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ORIGINAL RESEARCH

Resin Bonding using Etch-and-Rinse and Self-etch Adhesives to Decalcified Deciduous Enamel after Bioactive Glass Air Abrasion

[1]Alireza Eshghi, [2]Maryam Khoroushi, [3]Alireza Rezvani

ABSTRACT

Purpose: Bioactive glass air abrasion is a conservative technique for removal of initial decalcified enamel superficial layer and caries *vs* alumina air abrasion. This study evaluated shear bond strength of composite resin to sound and decalcified deciduous enamel using etch-and-rinse and self-etch adhesives after alumina and bioactive glass air abrasion.

Materials and methods: Ninety-six flat enamel surfaces, mounted in acrylic resin, were prepared from 48 deciduous molars. Half of the specimens were decalcified with a demineralizing solution. Both intact and decalcified specimens were assigned to two groups for alumina and bioactive glass air abrasion. In each group, the specimens were subdivided into two groups for application of Clearfil SE Bond or Optibond FL adhesives (n = 12). After composite resin bonding, the specimens underwent shear bond test. Data were analyzed using three-way analysis of variance (ANOVA), linear regression model and independent-sample t-test ($\alpha = 0.05$).

Results: No significant differences were noted in bond strength of composite resin after alumina or bioactive glass air abrasion ($p = 0.272$). Optibond FL adhesive and enamel decalcification produced higher bond strength ($p = 0.000$, $p = 0.001$ respectively).

Conclusion: In this study, bioactive glass air abrasion produced bond strength comparable to the conventional method. This technique might be an alternative method for preparation of normal and/or decalcified enamel of deciduous teeth for resin bonding.

Keywords: Air abrasion, Alumina, Bioactive glass, Bond strength, Decalcification, Enamel.

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[1]Associate Professor, [2]Professor, [3]Postgraduate Student

[1,3]Department of Pediatric Dentistry, Isfahan University of Medical Sciences, Isfahan, Iran

[2]Dental Materials Research Center, Isfahan University of Medical Sciences, Isfahan, Iran

Corresponding Author: Maryam Khoroushi, Professor Dental Materials Research Center, Isfahan University of Medical Sciences, Isfahan 81746-73461, Iran, Phone: 00983137922859, e-mail: khoroushi@dnt.mui.ac.ir

INTRODUCTION

Enamel bonding mechanism involves replacement of enamel minerals by monomers from the resin. After the setting process, the resin tags penetrated into enamel surface porosities are micromechanically retained.[1] During the acid etching process the smear layer is removed, clearing the enamel surface; therefore, enamel surface tension increases to create a surface with a high energy level.[2] In recent years, two etch-and-rinse and self-etch adhesive systems have been used during bonding procedures of composite resin to enamel and dentin surfaces. Three-step etch-and-rinse systems have been introduced as the gold standard for enamel- and dentin-bonding procedures. Although some previous studies have shown that self-etch bonding systems have low acid concentrations and high hydrophilicity, which decrease bond strength to enamel,[2] according to recent reports two-step self-etch bonding systems produce bond strength values comparable to those achieved with etch-and-rinse adhesives, particularly on prepared enamel.[2]

On the other hand, newly developed dental materials and techniques have opened new horizons for caries removal and tooth preparation. While enamel preparation by diamond burs is a routine technique, some alternative conservative surface preparation methods have also been used to increase the efficacy of acid etching.[1] Nowadays, air abrasion technique is generally recommended in minimally invasive dentistry. These techniques consist of conservative removal of carious lesions.[3] Abrasion technique was introduced by GV Black in 1950. Pain-free cavity preparation, conservative removal of carious lesions, and rounded internal and cavosurface angles are advantages of this technique.[4,5]

Alumina is the most frequently used material in air abrasion technique, which is applied using different particle sizes.[6,7] While alumina air abrasion contributes to conservative preparations as a result of the use of an end-cutting air-abrasive stream, recently bioactive glass materials have been introduced for air abrasion procedures.[3] Some studies have shown conservative removal of carious lesions and better therapeutic effects of bioactive glass compared to alumina.[4,8] A bioactive material is defined as a material, which elicits an appropriate response from living tissues. According to a recent study, in air abrasion technique differences in abrasiveness of bioactive glass and alumina give rise to differences in caries removal during cavity preparation,[9] which also applies to the differences in bioactive glass types.[10]

In recent years, improvements in adhesive dentistry have resulted in an increase in the use of tooth-colored restorations in deciduous teeth,[11] in which the outcomes of bond strength after application of different etch-and-rinse and self-etch adhesive systems are more conflicting in comparison to permanent dentition.[11] However, since self-etch bonding systems do not have a rinsing step, they seem to be more attractive, particularly for dentists when they deal with uncooperative children.[12] On the other hand, some previous studies have advocated air abrasion technique as an effective pain-free conservative pretreatment technique in primary dentition.[13] In high-risk children, where carious lesions progress uncontrollably, usually as a result of poor patient cooperation, early minimally invasive restorative procedures might be necessary to render properly sealed restorations.[14,15]

There is still insufficient data on the comparison of bioactive glass and alumina air abrasion techniques in relation to their effects on composite resin bond strength after application of etch-and-rinse and self-etch bonding systems in deciduous teeth. In addition, in many clinical situations, dental practitioners leave decalcified enamel in the depth of occlusal fissures because it is difficult to determine the exact zone of demineralized enamel.[16] Therefore, the aim of this *in vitro* study was to evaluate the effect of bioactive glass air abrasion on the shear bond strength to sound and decalcified deciduous enamel after application of a three-step etch-and-rinse adhesive and a two-step self-etch adhesive.

MATERIALS AND METHODS

This study was approved by the Ethics Committee for Research in Isfahan University of Medical Sciences. Forty-eight extracted human deciduous molars, without cracks or erosions and free of hypoplastic enamel and irregularities, were selected and stored in 0.2% thymol solution at 4ºC. The enamel surfaces were polished with nonfluoridated pumice and prophylactic cap. The teeth were rinsed with normal saline solution and dried. Then the crowns were separated from the roots, sectioned mesiodistally by using a diamond disk (D and Z, Diamante, Germany) in a trimming machine (Krupp Dental Denarapid GMBH, Germany) and embedded in flat cylindrical acrylic resin (Marlic Medical Company, Acropars, Tehran, Iran) molds with their buccal and lingual surfaces placed horizontally. The 96 enamel surfaces achieved were ground on wet silicon carbide papers up to grit 600 to produce flat surfaces.

Half of the enamel surfaces (n = 48) were coated with nail varnish, but a window measuring 6 × 6 mm was left exposed.[17] The specimens were placed for 96 hours in a demineralizing solution, containing 2.2 mm of $CaCl_2$, 2.2 mm of KH_2PO_4, and 0.05 M of acetic acid with a pH value of 4.4 at 37ºC. This process produce lesions with 120 to 200 μ depth in enamel.[17]

The demineralized and nondemineralized enamel specimens were assigned to two groups: control or treated with alumina and bioactive glass.

Each sound and demineralized enamel surface was prepared for application of air abrasion unit (Dentoprep, Ronvig Company, Denmark) by using two powders as abrasive materials: alumina and bioactive glass. In both alumina and bioactive glass groups Abradent device (60 Psi, 0.6 mm inner diameter, 10 mm distance and 90º angle of tipping) was used for air abrasion. Alumina particles measured 50 μ in diameter (Heinrich, Germany) and the powder flow rate was adjusted at 3 gm/min.[3] In the bioactive glass group, the same procedure was used except for the fact that bioactive glass powder (NovaBone Products, LLC Alachua, Florida, USA) was used.

Each prepared group was then subdivided into two subgroups for bonding composite resin with Clearfil SE Bond (Kuraray Company, Japan) as a self-etch adhesive system and Optibond FL (Kerr Company, USA) as an etch-and-rinse adhesive system (Table 1).

Subsequent to the application of each adhesive based on manufacturers' instructions (Table 1), cylindrical plastic molds measuring 2 mm in internal diameter and 1 mm in height (Orthorings, Ortho Organizers Inc, Carlsbad, CA, USA) were placed on enamel surfaces at room temperature (22ºC ± 1ºC) and A3 shade composite resin (Clearfil AP-X, A3, Kuraray, Japan) was introduced into each mold. Light-curing procedure was carried out by a light-curing unit at a light intensity of 480 mW/cm^2 for 40 seconds; the light intensity was checked by an LED radiometer (LED Radiometer, Model 100, Kerr, USA). The tip of the light-curing unit was placed at a distance of 1 mm from the composite resin surface. The bonded specimens were stored in a humid environment at 37ºC for 24 hours and then underwent 1,000 rounds of thermocycling at 5ºC/55ºC (Mp Based, KARA 1000 Inc, Tehran, Iran) with a 30-second dwell time and a 10-second transfer time. The specimens were finally tested in a universal testing machine (Walter and Bai, K21046, Löhningen, Switzerland). A knife-edge blade measuring 0.5 mm in terminal thickness was fixed in the machine and the shearing force was applied perpendicular to the enamel sample surface at a crosshead speed of 1 mm/min at the closest distance possible from the composite-enamel interface.

Data were analyzed with SPSS 16.0 using three-way ANOVA. Comparisons were made between all the variables under study, including adhesive types, abrasive materials,

Table 1: Materials used in the study and mode of their applications according to the manufacturers' instructions and compositions

Optibond FL(Kerr Co, Orange, CA, USA)	1. Etch with phosphoric acid (15 seconds) 2. Rinse for (15 seconds) and dry (5 seconds) 3. Apply primer and rub for 15 seconds 4. Dry for 5 seconds 5. Apply adhesive in a uniform thin layer 6. Light cure for 30 seconds	Etchant: 37.5% H_3PO_4 FL Prime: HEMA, GPDM, MMEP, water, ethanol, CQ, BHT FL adhesive: Bis-GMA, HEMA, GDMA, CQ, ODMAB, filler (fumed SiO_2, barium aluminoborosilicate, Na_2SiF_6), coupling factor A 174 (approximately 48 weight percent filled)
Clearfill SE bond	1. Apply primer for 20 seconds) 2. Use of dry air 3. Apply adhesive 4. Light cure for 10 seconds	Primer: 10-MDP, 2+HEMA, hydrophilic dimethacrylate (Kuraray Co, Japan) camphorquinone N,N-diethanol-P-toluidine Water Bond: 10-MDP, 2-HEMA, Bis-GMA N, N-diethanol-P toluidine Silanized colloidal silica (10)% Hydrophilic dimethacrylate Dicamphorquinone
Alumina Powder (Heinrich,Germany)	1. Put into powder jar and press the operating button	Al_2O_3 with the size of 50 µ
Bioactive Glass Powder (Nova Bone, USA)	Grinded into particles less than 50 µ then put into powder jar and press the operating button	45% SiO_2, 24.5% Na_2O, 24.5% CaO, 6% P_2O_5
Clearfil SE AP-X composite resin (Clearfil AP-X, A3, Kuraray, Japan)	Insert in a plastic mold and light cure for 40 seconds Silanized barium glass filler	Bis-GMA, TEGDMA, silanated silica filler, silanized colloidal silica, dl-camphorquinone, catalysts Accelerators and pigments

and decalcified and sound tooth structure, using independent-sample T-test. A linear regression model was applied for evaluating independent effect of each variable on bond strength. Statistical significance was defined at $p < 0.05$ for all the analyses. The fracture patterns of composite resin cylinders on enamel surfaces were evaluated under a light microscope at ×16 and classified as follows:

- Cohesive fracture: Fracture within the composite resin or enamel.
- Adhesive fracture: Fracture at the adhesive-composite resin interface.
- Mixed fracture: Adhesive/cohesive fracture.

One intact second deciduous molar was selected for SEM evaluation. The tooth was halved mesiodistally into two specimens and mounted in acrylic resin. One enamel surface was demineralized as previously described. Then both specimen surfaces were divided into three zones:

- Zone A: Abraded with alumina.
- Zone B: Abraded with bioactive glass.
- Zone C: Nonabraded.

After air abrasion, subsequent to a 10-minute ultrasonication procedure, the specimens were dehydrated for 24 hours, fixed on an aluminum mounting stub, and sputter-coated with platinum-gold to a thickness of 10 nm for SEM evaluation. SEM images were prepared under different magnifications at a distance of 20 mm. An accelerating voltage of 15.0 kVp was used for the analysis.

RESULTS

Shear bond strength (SBS) values in MPa (mean ± SD), minimum and maximum values and 95% confidence intervals (CI) for the groups are presented in Table 2.

Multiple comparisons by independent T-test for all the samples showed that Optibond FL gave rise to higher bond strength compared to Clearfil SE (mean difference = 4.5 MPa, $p < 0.001$) (Table 3). However, when comparisons were made in all the samples of sound and decalcified groups, greater bond strength values were noted in decalcified teeth (mean difference = 3.7, $p = 0.002$). Generally, bond strength was not statistically different between teeth abraded by alumina or by bioactive glass ($p = 0.311$). In subgroup analyses, bond strength was slightly higher in decalcified teeth when abraded by bioactive glass (mean difference = 1.9 MPa, $p = 0.087$). In contrast, alumina did not produce higher bond strength than bioactive glass in sound teeth (mean difference = 2.7, $p = 0.100$ with Clearfil SE and mean difference = 2.9, $p = 0.137$ with Optibond FL).

Given the fact that abrasion material type, condition of enamel, and the type of the adhesive used (etch-and-rinse *vs* self-etch) might have an effect the bond strength, a univariate ANOVA was applied to evaluate the effect of each factor separately on bond strength. Univariate ANOVA showed that SBS values in different groups were affected by the type of the bonding system used ($p = 0.000$, $F = 19.502$) and the condition of enamel (decalcified or otherwise) ($p = 0.001$, $F = 11.859$). However, the type of the abrasive material did not have a significant effect on SBS ($p = 0.272$, $F = 1.219$).

The fracture patterns are summarized in Table 4. Alumina groups had the least adhesive fractures among all the preparation methods.

SEM photomicrographs of the study groups are shown in Figures 1 and 2. As the photomicrographs show, the enamel surface roughness of specimens abraded with alumina was

Table 2: Bond strength of the specimens in different study groups

Groups	*Group definitions*	*CI 95%*					
		Mean	*SD*	*LB*	*UB*	*Minimum*	*Maximum*
1	Decalcified enamel Alumina abraded, CSEB	14.84	6.34	11.77	17.9	7.6	27.1
2	Decalcified enamel Bioactive abraded, CSEB	16.43	5.40	13.59	19.27	6.3	24.7
3	Decalcified enamel Alumina abraded, OFL	18.49	7.09	15.65	21.33	4.5	25.9
4	Decalcified enamel Bioactive abraded, OFL	17.92	5.33	14.97	20.87	7.9	25.1
5	Sound enamel Alumina abraded, CSEB	11.28	2.69	8.21	14.35	7.8	16.0
6	Sound enamel Bioactive abraded, CSEB	8.58	4.80	5.63	11.53	4.5	19.5
7	Sound enamel Alumina abraded, OFL	18.15	5.04	15.08	21.22	10.1	27.2
8	Sound enamel Bioactive abraded, OFL	15.17	4.81	12.33	18.01	6.9	24.2

CI: Confidence interval; LB: Lower bound; UB: Upper bound; OFL: Optibond FL; CSEB: Clearfil SE bond

Table 3: Comparison the mean of bond strength in different study groups regarding different variables including type of adhesive resin, enamel condition and abrasive media

Studied variables	*Adhesive*		*Enamel condition*		*Abrasive media*	
	Clearfil SE	*Optibond FL*	*Sound*	*Decalcified*	*Alumina*	*BAG*
SBS (MPa)	12.8 ± 5.7	17.3 ± 5.6	13.2 ± 5.6	16.9 ± 6.0	15.8 ± 6.1	14.5 ± 6.0
P	p <0.001		0.002		0.311	

SBS: Shear bond strength; BAG: Bioactive glass

Table 4: Different fracture modes in the study groups, N(%)

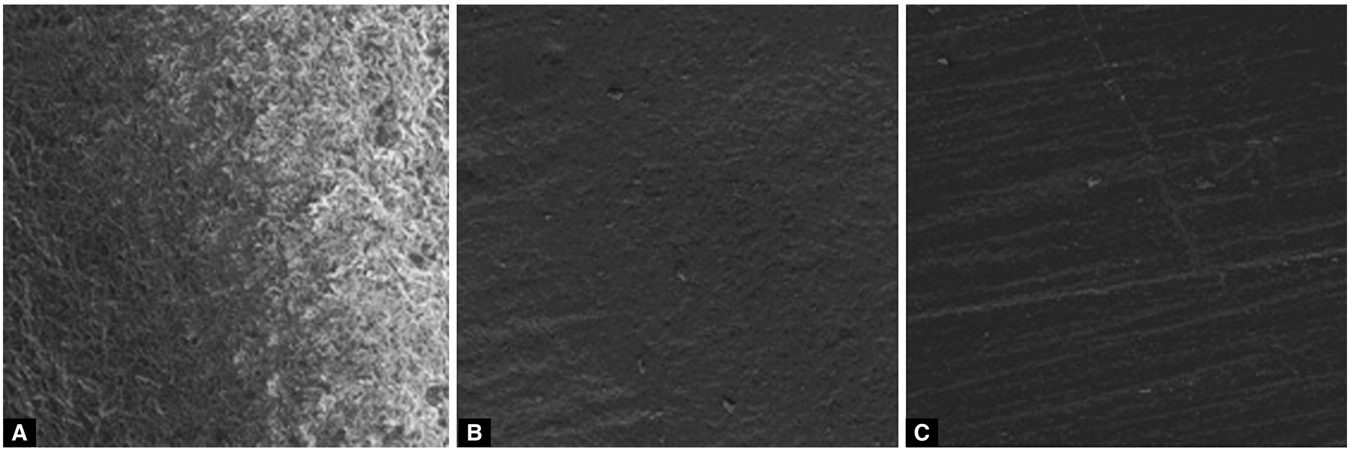
Modes of fracture groups (groups definitions)		*Adhesive*	*Cohesive*	*Mixed*	*Total*
1	(Alumina abraded, CSEB decalcified enamel)	6 (50%)	1 (8.4%)	5 (41.6%)	12 (100%)
2	(Bioactive abraded, CSEB decalcified enamel)	10 (83%)	0 (0%)	2 (16.6%)	12 (100%)
3	(Alumina abraded, OFL decalcified enamel)	4 (33%)	3 (25%)	5 (41.6%)	12 (100%)
4	(Decalcified enamel bioactive abraded, OFL)	9 (75%)	0 (0%)	3 (25%)	12 (100%)
5	(Alumina abraded, CSEB sound enamel)	6 (50%)	0 (0%)	6 (50%)	12 (100%)
6	(Bioactive abraded, CSEB sound enamel)	9 (75%)	0 (0%)	3 (25%)	12 (100%)
7	(Alumina abraded, OFL sound enamel)	4 (33.3%)	1 (8.3%)	7 (58.3%)	12 (100%)
8	(Bioactive abraded, OFL sound enamel)	8 (66.6%)	0 (0%)	4 (33.3%)	12 (100%)

OFL: Optibond FL; CSEB: Clearfil SE bond

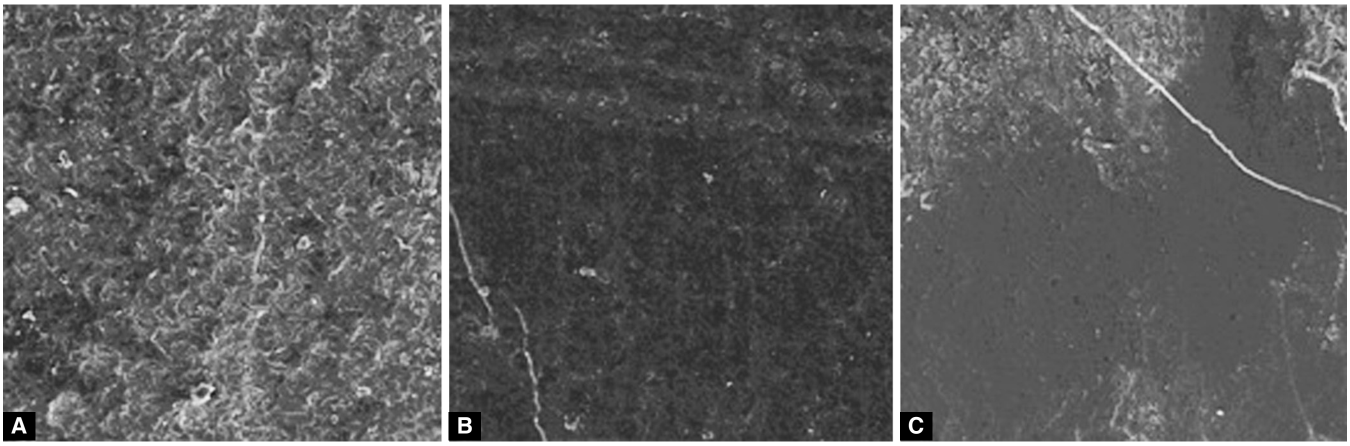
much more than that with bioactive glass. There were no differences between sound and decalcified specimens.

DISCUSSION

In high-risk patients for caries attack, where lesions progress in an uncontrollable manner and preventive measures generally fail as a result of poor patient cooperation, early restorative intervention using minimally invasive techniques may be required to minimally restore incipient carious lesions to prevent rapid and further long-term tooth destruction.[14,15] In such cases, occlusal lesions may present a diagnostic dilemma because plaque, debris and extrinsic stains mask the pathologic changes of the underlying enamel. Under such conditions, the fluoride-rich, more acid-resistant superficial layer of enamel lesions, too, may finally become cavitated.[16,18] In a large number of clinical situations, the enamel is



Figs 1A to C: A scanning electron micrograph of the decalcified enamel of primary second molar abraded with: (A) alumina, (B) bioactive glass and (C) no abrasion



Figs 2A to C: A scanning electron micrograph of the enamel of primary second molar abraded with: (A) alumina, (B) bioactive glass and (C) no abrasion

demineralized to some extent, which is, in particular, inevitable on occlusal surfaces after placement of a fissure sealant. Therefore, in this study, the bond strength values of sound and decalcified deciduous enamel were compared after pretreatment with alumina and bioactive glass air abrasion.

Aluminum oxide (10-55 µm) air abrasion technique is used in minimally invasive dentistry as a nonselective technique to remove extrinsic stains and sound and carious enamel and dentin during cavity preparation; the technique was introduced in 1945.[19-21] It is common for dental practitioners to use tactile sensation and an estimate of cutting depth during use of rotary techniques to cut and remove tooth structure; however, the alumina air abrasive jet enjoys none of these elements, rendering the technique operator-sensitive and resulting in the risk of over-preparation of the cavity. Therefore, dental practitioners should be aware of its potential to remove carious lesions to prepare cavities in a minimally invasive technique.[22]

According to the results of this study, the bond strength of composite resin to decalcified enamel was higher than that to sound enamel, which might be justified by more porous and rougher enamel surface. It seems that a rougher enamel surface gives rise to a greater surface area for the adhesive procedure and more resin tags are involved in bonding, resulting in a higher bond strength value. In a study by Xiaojun et al[23] the etched enamel surface showed a rougher surface compared to untreated enamel surface. They carried out an optical profilometric study of changes in enamel surface roughness during *in vitro* demineralization. They reported that although the overall tooth surface characteristics remain unchanged after demineralization, subtle surface features become more prominent as a result of an increase in surface roughness,[23] possibly consistent with the results of the present study indicating that an increase in surface roughness of enamel in decalcified groups resulted in a higher bond strength for composite resin.

Baysal et al[24] evaluated the effect of microabrasion and casein phosphopeptide-amorphous calcium phosphate on the shear bond strength of orthodontic brackets to demineralized enamel. The results showed higher bond strength in the undemineralized control group compared to the demineralized enamel group without pretreatment. In addition, Attin et al[25] reported lower bond strength of brackets to demineralized enamel in comparison to the control group.[25] The differences between these two studies and the present study might be attributed to the difference in demineralization technique and also different specimen preparation techniques used subsequent to demineralization.

In this study, univariate ANOVA between the two adhesive systems under study showed higher bond strength for Optibond FL subgroups in both decalcified and undecalcified groups. As Optibond FL is an etch-and-rinse adhesive, during the etching process, enamel prisms become exposed and open up completely; therefore, the resin can easily penetrates into the porosities created. On the other hand, Clearfil SE Bond is a mild two-step self-etch adhesive, which is less potent in demineralizing the enamel surface.[26] The results of this study are consistent with those of a study by Sengun et al,[1] indicating that three-step adhesive systems exhibit higher-bond strength compared to self-etch adhesive systems. However, Peutzfeldt[11] reported that the self-etching adhesive studied was an attractive alternative to the acid-etch technique for placement of a fissure sealant in young children because simplification of clinical steps is desirable.

In the present study, bond strength of composite resin to air abraded deciduous enamel was evaluated. In a previous study by Knobloch et al[27] microleakage and bond strength of fissure sealants to alumina-abraded enamel of deciduous teeth were evaluated. The results showed that use of air abrasion, along with etching, is the best technique to increase the bond strength of fissure sealants to deciduous teeth, consistent with the results of this study in which the bond strength of Optibond FL was higher due to additional etching process. In addition, Rodrigues et al advocated the application of air abrasion technique to detect occlusal caries in deciduous teeth.[18]

Peruchi et al evaluated the patterns of cuts produced by air abrasion technique in deciduous teeth and suggested that enamel is best removed in deciduous teeth when a tip measuring 0.38 mm in inner diameter is used at a distance of 2 mm from the surface.[13] Borsatto et al[28] evaluated and compared marginal microleakage of flowable composite resin in deciduous molars prepared with bur, laser and air-abrasion technique and reported less microleakage in the groups prepared with air abrasion technique and bur compared to the group prepared by laser irradiation. However, Aysegul et al[29] reported no differences in the microleakage of deciduous teeth after pretreatment with bur and air abrasion technique. In the studies mentioned above, alumina was used as a powder in air abrasion device and to the best of our knowledge, in no study has bioactive glass been used as a powder in air abrasion technique in deciduous teeth.

Recently, it has been suggested that abrasive materials be selected, which have physical properties similar to those of the substrate.[3] Alumina air abrasion technique can give rise to conservative cavity preparations by the end-cutting air abrasive stream. However, several studies have shown the conservative removal of carious lesions and more therapeutic effects of bioactive glass in comparison to alumina.[2]

The results of this study did not show any differences between composite resin bond strength of enamel using alumina and bioglass substances as air abrasion materials. Therefore, the hypothesis of the present study that air abrasion with pure bioglass does not affect shear bond strength was confirmed. It has been hypothesized that particles used in air abrasion techniques can penetrate into tooth structure, leading to exchange of ions with enamel surfaces, which might result in higher bond strength.[4]

Banerjee et al[22] suggested that bioactive glass air abrasion technique can selectively remove surface stains, debris and carious demineralized enamel, but cannot bulk-remove enamel from sound surfaces. However, air abrasion using alumina powder results in the bulk-removal of both sound and carious tooth structure. They reported that alumina air abrasion technique often gives rise to over-preparation of cavities, especially in enamel, because the efficacious use of alumina air abrasion technique on early carious lesions relies on operator judgment alone, which will be affected by the lack of visual and tactile feedbacks. The results of this study showed that use of bioactive glass air abrasion technique in the removal of initial caries-like lesions gives rise to similar bond strength of composite resin despite its selectivity in caries removal. Some previous authors have claimed that the apparent selectivity of bioactive glass might be attributed to different physical characteristics of carious and sound enamel. Subsurface cracking of the enamel is supposed to cut it before a chip is detached from the material due to its minimal organic content and brittle prismatic nature. Demineralized enamel is more porous and softer than sound enamel, compromising its mechanical properties. It has been suggested that bioactive glass powder be selected to closely match the physical properties of the abrasive material with those of the substrate. In another study by Banerjee et al[22] it was demonstrated that bioactive glass abrasion technique completely removes the demineralized enamel from artificial lesions with clinically insignificant over-preparation of sound tooth structure, indicating technique selectivity toward grossly demineralized enamel. Alumina air abrasion technique removes large amounts of enamel in both sound and demineralized tissues, indicating that operator selectivity is required to use techniques effective in clinical practice. In addition, Paolinelis et al[4] showed that bioglass can cut carious dentin in a slower rate compared to alumina powder.

In this study, bioactive glass particles (NovaBone) were used after being ground to particles smaller than 50 μ. However, the pressure and time of the application was set on 70 Psi and 10 seconds, respectively. Based on a pre-vious study, variables such as powder flow rate, particle size and exit pressure have a significant effect on the efficacy of the air abrasion technique. It appears use of bioactive glass air abrasion removes extrinsic stains and debris with no effect on sound enamel, which is an indication that it can be a new technique for clinical applications.[19] Bioactive glass air abrasion made less physical damage to enamel and no cavity is created in a clinical setting.[30] It is recommended that in future studies, bioactive glass powders be used with different particle sizes and compositions, and with variations in parameters of the air abrasion device.

According to the results of SEM evaluations, both bioactive glass and alumina air abrasion resulted in microscopic changes of the enamel surface in all the samples, including decalcified and sound deciduous enamel samples, consistent with the results of previous studies.[20,30,31] The modified rough surfaces in both groups were clean, which rendered them good substrates for better and more durable bond, followed by bonding of resin-based restorative materials such as preventive resin sealant restorations or other conservative resin restorations. The results of SEM evaluations of tooth surface in both sound and decalcified enamel in deciduous teeth revealed more rough surfaces in samples abraded with alumina compared to bioactive glass. More investigations are recommended to evaluate mechanical and biochemical surface characteristics of enamel after bioactive glass air abrasion. Furthermore, there is a need to future study to evaluate the SEM views of much more samples subsequent to alumina and bioactive glass air abrasion and fracture modes as well.

CONCLUSION

Under the limitations of this study, it can be concluded that regarding bond strength and SEM evaluations, BAG air abrasion, rather than alumina air abrasion, might be recommended as a reliable technique for preparation of sound or decalcified enamel for resin bonding procedures. However, it should be mentioned that the use of etch-and-rinse adhesive systems results in higher bond strength.

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