# Evaluation and comparison of the self-etching primer in different preparation times with traditional bonding method on shear bond strength of stainless steel brackets to enamel.

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**Abstract**

**Introduction:** One of the most important aspects of self-etching primer system in orthodontics is the duration of adhesive resin use after application of self-etching primer. Evaluating time delay effect on bond strength is the objective of this study.

**Materials and methods:** In this interventional-experimental study,72 premolar with sound buccal enamel were selected, and randomly divided in four groups. In the first group buccal surface were etched for 30 seconds, with 37% phosphoric acid. After washing and drying, primer XT was applied on teeth and brackets. Transbond XT was used in bonding. Light with500 mw/cm$^2$ was glowed from mesial, occlusal and distal surface for fifteen seconds, 5 and 10 minutes respectively. After thermocycling of all samples, debonding strength was measured with the help of DARTEC machine. Analysis was done by ANOVA and Duncan.

**Results:** The highest shear bond strength (19.4 Mpa) was seen in group one and the lowest (9.87 Mpa) in group four. Between the remaining groups and group one, there was a significant difference in mean shear bond strength. Scan electron microscope showed a strong deep tag between tooth enamel surface and adhesive in group one.

**Conclusion:** Significant difference in shear bond strength of two groups, traditional etching and self-etching primer was observed. Mean of shear bond strength with self-etching primer method was acceptable and delay in applying resin composite had no significant effect on shear bond strength of brackets to enamel.

**Key words:** resin composite, self-etching primer, acid etch technique

(Received Feb 2010; Revised and accepted Nov 2010)

In early origin of orthodontic treatments banding was used for fixation of material, that needed time and appropriate approach to proximal surface of teeth for fixation[1]

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By introduction of etching method by Bonocore in 1955, and bonding method, bond of orthodontic brackets to the enamel by using etching method and resin composite, by Newman in 1965 become possible. Application of this method included less risk of enamel decalcification , less stimulation of gingival tissues, better plaque control, obvious cosmetic effect which is nowadays mainly in use.[2] But using this method in orthodontics also had disadvantages including risk of being contaminated with saliva and humidity during enamel etching, decalcification and white spot around orthodontic brackets [4,5] and probably injury to the enamel while debonding.[6,7]

By introducing self-etching primer (SEP), important changes in bonding took place.[8,9,10] This material, reduced the steps, separate etching and priming in frame of one step and elimination of washing step is not only helpful in time saving but also it is more comfortable for patient and for easy control of saliva and humidity.[11] According to Arnold, scale of time which was saved was nearly 65%.[13] This time significantly can be shorter than the time used in traditional method. Due to the monomers that cause etching and bonding, one complete hybrid layer is formed and less depression of etching [12,14] and less dissolving of enamel are other characteristics of SEP.[11,15] A promotion for easy usage and saving clinical time took place in recent years. This method can be a beneficial method for usage because it takes less time and sensitivity. Various studies showed that bond strength formed by SEP shows no difference from the bond formed by traditional etching method and bonding.[13,16,17,18] SEP type, composite type and evaluation and confirmation by electron microscope are points to be mentioned in this study when compared to the previous ones. It has been stated by few researchers that traditional method is preferable specially in lingual bonding due to its strong bond.[19] Another important aspect and debatable usage of SEP, is the usage of the time of adhesive resin after using SEP that according to various point of view may affect shear bond strength and presents various results.

The main goal of this study was the comparison and evaluation of self etching primer and likely its usage on shear bond strength of stainless steel brackets to enamel with the traditional bonding method.

## Material and methods

In this experimental study, 72 normal human premolar teeth with sound enamel (without any visible crack under light), extracted due to orthodontic reasons, were selected and according to ISO 3696 standard were dipped in 0.5% chloramin solution as an anti septic, and also according to the ISOTR 11405 standard, the time interval between extracting teeth and research was not more than 6 months.[17] Soft tissue and debries around teeth were removed by hand instrument and blade no12. They were cleaned and restored in distilled water. For preparation of samples, cylinders made of 5cc syringe were used. Internal surface of the cylinder was dipped with a lubricant and were filled with self hardening acro-pars acrylic.

Samples were placed in acrylic in such a way that maximum 1/3 tooth median convexity was in contact with the blade of survivor. (Fig. 1)



**Figure 1:Sample tooth mounted in acrylic**

Mesiodistal dimension should be perpendicular to longitudinal axis of tooth. Temperature was controlled due to acrylic polymerization, by placing cylinders in water. After that all samples were cleaned with brush for 10 seconds with the low speed instrument which had no oily secretions with a constant speed. Then all surfaces were dried. Consequent , samples were divided into four groups each group had 18. In all groups dynalock brackets ( with 18 slots ) for premolar teeth (3M) transbond XT,optilux 501 composite and kerr lightening system with strength of 500 mw/cm$^2$ (Kerr) for polymerization. Bonding steps in four groups were the same. Tooth buccal enamel surface were etched with 37% phosphoric acid according to the suggestion of manufacturer. Washed for 15 seconds with water and then

dried for 15 seconds with oil free air spray. After that, primer XT (3M) was used in a thin layer on etched surface of teeth. Base of brackets were placed then after short and slow spraying air on primer, then composite was placed and extra composite around the base of bracket was removed. The composite was cured with lightening system optilux 501 using 500 mw/cm$^2$ of lightening strength. Light was used from occlusal, mesial and distal for 20 seconds. In second, third and fourth groups, buccal surface enamel were prepared with self etching primer (Transbond plus self etching primer 3M unitek) for 15 seconds 5 minutes and 10 minutes respectively. Preparation included placing SEP on buccal surface and rubbing for 3 seconds on necessary regions. Then brackets were placed according to the protocol of group one, and were polymerized. After preparation, all samples of the four groups were placed in distilled water for 48 hours. Then for 500 times they were placed under thermocycle 5oC and 55oC. For evaluation of shear bond strength, Dartec ( Dartec Ltd of tourbridg, UK ) system was used. This system had two jaws, one is fixed and other is mobile. For placing acrylic cylinders, special places in fixed jaw were prepared, and ablade was designed to enter a shear force. Then the shearing force of 1mm speed and cellular capacity of 100 Newton was applied to each tooth. Force was entered on occlusal base of bracket in all samples (Fig. 2) and while debonding, strength was registered by the system. For analysis of data one way ANOVA and then Ducan analysis were used.



**Figure 2:Sample in test**

**Method of preparation of tooth for SEM**

After debonding, three samples from each of group one and two were randomly selected and sheared by the instrument on its longitudinal axis. Samples were placed in drying system (dissicator) for one week in complete dryness, before being speculated by electron microscope. As second groups' tooth surfaces were prepared completely according to the manufacturer's instruction , it was confirmed by SEM basis absorption that the depth of composite penetration through enamel was less as compared to control group, there was no need to check SEM in the third and fourth groups.

**Results:**

The mean shear bond strength of each group is listed in table 1. According to Duncan test there was significant difference between first group and the rest three groups in shear bond strength ($p < 0.001$). However no significant difference between group three and four was observed.

Based on quality analysis of self etching primer cuts strong and complete depression between adhesive and enamel surface of teeth was obvious in group one. While this matter was not seen in group two(Fig. 3,4).



**Figure 3:SEM of traditional etching**



**Figure 4:SEM of Self etching primer**

**Table 1: Mean and standard deviation of shear bond strength in study groups (in Newton)**

| Groups | mean | number | Standard deviation | Minimal | maximum | amplitude |
|---|---|---|---|---|---|---|
| 1st traditonal method | 19.4086 | 18 | 2.88520 | 13.18 | 23.82 | 10.64 |
| 2nd (15-seconds , SEP) | 10.6960 | 18 | 1.76542 | 8.15 | 15.35 | 7.20 |
| `3rd (5 minutes, SEP) | 10.1145 | 18 | 1.45606 | 6.66 | 13.89 | 7.23 |
| 4rth (10minutes ,SEP) | 9.8780 | 18 | 1.42677 | 7.40 | 12.90 | 5.50 |

**Discussion**

The results indicated that the mean shear bond strength of brackets by acid etching method was 19.40 MPa, that was significantly different from mean shear bond strength of self etching primer (group two, three and four).

As regard to the mean shear bond strength of brackets to tooth with self etching primer method in group two, three and four, only the remaining time of SEP on tooth was different, the significant difference in mean shear bond strength was not inspected.

According to Bishara and colleagues, who evaluated the effect of self-etching primers on bond strength of orthodontic brackets with resin composite adhesive, use of self-etching primer (prompt L – pop) with transbond XT, resulted in the shear bond strength that was acceptable from clinical point of view. [11]

Maijir and Smith, suggested in an article in American association of orthodontists that 8-10 MPa shear bond strength was least acceptable amount for orthodontic brackets that were based on shear bond strength.[2]

Mean shear bond strength of bonding brackets by etching method with Transbond XT composite (3M) in current study was 19.4 MPa, which was higher than Bishara [12,19], Arnold [13] and Zeppieri.[23] The difference may be due to the adhesive and resin type, the difference in mesh type and brackets used.

Kanemura and colleagues stated that there is no difference between bond strength in self-etching primer and traditional multiple steps that enamel was scratched [23], although the mean shear bond strength of brackets to enamel by self-etching primer was less than the traditional etching method [14,15], but it should be reminded that this amount was higher than the minimal amount suggested for bonding brackets of teeth . So it is clinically acceptable,[14,21] although when enamel is normal and untouched , strength of bond with self-etching primer is meaningfully less than the multiple stages.[24]

In his study, Arnold used self-etching primer system for bonding. He conduded that up to 10 minutes delay in adhesive usage after self-etching primer has no significant effect on shear bond strength of brackets to enamel[13]. This completely resembles the current research, results regarding the ting of composited regin application that should be within 2 minutes after self-etching primer, and it can not be delayed to 10 minutes. as suggested by manufacture maxillary arch from one side to another can be bonded practically in a single application of self-etching primer.

Based on SEM results in groups of traditional etching complete and strong depressions of enamel surface are present, while in groups that use self-etching primer, distinct interference between enamel surface and adhesive is present, this is bond the reason for lower shear bond strength of this group as compared to traditional etching group. The findings are in consistence to coincided with Yamada. He used mega bond self etching primer, polyacrylate , and phosphoric acid. He observed the amount of dissolving enamel in SEM is less than the other two acids and concluded that it is self beneficial. Cehreliz proposed that there was no significant difference between shear bond strength of brackets to enamel in five groups, that used self-etching primer. The mean shear bond strength of brackets to enamel by self-etching primer in current study is 9.87 – 10.99 MPa ,which is higher than the minimal stated by Carstensen in 1993 for shear bond strength that leaded to successful clinical bonding. He stated that shear bond strength of 6-8 MPa leads to an acceptable and successive clinically orthodontic bonding which is three times less than the least bond strength necessary for compensation of polymerization shrinkage, produced by contemporary restorative composite repairement.[26]

**Conclusion**

1) The highest shear bond strength of brackets to evanel was seen when traditional etching method used.
2) 2) There is significant difference between the shear bond strength of brackets bonded to enamel with traditional etching method and self-etching primer method.
3) Although there is significant difference between the shear bond strength of two groups i.e. traditional etching method and self-etching primer method, mean shear bond strength by self-etching primer is acceptable from a clinical point of view.

4) Time delay of 5-10 minutes in composite resin used after self-etching primer had no significant effect on shear bond strength of brackets to enamel.

5) Considering the lack of any effect of time delay on brackets shear bond strength to enamel; this material could be used in a dental arch without any concern of decreased strength of shear bond of brackets.

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