Research Article

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Evaluate the Effect of Saliva Contamination on Tensile Bond Strength (TBS) of Brackets Bonded Using Different Primer Technique

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ABSTRACT

Background: To evaluate the effect of saliva contamination on tensile bond strength (TBS) of brackets bonded using different primer technique.

Materials and methods: 90 sound human premolars that had been extracted for orthodontic purpose were collected from patient between 15-30 years. The teeth were divided into 3 equal groups with an equal number of 1st & 2nd upper & lower premolars in each group. The buccal surface of each tooth was cleaned with fluoride-free pumice & water slurry with dental rotary handpiece & brush, washed & dried with compressed air cleaned surface then etched with phosphoric acid for 30 seconds, washed and dried. In the group, A control group the teeth were contaminated with saliva bonded with normal etching and primer technique. In group B the teeth were contaminated with saliva and bonded with self etch primer technique. In group C the teeth were contaminated with saliva and bonded with moisture insensitive primer.

Result: The results of the analysis of variance indicated that there were significant differences (F value =7.458, *P value=.018* in bond strengths between the various groups tested. The highest value of shear bond strength occurred when contaminated with saliva and bonded with MIP technique (group C). The mean bonded strength of MIP was 15.4297± 6.63519 Mpa. When bonding was done with conventional technique (group A) shear bond strength obtained was slightly lower (mean= 13.43± 4.63 Mpa) as compared to group C. On the other hand lowest shear bond strength among all three groups occurred when bonding was done with SEP technique. The mean bond strength of group B was 10.2517± 6.63519Mpa.

Conclusion: Self-etch primer displayed considerably superior performance under dry compared with contaminated conditions. Mean value of the MIP was comparatively higher than the other primer technique. Furthermore, research should be recommended for a better result.

Keywords: Tensile bond strength, shear bond strength, saliva contamination, self etch primer, moisture insensitive primer.

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INTRODUCTION

Modern contemporary orthodontics relies on the accurate placement of directly bonded attachments to the teeth in order to achieve the desired three-dimensional control of tooth movement. Even though the direct bonding of such attachments to enamel is nowadays routine for most orthodontists, there is the ever-present desire to try to simplify the procedure without compromising reliability. More than 50 years ago, Buonocore demonstrated that the adhesion of acrylic restorative materials increased significantly when it was preceded by an acid-etch technique on enamel. Since then, additional advances have been made that improve bond strength on tooth enamel.[1] Since the concept of adhesive dentistry was introduced by Buonocore dental adhesive have been widely used in orthodontics, preventive dentistry and restorative dentistry. Achieving good moisture control is a prerequisite for permanent stable bonding of conventional hydrophobic resin bonding agents. The conventional bonding of orthodontic materials to enamel surfaces has produced good adhesive results. However, it is time-consuming because a series of steps have to be followed for its execution, namely acid etching, primer application, and the bonding itself.[2]

To simplify the procedure and to reduce the time spent for orthodontic bonding, self-etching primer (SEP) products are available in the dental market, which uses a mixture combining acid and primer into one solution. According to White, SEPs are easily manipulated and used, resulting in comfort for the patients and decreasing the chair time by 65%. [3]

However, the stress is still on clinically adequate bond strength, which is affected by bracket base design, the adhesive used, bonding protocol, etc. Bonding is a technique sensitive procedure, and moisture is cited as the most common cause of bond failure. Contamination causes plugging of porosities caused by acid etching and a reduction in surface energy. Thus, the penetration of the resin is impaired, and the micromechanical retention is compromised. [4]Another novel concept is the sixth-generation bonding systems, where etching and priming agents are combined into a single acidic primer solution. These self-etch primers help the clinician save time, reduce cross-contamination, and reduce wastage. Because they are hydrophilic, it is logical to presume that they may be effective in situations with minimal moisture contamination.[5]

Salivary control and maintenance of a dry operating field is a prime requisite of orthodontic bonding because the most commonly used orthodontic primers and adhesives contain hydrophobic functional monomers (bis-GMA formula). Many devices such as saliva ejectors, salivary duct obstructers, antisialagogue tablets or injections are used in routine orthodontic practice. However, they are not adequate for moisture control in certain clinical situations such as bonding to surgically expose impacted teeth, teeth with primary or secondary eruption failure partially erupted teeth, lingual bonding of brackets or retainers, bonding molar tubes or buttons on second or third molars, etc., Contamination can occur at two critical times. After the tooth surface has been etched than the primer has been applied. Bonding could be compromised in both these situations. A reduction in bond strength of composite resins to etched enamel after moisture and saliva contamination has been reported by several authors.[6]

The presence of moisture is an inherent condition when bonding in the oral cavity and has long been considered as the most common reason for bond failure. Contamination causes plugging of the porosities produced by acid etching and a reduction in surface energy. In this way, resin penetration is impaired, and micromechanical retention is compromised. The detrimental effect of moisture on orthodontic bonding may also be due to water absorption and induction of the plasticizing effect in the polymer network. The latter involves the creation of hydrated zones at the polar monomer sites and the oxidation of pendant C=C bonds attached to the network which release by-products such as formaldehyde so producing a plasticizing effect.[7]

Saliva contamination is one of the most common problems encountered during bracket bonding, placement of fissure sealants on partially erupted mandibular molars or the restoration of para- or subgingival cervical lesions with resin composites. In contrast to conventional hydrophobic bonding agents, self-etching adhesives contain not only hydrophobic but also hydrophilic monomers. Two-step self-etch adhesive systems contain hydrophilic monomers in a self-etching primer and hydrophobic monomers in a bonding resin. One-step, one-bottle self-etching adhesives are "all-in-one" mixtures of hydrophilic and hydrophobic monomers. Both the hydrophilic and hydrophobic monomers are mixed just before the application of one-step, two-bottle self-etching adhesives. The self-etching adhesives simplify the application procedure from multiple steps (etching, rinsing, priming and bonding) into two steps (a combination of etching and priming, and bonding) or one step. The majority of previously published reports have focused on the influence of saliva on orthodontic adhesives-[8-10] or fissure sealants,[11-12] and only a few reports have dealt with the effect of salivary contamination on resin restorations.[13] Controversial data have been reported regarding the effect of saliva contamination on the enamel bond strength of adhesives because it depends not only on the individual adhesive used but also on the adhesive in combination with the primer.[14] To address this reality, hydrophilic bonding materials have been developed. The fourth-generation bonding system, the moisture-insensitive primers (MIPs), and the fifth-generation bonding systems, that is, self-etching primer (SEP) are hydrophilic in nature.

Additional advances have been made that improve bond strength on tooth enamel. Although traditional bond material must be applied in completely dry and isolated fields to produce clinically acceptable bond strength, some manufactures have recently started to introduce hydrophilic substances into their composition. These substances allow for greater shear bond strength (SBS) on wet surfaces by enabling the composite to pass beyond the organic adhesive coating formed by moisture on the enamel's surface.[15] Hydrophilic bond system has been an important development in orthodontic practice because many routine clinical procedures are not carried out under ideal conditions. In particular, it can be difficult to bond attachments to hard-to-reach place such as the gingival areas, second molars, and partially erupted or impacted teeth, inflammatory conditions etc. in these cases bonding failure in common, and rebonding, which consumes chair time and is a burden for both orthodontics and patient.[4] As self etch primer in the same bottle so separate etching and washing of tooth surface are not required which saves chair side time for an orthodontist. In unsuccessful bonding procedures, most of the porosities produced by enamel acid-etch procedure become plugged with moisture. As a result, resin penetration is impaired, and when insufficient numbers and lengths of resin tags, from bond strength, has reduced. Contamination of the enamel surface, therefore, requires the etching procedure to be repeated to ensure the adequate bonding of composite. So the purpose of the study is to evaluate the effect of saliva contamination on tensile bond strength (TBS) of brackets bonded using different primer technique.

MATERIALS AND METHODS

90 sound human premolars that had been extracted for orthodontic purpose were collected from patient between 15-30 years because root completion takes place 12-14 years in premolars. All teeth were stored in normal saline solution for a maximum of 1 week before testing. The teeth were divided into 3 equal groups with an equal number of 1st & 2nd upper & lower premolars in each group to prevent bias caused by possible differences in bond strength among tooth types. The buccal surface of each tooth was cleaned with fluoride-free pumice & water slurry with dental rotary handpiece & brushes, washed & dried with compressed air cleaned surface then etched with phosphoric acid for 30 seconds, washed and dried.

Teeth were divided into 3 groups-

Group A/ control group- The teeth in this group were contaminated with saliva bonded with normal etching and primer technique.

Group B- The teeth in this group were contaminated with saliva and bonded with self etch primer technique.

Group C- The teeth in this group were contaminated with saliva and bonded with moisture insensitive.

All teeth were stored in distilled water at room temperature for 24 hours. The teeth were mounted vertically in an Instron machine. A wire loop was placed under the gingival wings of the orthodontic bracket so that the direction of pull produced shearing force in the long axis of the tooth. A crosshead speed of 1mm/min was used. The stress at the band will be recorded in megapascals (Mpa).

Bond strength testing

A Universal testing machine was used to test shear bond strength. The specimen mounted in its acrylic block was secured to the lower grip of the machine (fixed head). To maintain a consistent debonding force, a custom-made blade was fixed in the upper grip (movable head) connected to the load cell. The blade was positioned in such a way that it was touching the bracket. A cross-head speed of one mm/minute was used. A computer was used to record the force applied to debond the bonded bracket in the unit of Newton. The bond strength was calculated in megapascals using the formula

$$\text{Bond strength in MPa} = \frac{\text{Force in Newton}}{\text{The surface area of Brackets in mm}^2}$$

- The surface area of the bracket was 10.61 mm^2, as given by the manufacturer.
- Conversion rates of various parameters

1 Newton=101.9 Gram
1 Newton=3.59 Ounce (OZ)
1Ounce=28.4 Grams

Statistics were performed using the Statistical Package for Social Sciences (SPSS) version 23.0. Frequency distribution tables were used for summarizing the data. Independent samples t-test and ANOVA test were used to compare the mean between groups. All tests were performed at 0.05 level of significance.

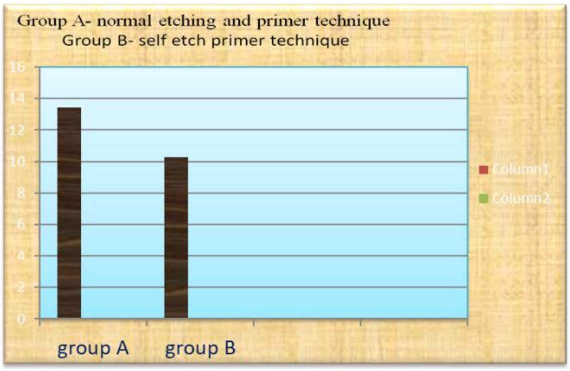
RESULTS

Table 1, Graph 1 shows the comparison of strength between group A and group B

Table 1: Comparison of Bond Strength In Group A & Group B

Bond strength	N	Mean ± Std. Deviation	Std. Error Mean	P – Value
A	30	13.4323±4.63092	.84549	
B	30	10.2517± 6.63519	1.21141	.018 (S)

Graph 1: Comparison of strength of group A and group B.



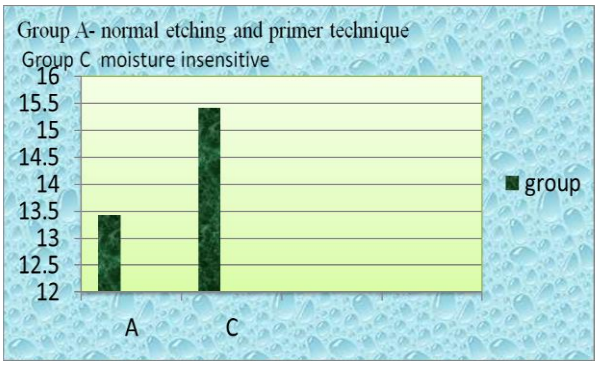
Unpaired student 't' test was done to compare the mean bond strength between group A & B in which the 't' test value obtained is 2.515 which is statistically significant (P-value = 0.018)

Table 2, Graph 2 shows the comparison of strength between group A and group C

Table 2: Comparison of Bond Strength in Group A & Group C

Bond strength	N	Mean ± Std. Deviation	Std. Error Mean	P – Value
A	30	13.4323±4.63092	.84549	
C	30	15.4297± 6.63519	.74886	.307 (NS)

Graph 2: Comparison of bond strength of group A and group C



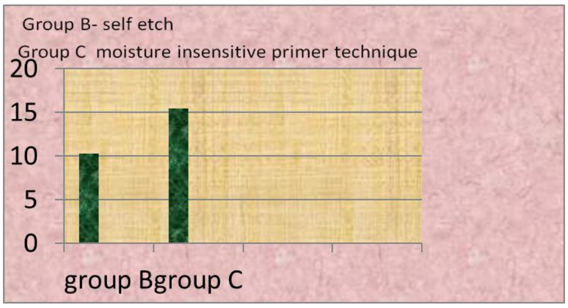
Unpaired student 't' test was done to compare the mean bond strength between group A & C (Table -2) in which the 't' test value obtained is 1.902 which is not significant (P-value = 0.307)

Table 3, Graph 3 shows the comparison of strength between group B and group C

Table 3: Comparison of Bond Strength in Group B & Group C.

Bond strength	N	Mean ± Std. Deviation	Std. Error Mean	P – Value
B	30	10.2517± 6.63519	.84549	.001 (HS)
C	30	15.4297± 6.63519	1.21141	

Graph 3. Comparison of bond strength of group B and group C



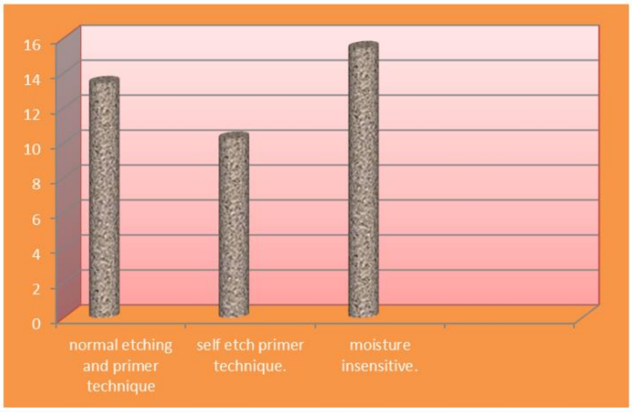
Unpaired student 't' test was done to compare the mean bond strength between group B & C (Table -3) in which the 't' test value obtained is 4.405 which is highly significant (P value = 0.001)

Table 4, Graph 4 shows the comparison of strength between group A, group B and group C

Table 4: Comparison Of Bond Strength In Group A & Group B & Group C.

Bond strength	**N**	**Mean ± Std. Deviation**	**F**	**P – Value**
A	30	13.4323±4.63092	7.458	.001 (HS)
B	30	10.2517± 6.63519		
C	30	15.4297± 6.63519		

Graph 1: Mean bond strength of different group



The descriptive statistics including the Mean & Standard deviation for each of the three groups are presented.

- The results of the analysis of variance indicated that there was significant differences (F value =7.458, *P value=.018* in bond strengths between the various groups tested.
- The highest value of shear bond strength occurred when contaminated with saliva and bonded with MIP technique (group C). The mean bonded strength of MIP was 15.4297± 6.63519 Mpa.
- When bonding was done with conventional technique (group A) shear bond strength obtained was slightly lower (mean= 13.43± 4.63 Mpa) as compared to group C.
- On the other hand, the lowest shear bond strength among all three groups occurred when bonding was done with SEP technique. The mean bond strength of group B was 10.2517± 6.63519Mpa.

Table 5, Graph 5 shows the comparison of strength between intragroup

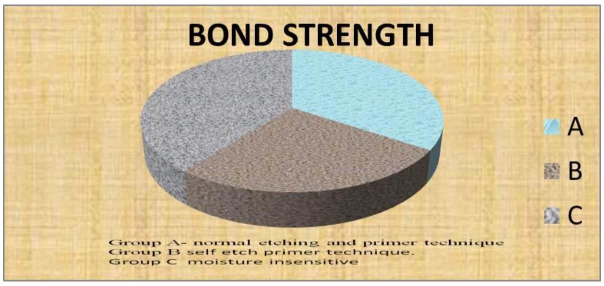
- Tukey's Post Hoc Analysis was done for intragroup comparison.
- Mean difference in bond strength between group A & group B is 3.18067which is significant (P-value =0.018)
- Mean difference in bond strength between Group A & Group C is 1.99733 which is Not Significant (P-value =0.307)

- The result shows that the mean difference in bond strength between group B & group C is 5.17800which is highly significant (P-value =0.001)

Table no 5- Comparison of Bond Strength between intra Groups

Groups	Mean Difference in Bond Strength	P VALUE
A-Group v/s B-Group	3.18067	0.018
A-Group v/s C-Group	1.99733	0.307
B-Group v/s C-Group	5.17800	0.001

Graph 5: Pie chart of mean bond strength of different group



DISCUSSION

The direct bonding of orthodontic brackets has dramatically improved the clinical practice of orthodontics, but contamination with saliva still poses a problem, especially while bonding posterior teeth and hard-to-reach places such as the gingival area, second molars, partially erupted or impacted teeth etc. In these cases, bonding failure is common and rebounding is a burden for both orthodontist and patient as it is time-consuming.

Due to the hydrophobic nature of traditional Bis-GMA resins, the efficiency of the same is reduced in a wet environment. Thus MIPs have been used and are found to offer comparable strength under wet conditions.

These primers are adaptations of dentin-bonding agents, which have hydrophilic components such as HEMA, which allows a lower contact angle and an extension of the molecule, which readily bonds to the resin composite Transbond MIP used are ethanol-based primers. Ethanol has the property to diffuse and is easily miscible in water. Therefore, it demonstrates higher bond strength when used on contaminated wet enamel surfaces compared to that of acetone based primers which do not get easily diffused in water as far as enamel bonding is concerned and thus produces lesser bond strength when compared with ethanol-based primers (Transbond XT) under moist conditions. It contains a hydrophilic drying and wetting agent. The drying agent seeks out moisture, evaporates it from the bonding field and draws the resin in, ensuring reliable, consistent bonding.

Clinically acceptable bond strengths have been reported to a range from 5 Mpa to 8 Mpa. [16] The present study showed that the mean shear bond strength when the conventional primer was used was more than the mean shear bond strength when SEP was used. This result has contradicted the findings of Zeppieri IL, Chung CH et al. Bishara et al, showed that the mean shear bond strength of SEP in a wet environment is 8.65±2.87 Mpa which was adequate and clinically acceptable as recommended by Reynolds. These findings were similar to zippier IL, Chung CH et al. Where they stated that saliva contamination did not affect the bond strength of SEP when SEP was reapplied.

Littlewood et al.[17] have reported lower bond strength with the fifth-generation MIP primer (6.43 Mpa) compared with a conventional primer (8.71 Mpa) in dry conditions using APC brackets bonded on human premolars. Faltermeier et al.[18] evaluated the SBS of a conventional primer (Transbond XT) and a MIP (Transbond MIP) under dry conditions/after contamination with natural saliva, blood, remnants of etchant gel and found that Transbond XT and Transbond MIP showed no significant difference in SBS. Deprá et al. [19] evaluated the influence of saliva contamination on the bond strength of metallic brackets bonded with a hydrophobic and hydrophilic composite resin system. The results of the study concluded that the SBS of the hydrophilic group was not affected when compared with a hydrophobic group supporting this study.

The present study compared three group primers designed for orthodontic purposes and evaluated the influence of saliva contamination and different decontamination procedures on the bracket shear bond strengths. One of the main causes of bracket bond failure is contamination during the bonding process. It has been found that the presence of saliva [20-23] can decrease the bond strength in orthodontic resin bonding systems.

The highest value of shear bond strength occurred when contaminated with saliva and bonded with MIP technique (group C). The mean bonded strength of MIP was 15.4297± 6.63519 Mpa.

When bonding was done with conventional technique (group A) shear bond strength obtained was slightly lower (mean= 13.43± 4.63 Mpa) as compared to group C.

On the other hand, the lowest shear bond strength among all three groups occurred when bonding was done with SEP technique. The mean bond strength of group B was 10.2517± 6.63519Mpa. Hence the results of this present study are consistent with the results of previous studies on the use of MIP.

Conventional primer does not offer adequate bond strength under conditions of moisture contamination. Conventional primer does offer adequate and comparable bond strength to self-etch primer and MIP under dry conditions and, therefore, may be more cost-effective. MIP and self-etching primer offered adequate bond strength under contaminated conditions also.

Bonding is a technique sensitive procedure this study reveals that SEP provides adequate bond strength within the clinically acceptable limits. By reducing the number of steps during the bonding, clinicians are able to save time and reduce the potential for moisture, saliva, blood or plasma contamination and technique sensitivity during the bonding procedure. Combining conditioning and priming into a single treatment step results in an improvement in both time and cost-effectiveness to the clinician and the patient. Although still unpredictable, SEP systems have undergone a rapid evolution over the past few years, possibly, in future, dental adhesion will involve only one-step procedure for optimum bonding.

CONCLUSION

Analysis of the results of the study showed that the shear bond strength of primers was acceptable, though that contaminated with saliva and bonded with self etch primer technique is significantly higher compare to contaminated with saliva and bonded with separate etchant & primer technique and normal etching and primer technique under ideal condition. The mean bond strength between normal etching and primer technique under ideal condition is lesser than contaminated with saliva and bonded with self etch primer technique, but no significant difference present. Self-etch primer displayed considerably superior performance under dry compared with contaminated conditions. Mean value of the MIP was comparatively higher than the other primer technique. Furthermore, research should be recommended for a better result.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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