

# Shear resistance evaluation on the enamel surface of deciduous teeth following acid etching with or without previous air abrasion

## Resistência ao cisalhamento em esmalte de dentes decíduos após condicionamento ácido associado ou não à abrasão a ar

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### ABSTRACT

*The purpose of this study was to evaluate the shear resistance of a composite resin to the enamel surface of deciduous teeth after acid etching surface with or without previous air abrasion. Sixteen sound exfoliated deciduous incisors were assigned to 2 groups. Group I was acid etched with 37% phosphoric acid and Group II was air abraded with 50-µm aluminum oxide particles for 15 seconds, at 80 psi and a 5-mm distance from the dental surface. The adhesive system Scotchbond Multi Purpose and Z100 composite resin was applied on both experimental groups. The Student's t test demonstrated significant statistical difference between the groups ( $p=0.0001$ ). The mean shear bond strengths for groups I and II are 10.65 MPa and 6.32 MPa, respectively. The authors concluded that the maximum bond strength was achieved by isolated acid etching, which yielded a significantly larger shear resistance than in combination with air abrasion.*

### UNITERMS

*Denting bonding agents; tensile strength; dental enamel; deciduous tooth, acid etching*

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### INTRODUCTION

The advent of acid etching and adhesive systems allowed for more conservative preparations, eliminating the need to accomplish additional retentive features, simplifying the restorative procedures and making them shorter in time.

In agreement with Kanellis<sup>14</sup> (1995), the development of the air abrasion technique allowed a reduction of one third of the time required by acid etching for sealant application, which was regarded as an important factor for child care.

Air abrasion removes dental structure by means of aluminum oxide particles, which are bounced off tooth structure through kinetic energy,<sup>20,26</sup> bringing about minimum fatigue, tension<sup>20</sup> or anxiety.<sup>3,26</sup>

This technique has some advantages compared to the conventional rotatory system for cavity preparation.

More comfort may be provided to the patient, due to the possibility to accomplish the cavity preparation without pain, vibration, pressure, heating and noise<sup>12,18,19,25</sup>, besides absence of the typical unpleasant smell associated at times with caries removal<sup>11,27</sup>. According to Christensen<sup>7</sup> (1997), these characteristics prevent psychological trauma to anxious patients and young children.

Despite of all these advantages, the rotatory instruments were not completely replaced. Air abrasion may not be functional in some situations, such as for the removal of softened carious dentin and accomplishment of extensive dental preparations.

The possibility of replacement of acid etching technique by air abrasion is considered, since it creates roughness on the dental surface.

According to Boyd et al.<sup>4</sup> (1997) air abrasion was as effective as acid etching in yielding bond strength and retaining a sealant. Keen et al.<sup>17</sup> (1994) also observed that air abrasion provided similar or higher bond strength to both enamel and dentin when compared to acid etching.

Air abrasion may increase the bond strength of restorative materials to the dental surface, yet according to Berry III et al.<sup>1</sup> (1994) this system does not eliminate the need of acid etching. Berry III & Ward<sup>2</sup> (1995), Brockmann et al.<sup>5</sup> (1989) and Valentino & Nathanson<sup>29</sup> (1996) observed in their studies that the maximum bond strength of the composite resin to the dental surface was achieved through the association between enamel etching with phosphoric acid and air abrasion. Ellis et al.<sup>9</sup> (1999) evaluated shear bond strength using various surface pretreatment methods and concluded that air abrasion achieved with 50 micron aluminum oxide is an effective pretreatment for sealant placement and in combination with phosphoric acid treatment significantly enhanced the short and long term bond of a sealant to enamel.

Most of air abrasion studies were carried out in permanent teeth, however this method is also indicated for Pediatric Dentistry due to the greater comfort provided to the patient. It is known that deciduous and permanent teeth are different in dimension, shape, color and morphology. Thus, the deciduous teeth can present differences in the adhesive strength after acid etching and air abrasion.

Considering all such controversies in the literature, this study aimed at evaluating the shear resistance of a composite resin to the enamel surface of sound deciduous teeth after acid etching of the enamel, with or without air abrasion.

## **MATERIALS AND METHODS**

For this study, a total of 16 sound deciduous upper central incisors were obtained at the Child Care Clinic of Araraquara Dental School – UNESP, after avulsion or physiologic exfoliation. The presence of cracks, loss of dental structure or any other structural defect that could interfere in the results were evaluated. The teeth that presented these defects were excluded of the study. All teeth included in this study were examined with an explorer in order to confirm the absence of

carious tissue. These teeth were sectioned through their cervical areas by means of diamond burs with high-speed turbine and water cooling, for elimination of the dental roots.

Dental dies were obtained through positioning of the teeth with their buccal aspects towards the bottom of cylindrical patterns with 16mm in height, fabricated from a PVC tube measuring 16mm in diameter, for posterior inclusion in epoxy resin. After curing of the resin, all teeth were cleaned with pumice slurry and water using a prophylaxis cup in a low-speed handpiece, followed by ultrasonic cleansing during 10 minutes.

Over the enamel surface, an adhesive tape was fixated with a circular perforation measuring 2mm in diameter, accomplished by means of an adapted rubber dam punch.

The specimens were then divided in two groups with eight teeth each of them:

- group 1: acid etching of the dental surface with 37% phosphoric acid for 30 seconds, water washing for 30 seconds and air-drying.
- group 2: preparation of the enamel surface with the air abrasion system (Prep Star – Danville Engineering), making use of 50- $\mu$ m aluminum oxide particles during 15 seconds, at 80 psi and a 5-mm distance from the dental surface. Afterwards, the teeth were washed and received application of 37% phosphoric acid for 30 seconds, then water-washed for 30 seconds and air-dried.

Soon after, the adhesive system Scotchbond Multi Purpose (3M - Brazil) was applied on both experimental groups, according to the manufacturer's instructions.

The dies were adapted to a metallic pattern sectioned in two pieces, which yielded the cylindrical test specimens measuring 2mm in diameter and 6mm in length.

The patterns were filled with Z100 composite resin (3M) in three incremental portions measuring approximately two millimeters, light-cured for forty seconds each.

After removal of the pattern, the specimens were stored in distilled water at 37°C for 24 hours and then connected to a proper device for placement on an assay machine MTS 810 (Material Test System) for the shear resistance test, by means of a joint with a crevice-like end measuring 0.5mm in thickness, applied to the

cylinder base with a speed of 0.5mm/min, making use of the 1 kN load cell.

## RESULTS

Table 1 presents rupture tension values for the groups 1 and 2. Graph 1 and Table 2 demonstrate

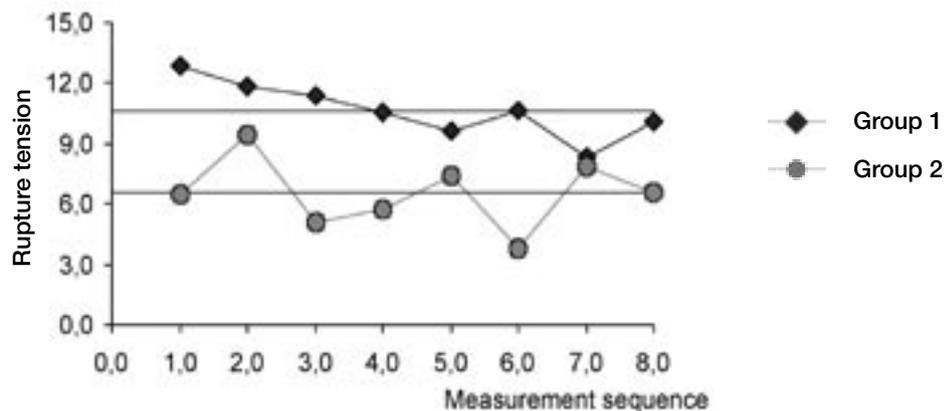
that the values observed for the measurements in group 1 (10.65 MPa) were significantly larger than that observed for group 2 (6.32 MPa). The value of the Student's t test was 5.64, with 14 degrees of freedom and  $p=0.0001$ , demonstrating a statistically strong evidence of differences between the means.

**Table 1 – Rupture tension means and standard deviation for groups 1 and 2**

Groups	Rupture tension mean (MPa)	Standard deviation
1	10.65	1.40
2	6.32	1.66

**Table 2 – Student's t test**

Degrees of freedom	Difference in means	Student't	Standard deviation	p
14	4.33	5.64	1.54	0.0001



**FIGURE 1 – Rupture tension measurements in the sequence in which they were achieved.**

## DISCUSSION

Acid etching yields microscopic porosities on the enamel surface, allowing the formation of *tags* that might allow the effective bonding of resin materials to the dental structure. Thus, it significantly reduces microleakage<sup>10</sup> and even though it is the preferred and most frequently indicated technique to promote adhesion, it is regarded as sensitive and time-consuming, since it involves a number of technical steps<sup>15,26</sup>.

Air abrasion has been studied throughout the last years as a substitute to acid etching, besides assisting the diagnosis of carious lesions, cavity preparations and tooth surface cleaning.

Katora et al.<sup>16</sup> (1981) mentioned that air abrasion results significant alterations on the dental surface. According to Guirguis et al.<sup>13</sup> (1999) these changes do not seem to be enough to provide a good retention, since more microleakage was observed in samples submitted to air abrasion without acid etching. Nikaido et al.<sup>23</sup> (1996) demonstrated that the treatment of bovine enamel surface through the air abrasion technique reduced the bond strength, except for dentin air abraded with alumina. After air abrasion of the dental surface, Fu & Hannig<sup>10</sup> (1999) reported the need to accomplish acid etching, which increases humectation and surface roughness, reducing microleakage.

The study conducted by Kanellis et al.<sup>15</sup> (1997) did not reveal any differences in the retention of sealants to the occlusal surface of first permanent molars after previous application of acid etching or air abrasion, yet the distolingual and buccal surfaces presented significantly lower retention after air abrasion. According to the authors, this finding may be related to the improper modification of the enamel on these surfaces, thus yielding insufficient irregularities for sealant retention. Good outcomes were observed through combination of air abrasion and acid etching by Ellis et al.<sup>9</sup> (1999), which provided an increase in the bond strength between the sealant and the enamel surface. Berry III & Ward<sup>2</sup> (1995) demonstrated that the maximum bond strength was achieved through air abrasion along with etching with phosphoric acid. Even so in the present study, different result was found therefore the association of air abrasion and acid etching caused reduction in the adhesive strength.

The present study demonstrated a significantly higher shear resistance after isolated employment

of acid etching (10.65 MPa) when compared to the group submitted to previous air abrasion (6.32 MPa). Mulcahey et al.<sup>22</sup> (1999) also observed lower bond strength of orthodontic brackets after preparation of the dental surface with air abrasion in relation to the acid etching technique. Rinaudo et al.<sup>26</sup> (1997) demonstrated that the isolated accomplishment of air abrasion does not eliminate the need of acid etching before the application of a dentin adhesive system, as well as Olsen et al.<sup>24</sup> (1997), who reported that the bond strength observed in surfaces previously submitted to air abrasion was significantly lower than those prepared just through acid etching. Los & Barkmeier<sup>21</sup> (1994) studied the effects of dentin air abrasion with aluminum oxid and hydroxyapatite on adhesive bond strength and concluded that air abrasion of dentin does not significantly enhanced the bond strength of composite to dentin using newer generation resin adhesive systems.

Different from the mentioned studies, which evaluated air abrasion on human permanent teeth or bovine teeth, the present study evaluated enamel of deciduous teeth. It is known that the enamel layer of deciduous teeth is thinner than permanent teeth. Perhaps the time used for air abrasion in this study (fifteen seconds) had caused many damages to the enamel, maybe exposing dentin surface. Even so, Brown & Barkmeier<sup>6</sup> (1996) used air abrasion on permanent teeth for sixty seconds and they concluded that the association between acid etching and alumina air abrasion produced the highest bond strengths, but not significantly greater than the bond strengths of acid alone. Santos-Pinto et al.<sup>28</sup> (2001) used air abrasion on third molars for fifteen seconds and they verified that tip with 45° and 0,48mm produced enamel cuts with greatest depth that varied from 24µm to 69µm. Cordeiro<sup>8</sup> (2001) applied air abrasion on deciduous teeth with 50-µm particles during ten seconds and she found an average depth of 44,68µm.

If the dentin surface was exposed, the results of this study may be explained by the obliteration of the dentinal tubuli by the aluminum oxide particles after application of the air abrasion technique, with a resulting decrease in the bond strength of the restorative materials. On the other hand, Laurell et al.<sup>19</sup> (1995) mentioned that these particles are rather too large to penetrate the tubuli, thus such obliteration would probably be due to the dentin itself after application of the particles, promoting an effect similar to a *smear layer*.

Regarding the enamel surface, scanning electron microscopy demonstrated a less remarkable and apparently less effective surface roughness by air abrasion than that observed after acid etching of the enamel.<sup>16</sup> Even so, it is known that over-etching results in excessive porosities and longer and weaker tags, further resulting in weakened enamel surface and a weaker bond. Thus, air abrasion prior to enamel acid etching may have a similar combination of effects. This could potentially

offer some explanation why the results of etching alone was stronger than air abrasion associated with acid etching.

## CONCLUSION

The air abrasion technique with acid etching provided lower bond strength of the composite resin to the enamel surface of deciduous teeth compared to acid etching without air abrasion.

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## RESUMO

A proposta deste estudo foi avaliar a força de cisalhamento de uma resina composta à superfície de esmalte de dentes decíduos hígidos após condicionamento ácido precedido ou não da técnica de abrasão a ar. Dezesesseis incisivos decíduos esfoliados foram distribuídos em 2 grupos. Foi feito condicionamento com ácido fosfórico a 37% para os espécimes do grupo I e, os espécimes do grupo II foram abradidos com partículas de óxido de alumínio de 50 µm por 15 segundos, com pressão de 80 psi e 5 mm de distância da superfície dental. O sistema adesivo Scotchbond Multi Purpose a resina composta Z100 foram aplicados nos dois grupos experimentais. O teste t de Student demonstrou diferença estatisticamente significativa entre os grupos ( $p=0,0001$ ). As médias de força adesiva para os grupos I e II foram 10,65 MPa e 6,32 MPa, respectivamente. Os autores concluíram que a maior força de união foi obtida quando utilizaram apenas o condicionamento ácido, que gerou força de resistência ao cisalhamento significativamente maior do que sua combinação com abrasão a ar.

## UNITERMOS

Adesivos dentinários; resistência à tração; esmalte dentário; dente decíduo, ataque ácido

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