



## Bond strength to etched and Re-etched enamel, dentin and dentino-enamel junction

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### Abstract

Etching and re-etching are frequently done technique to alter the tooth surface and makes it more receptive to adhesion. This study was done to assess the effect of re-etching technique on bond strength to enamel, dentin and dentino-enamel junction.

60 extracted human upper premolars teeth were collected cleaned, sectioned at the level of cervical line, embedded in acrylic block exposing certain grounded flat surface of the crown and divided into 2 groups:

Group A (30 etched specimens) etched with total etch (37% phosphoric acid) for 15 sec.

Group B (30 re-etched specimens) etched and re-etched with total etch (37% phosphoric acid).

Both groups were subdivided into:

Subgroup 1 10 enamel specimens

Subgroup 2 10 dentin specimens

Subgroup 3 10 dentino-enamel junction specimens

A standardized cylinders of light cure composite resin were bonded, and the specimens were stored in deionized distilled water for 24 h. and testing was done with zwick test machine and statistically analyzed using analysis of variance test (ANOVA) and student t-test.

The results showed non significant difference between all subgroups in group A(etching group) and between all subgroups in group A Vs. group B subgroup 2(re-etched E), and showed a significant difference between all subgroups in group A Vs group B subgroup 3 (re- etched EDJ) and between group B sub1&2 (re-etched E & D) Vs group B sub 3 ( re-etched DEJ) ,furthermore there were a highly significant differences between all subgroups in group A Vs group B sub 2(re-etched D) and between group B sub 2(re-etched E) Vs groupB sub 2(re-etched D).

Re-etching the enamel didn't decrease the shear bond while re-etching dentin markedly decreased the bond strength. Further more re-etching the dentino-enamel junction lies in between.

**Key words: Etching, re-etching, enamel, dentin, dentino-enamel junction.**

### Introduction

Adhesive dentistry began in 1955, when it was found that acids could used to alter the surface of enamel and makes it more receptive to adhesion. It

was possible to obtain a micromechanical bond between resin restorative materials and acid etched enamel surface<sup>(1)</sup>.

Bonding to enamel is an established technique in every day practice. However bonding to dentin compared to enamel is exceptionally difficult.

The use of current generations adhesives that can penetrate dentin tubules forming hybrid layer, provide strong bond<sup>(2)</sup>. But still, many studies has focused on the bonding of enamel or dentin to adhesive materials, little is known about bonding to the region approximating the dentino-enamel junction (DEJ). Because of the complex nature of the anatomical structure of the DEJ, it's etch pattern may differ from enamel or dentin and may, as a result affect the bonding of adhesive materials<sup>(3)</sup>.

One of the requirements for good bonding is the optimum etching technique, time, concentration as well as type of etchant<sup>(4)</sup>. Phosphoric acid at a concentration between 30% to 40% is the widely used acid with lower concentrations of this acid or other weaker acid etches effectively as 37% phosphoric acid<sup>(1, 4,5)</sup>.

Excessive etching result in unfilled (unbounded) decalcified zone which act as a weakened layer or zone contributing to fracture<sup>(4,6)</sup>. A newly placed composite restoration is sometimes considered un acceptable or un satisfactory for so many reasons like contamination or failed bond.<sup>(7,8)</sup>

With past generations of bonding agents, contamination or failed bond required rinsing and re-etching to create a suitable surface for bonding. The current bonding agents are relatively moisture tolerant and much less technique sensitive.<sup>(6,9)</sup>

The purpose of this study was to assess the effect of re-etching technique on bond strength of enamel, dentin (inner and peripheral) and dentino-enamel junction region.

## Materials and Method

Eighty extracted upper premolars teeth were collected, cleaned with slurry of flour of pumice in rubber cup used in low speed hand piece<sup>(10)</sup>, and sectioned at the level of cervical line. The teeth were ground flat at certain surface of the crown, embedded in acrylic block and were divided into two groups according to the surface treatment.

### They received:

**Group A** (30 etching samples), etched with 37% phosphoric acid gel (total etch) for 15 seconds, washed for 30 seconds and dried for 5 sec.<sup>(11-13)</sup>

**Group B** (30 re-etch samples), etched with 37% phosphoric acid gel (total etch) for 15 seconds, washed for 30 seconds and dried for 5 seconds, then re-etched again with the same acid for another 15 second, washed for 30 second and dried for 5 sec.

Both groups were subdivided into four subgroups according to the surface region being treated (Figure 1) into:

#### **Subgroup 1** (10 enamel specimens)

The labial surface of the crown ground flat with wet 600mm grit silicon carbide abrasive disk as reported with other bond strength studies<sup>(14-17)</sup>, then the crown of the tooth embedded in acrylic resin to form block of 30X30X 15mm exposing the flat enamel surface.

#### **Subgroup 2** (10 dentin specimens)

The labial surface of the crown was ground flat till all the enamel was removed than the crown of the tooth embedded in acrylic resin exposing the flat labial dentin surface only.

#### **Subgroup 3** (10 dentino-enamel junction specimens)

The occlusal surface of the crown was ground flat till all enamel was removed then the crown of the tooth embedded in acrylic resin

exposing the flat occlusal dentino-enamel surface.

The bonding procedure was done according to the manufacturer instructions. The primer was applied to the dentin specimens and air dried for 10 sec., followed by the application of the adhesive agent to the enamel and dentin specimens and light cured for 20 sec.

A standardized clear translucent plastic strew with an internal diameter of 3.8mm (11.34mm<sup>2</sup> surface area) and 5mm length was filled with composite (Composan LCM, premedical, Germany), and placed on the exposed flat crown surface in a vertical position and light cured for 40 sec. in four directions<sup>(15)</sup>. Specimens were stored in deionized distilled water for such<sup>(16)</sup>. Testing was done by the Zwick testing machine applying shearing force with specially designed chisel-shaped rode with cross head speed of 5mm per minute applied at the inter face between the tooth surface and the bonded composite resin. The load cell was set at 100kg.

The specimens were stressed to failure the force was recorded in Newton, which was then divided by the surface area (11.34mm<sup>2</sup>) to obtain the shear bond strength calculated in MPa<sup>(17)</sup>. Data obtained were statistically analyzed using analysis of variance (ANOVA) test and t-test.

## Results

The mean shear bond strength values and standard deviations (SD) all in MPa are presented in table 1 and figure 2

Group A sub. 1 (etched enamel) showed the higher mean (19.38 ± 3.75) while group B sub. 2(re-etched dentin) showed the lowest mean of shear bond strength (11.51±4.03)

The statistical analysis of the data using ANOVA test indicated highly

significant difference (P<0.01) the source of differences was investigated using student t-test the statistical analysis of the data using t-test showed:

- There were no significant differences between:
  - All subgroups in group A(etched group)
  - All subgroups in group A Vs group B sub 1(re-etched E)
- There were a significant differences between:
  - All subgroups in group A Vs group B subgroup 3(re-etched DEJ)
  - Group B subgroup 1& 2 Vs group B subgroup 3(re etched E&D)
- There were a highly significant differences between
  - All subgroups in group A Vs group B subgroup 2(re-etched D)
  - Group A subgroup 1(etched E) Vs group B subgroup 2(re-etched D)

## Discussion

Acid etching and re-etching are frequently done technique in every dental clinic to alter the tooth surface and makes it more receptive to adhesion<sup>(6,9)</sup>. Total acid etchant technique involves the application of 37% phosphoric acid directly on the enamel and dentin for 15 Sec is the technique of choice for the dentist and the researchers since it is the only percent of phosphoric acid commercially available in the market especially in Iraq ,we select the composam LCM composite material in this study because it is a universal, light-curing microhybrid dental composite that has a wide range of application therefore, very widely used specially in our country.

In this study two variables were observed (re-etched variable and the

tooth region variable) while the other variable were fixed.

### **Etching and re-etching the enamel:**

Acid will improve the mechanical bonding and marginal seal of the composite restoration. It is also increase the surface area for bonding and produce higher surface energy to enhance wetting of the adhesive agent<sup>(4-6)</sup>.

The enamel is a highly mineralized tissue<sup>(3)</sup>, the patterns of the etchant enamel with total etch for 15 to 60 sec. vary from dissolution of the enamel prism cores to the dissolution at rod peripheries or a combination of these patterns<sup>(4,5)</sup>, acid etching removes about 10mm from the enamel surface and creates a micro porous layer ranged from 5-50mm deep<sup>(13)</sup>.

Re-etching according to the result of this study didn't significantly lower the bond strength to enamel since enamel bonding depends on the interactions of the resin tags with surface irregularities created by acid etching the enamel<sup>(1,11)</sup> which seems to be un affected with re-etching.

### **Etching and re-etching dentin:**

Acid etching the dentin will remove the smear layer and smear plug and open the dentinal tubules thus increase the surface area that available for retention<sup>(12)</sup>.

The dentinal tubules are opened and widened and the peritubular dentin and intertubular dentin are superficially demineralized to expose a fine network of collagen fiber. Fewer number of short resin tags with narrow neck and lateral branches are present<sup>(1, 13)</sup>.

Re-etching the dentin according to the result of this study resulted in a highly significant reduction of the bond strength, such a difference in the effect of re-etching on the enamel and dentin attributed to the histological

differences between enamel and dentin (enamel is 92% inorganic materials, dentin is on average only 45% inorganic with a higher water content)<sup>(4)</sup> thus a difference in patterns of etching resulted from the same acid ,dentin bonding depend on the hybrid layer (4-7mm) that created from the combination of the resin and demineralized dentin<sup>(2,4)</sup>.

Re-etching of the dentin may result in removal of additional mineral content, making it difficult for bonding agent to penetrate fully into the demeneralized area resulted in unfilled (un bonded)decalsified zone which act as aweakened zone contributed to fracture<sup>(2,6)</sup>.

These findings agreed with Vargas MA et al in 1994<sup>(6)</sup>.

### **Etching and re-etching the dentino-enamel junction :**

this region rich in organic material and has less mineral content in the present of parallel-oriented course collagen bundles and predominate branches of dentinal tubules. Interestingly the etched peripheral dentin surface produce almost the same bond strength at the enamel surface, there is no doubt that the high bond strength to dentin or dentin near the DEJ was derived from the significant impregnation of resin into the etched surface. The strong bonding might, in part, be attributed to the fact that the peripheral area was more receptive to the bonding resin as previously reported<sup>(3)</sup>. The DE regions more susceptible to acid etch than enamel or dentin, the collagen fibers or branching of tubules at DEJ may accelerate the lateral spread of etching solution. This phenomenon is similar to the lateral spread of early caries that progresses laterally at the DEJ<sup>(3,4)</sup>, in addition to the fact that DEJ is acomplex fiber -reinforced moderately mineralized region<sup>(3)</sup>. These fact might

be the reason of our results in this study that showed the bonding to DEJ resulted in a shear bond strength values lies in between those to etched enamel and dentin, that coincide with those of Shimada et al 2003<sup>(3)</sup>.

Furthermore the difference in pattern of etching specially the lateral spreading of the acid might be the rational behind the result of re-etching that region that showed only slight reduction to the shear bond strength value.

## Conclusions

1. Etching enamel produces the highest bond and re-etching didn't decrease the shear bond.
2. Etching dentin produce slight but comparable bond strength to that of enamel and re-etching produce highly reduction in bond strength.
3. Etching DEJ produce intermediate bond strength to enamel and dentin, and re-etching slightly decreased the bond strength.

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Table 1: Descriptive statistics (mean and SP in MPa)

Groups	Mean	SD
A subgroup 1	19.38	± 3.75
A subgroup 2	18.23	±3.86
A subgroup 3	18.58	±5.71
B subgroup 1	17.16	±4.05
B subgroup 2	11.51	±4.03
B subgroup 3	14.18	±6.14



Figure 1 the four subgroups: 1 enamel (E), 2 dentin (D), and 3 dentino enamel junction (DEJ)

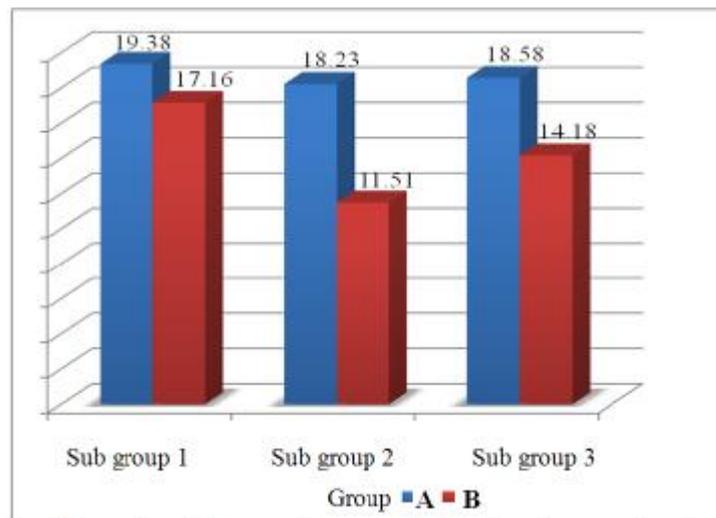


Figure 2: Bar chart shows the difference in means of shear bond strength values in MPa for all groups and subgroups.