ restoration interface of the cavity preparation
2	Dye penetration up to the end of the tooth/ restoration interface of the cavity preparation
3	Dye penetration up to the cavity base or beyond

The same lining and restorative materials previously used were also employed in the second group (SAT–experimental). After complete drying, the cavity was completely filled with conventional glass ionomer cement. The Scotchbond Multi-Purpose (3M Dental Products) bonding agent was immediately applied on the ionomer base and light cured for 10 seconds prior to placement of the composite resin.

In the third group (E–control), using the resin-modified glass ionomer cement (Vitremer) base, the ionomer surface was etched. In this group, the resin-modified glass ionomer cement (Vitremer) once inserted into the cavity, was light cured and etched with 35% phosphoric acid. The bonding agent was applied on the ionomer surface and light cured. Afterward, the composite resin (Z100) was placed on top of the bonding agent in 2 increments, in such a way that each of them was light-cured for 40 seconds.

The resin-modified glass ionomer cement (Vitremer) was used as a base for the composite resin (Z100) in the fourth group (SAT–experimental). The bonding agent was immediately applied on the ionomer surface and light cured. Afterward, the composite resin (Z100) was placed on top of the bonding agent in 2 increments, in such a way that each of them was light cured for 40 seconds.

All of the test specimens were stored in an aqueous solution at 37°C for 24 hours before the tensile test using an Instron test machine (model 4442, Instron Corporation) at a crosshead speed of 0.5 mm per minute.

Microleakage

Forty other human primary molars with root resorption characteristic of the physiological exfoliation were chosen, and standardized Class I cavity preparation was performed with 1094 (Fava) inverted-cone, diamond-coated tips, approximately 4 mm in diameter and 2 mm in depth, at high speed. All the teeth were randomly divided using the same group distribution (Table 1) as the bond strength. The only existing variation among the tensile test groups regarding the microleakage groups was the use, in the latter, of the etching with 35% phosphoric acid and the application of the primer (Scotchbond Multi-Purpose, 3M Dental Products) on all the enamel walls of the cavity preparation prior to placement of the glass ionomer cement.

The teeth were sealed with epoxy resin (Ultrarapid Araldite, Brascola, SBC/SP) and red nail polish (Colorama–CEIL–COML. EXP. INDL. Ltda.) on all surfaces, except at 1 mm from the restoration margins. All the specimens were immersed in a 1% rodamine solution (pH=7.2) for 24 hours at 37°C[7] and sectioned mesiodistally in a single cut for microleakage evaluation.[8] The microleakage was analyzed with a stereooscopic magnifying glass at ×2.1 magnification (Olympus SZ–Pt Japan; SZ 40) and evaluated via pictures (Kodak Gold 100 film) by 3 calibrated examiners. The evaluation criterion of the degree of microleakage is shown in Table 2.[9]

A tooth from each of the groups of the microleakage test was randomly selected for scanning electron microscopy study (Figures 1, 2, 3, and 4).

Results

Bond strength

The tensile bond strength mean values and standard deviation are shown in Table 3. The analysis of variance and the Tukey test at a significance level of 5% were applied (Tables 4 and 5). No statistical differences were found between groups 1 (6.87) and 2 (7.55) and between groups 3 (15.91) and 4 (13.67) (Table 4).

Microleakage study

The Kruskal-Wallis test was applied at a significance level of 5% with a total number of 40 evaluations, divided into 4 samples of 10 evaluations each. No statistically significant differences were found. (H value=3.94, P=.2680)

Scanning electron microscopy study

In Group 1, the glass ionomer cement/composite resin interface shows a perfect bond between the 2 materials, and the bonding agent can be noticed in a narrow strip inside the glass ionomer cement near the composite resin (Figure 1). In Group 2, where SAT was used, great interlocking between the glass ionomer cement and the composite resin is observed, with areas of the glass ionomer cement located inside the composite resin (Figure 2). The resin-modified glass ionomer cement/composite resin (Vitremer/Z100) interface in Group 3 with a ×460 magnification did not exhibit close contact between these 2 materials (Figure 3). In the last group, the resin-modified glass ionomer cement

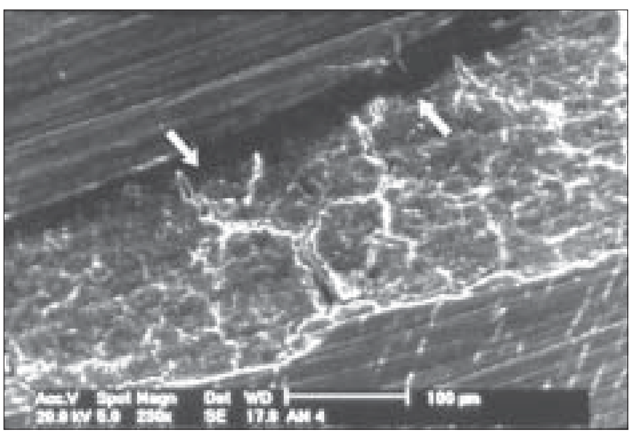

Figure 1. The glass ionomer cement/composite resin interface shows a perfect bond (Group 1).

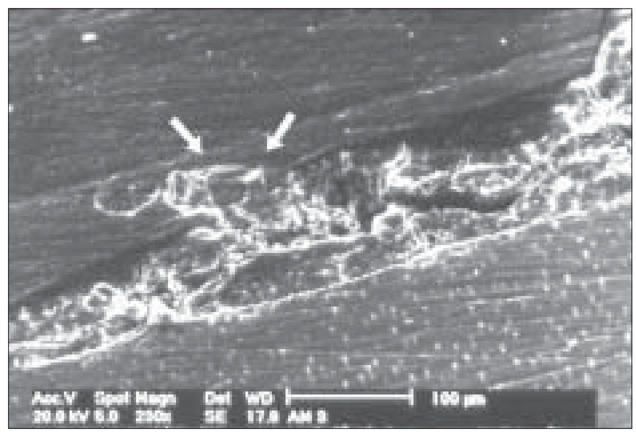

Figure 2. Notice a great interlocking between the glass ionomer cement and the composite resin (Group 2).

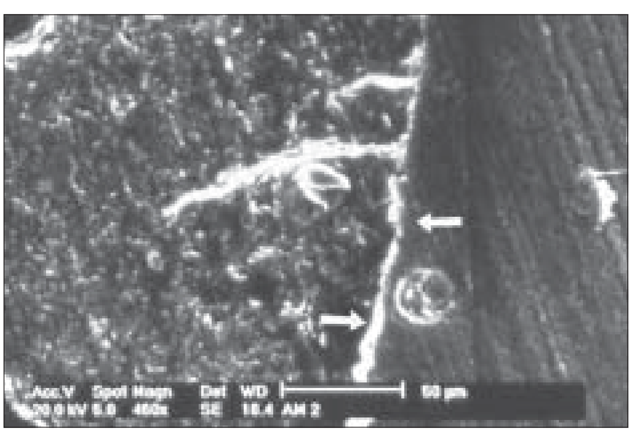

Figure 3. The resin-modified glass ionomer cement/composite resin did not exhibit close contact between these 2 materials (Group 3).

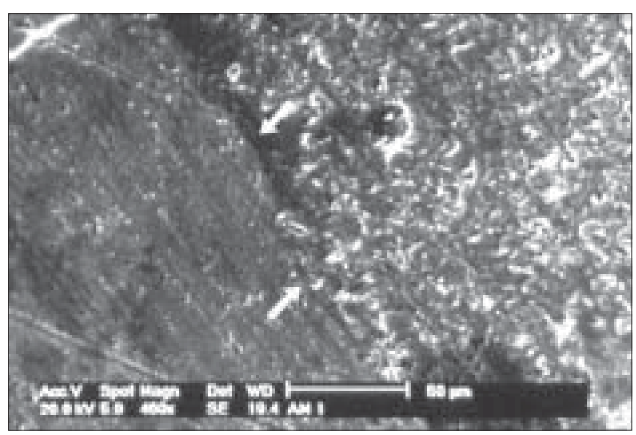

Figure 4. The resin-modified glass ionomer cement and the composite resin seem to be perfectly fitted, with a considerably smooth transition zone (Group 4).

Table 3. Tensile Bond Strength Mean Values (MPa) and Standard Deviation

	E* (Group 1) Vidrion F+ Z100	SAT† (Group 2) Vidrion F+ Z100	E* (Group 3) Vitremer+ Z100	SAT† (Group 4) Vitremer+ Z100
Groups	6.87 (2.29)	7.55 (2.00)	15.91 (3.66)	13.67 (3.74)

*Etching of the ionomer surface.
†Simultaneous activation technique.

Table 4. Analysis of Variance for the Means of the 4 Experimental Groups and the F Test at the 5% Significance Level

Source of variation	Degrees of freedom	Mean square	F
Groups	3	200.71	21.86*
Residual	36	9.18	
Total	39		

*Significant at the 5% significance level.

Table 5. Means of the Different Groups and the Probability of the Tukey Test at the 5% Significance Level

	Group 1 Mean=6.87	Group 2 Mean=7.55	Group 3 Mean=15.91	Group 4 Mean=13.67
Group 1		0.958	0.00015*	0.00023*
Group 2	0.958		0.00016*	0.00050*
Group 3	0.00015*	0.00016*		0.36533
Group 4	0.00023*	0.00050*	0.36533	

*Significant at the 5% significance level.

(Vitremer) and the composite resin (Z100) seem to be perfectly fitted, with a considerably smooth transition zone (Figure 4).

Discussion

The results obtained are in agreement with Sheth[10] et al, Kerby and Knobloch[5], Amin[11] et al, and Zanata[12] et al since the etching of the ionomer surface did not result in a significant improvement in the bonding of the glass ionomer cement (conventional and resin-modified) to the composite resin.

An important factor in this study is that, after light curing the bonding agent, both ionomer cements carried on the chemical setting. Perhaps this continuous acid-base reaction of the conventional glass ionomer cements under the light-cured adhesive has contributed to the setting of the micromechanical interlocking between the ionomer base and the composite resin, justifying a higher mean value obtained through the SAT with regard to the etched specimens. The contrary thought can be used in the case of the resin-modified glass ionomer cement (Vitremer) in which, despite the continuous acid-base reaction and the chemical polymerization of methacrylate groups in the dark, the absence of light curing prior to application of the bonding agent seems not to have permitted this material to achieve a complete polymerization, thus inverting the values among the means of the groups.

The obtained results are in agreement with García-Godoy[13] et al and Sheth[10] et al since the authors did not find statistically significant differences in the dye penetration whether the conventional glass ionomer cement is etched or not prior to application of the bonding agent and the composite resin.

Conclusions

The SAT is a less complex, quicker, and feasible alternative for the bonding of glass ionomer cements to composite resins in primary molars.

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Abstract of the Scientific Literature

Apnea

Apnea, the partial or complete cessation of respiratory flow, is classified into 3 different types depending on the underlying pathophysiology and clinical presentation: central apnea, obstructive apnea, and mixed (apnea exhibiting both central and obstructive elements). Central apnea is the absence of respiratory effort from failure of brainstem neurons to generate an excitatory impulse and subsequently stimulate respiratory muscles. Central apnea can affect term neonates and infants as a consequence of their relatively immature brainstem. Brief episodes of apnea are fairly common, but an episode of more than 20 seconds is usually considered pathologic. Preterm neonates can present with idiopathic apnea of prematurity or with apnea from a variety of serious underlying conditions. Obstructive apnea typically occurs in older children and may involve the upper airway (nasal polyps, hypertrophied adenoids), oropharynx (enlarged tonsils, macroglossia), or the larynx (subglottic stenosis, laryngomalacia). Clinically, children may present with snoring, respiratory distress while sleeping, behavioral problems, failure to thrive, and developmental delay. Obstructive sleep apnea (OSA) is not a benign condition and can lead to death. It is estimated that 2% to 3% of children have sleep disorders and children at particular risk are those who have Trisomy 21, craniofacial anomalies, and neuromuscular disorders. Of the children who have OSA, between 75% and 100% snore. Enuresis, diaphoresis, and hyperextension of the head during sleep also have strong predictive values for OSA. Obesity and OSA is more prevalent in adults; almost 30% of the children with OSA are underweight, as affected children may lose weight and fail to grow because of interrelated difficulties with eating and chronic hypoxemia. BEARS, a mnemonic tool, may be used to guide a clinician taking a sleep history: **B**edtime problems, **E**xcessive daytime sleepiness, **A**wakenings at night, **R**egularity and duration of sleep, **S**noring.

There are several strategies to confirm the diagnosis of OSA: overnight pulse oximetry, a sleep audiotape recorded by the parents, the Multiple Sleep Latency Test (of limited use in pediatrics), and polysomnography (PSG), which is considered the gold standard. PSG uses a chest wall motion detector, nasal air flow meter, heart rate monitor, and a pulse oximeter for diagnosis. Not all children suspected of having OSA require PSG, particularly when the indication for a tonsillectomy and adenoidectomy is clear, but PSG can provide critical information when (1) there is uncertainty about the severity of OSA, (2) in the presence of severe neurologic disease, (3) with a very young child, and (4) with a medical condition that might complicate surgical intervention.

Comments: The detection of children with a history of apneic episodes and/or OSA is important to the pediatric dentist, particularly if one is considering conscious sedation, deep sedation, or general anesthesia in the course of dental treatment. It is interesting to note that, unlike the association of obesity and OSA found in adults, approximately one third of the children with obstructive sleep apnea are underweight. **SS**

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