

# Moisture insensitive primer: A myth or truth

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## ABSTRACT

**Objectives:** To compare the mean shear bond strength (SBS) of moisture insensitive primer (MIP) used for orthodontic bonding in the presence and absence of saliva.

**Materials and Methods:** A total of 60 human noncarious maxillary premolars with sound buccal surfaces, recently extracted were collected in two groups of each 30. Maxillary premolar brackets were bonded to the teeth using light cure (Transbond XT, 3M Unitek, Monrovia, CA, USA) and MIP (Transbond MIP 3M Unitek, Monrovia, CA, USA,) in the presence and absence of saliva. Operators' saliva was used during the bonding under moist condition. After debonding, all the specimens were examined under a stereomicroscope ( $\times 40$  magnification) for adhesive remnant using adhesive remnant index (ARI). The SBS tests were done using Instron universal testing machine at cross-head speed of 1 mm/min, force passing parallel to the buccal surface using custom rod and registered in Newtons later converted into Megapascals.

**Results:** Light cure and MIP (Transbond MIP and Transbond XT, 3M Unitek, Monrovia, CA, USA) in the absence of saliva showed higher mean SBS than the presence of saliva. Group I (light cure and MIP) in the absence of saliva showed mean SBS of  $9.65 \pm 0.90$  Mpa. Group II (light cure and MIP) with the presence of saliva showed mean SBS of  $9.03 \pm 1.14$  Mpa. The difference between both the groups was statistically significant, as confirmed by paired *t*-test ( $P < 0.05$ ). In-Group I, ARI scores showed that more than half of the adhesive was left over the tooth surface, and Group II showed that there was no or insignificant amount of adhesive left over the tooth surface. Chi-square test revealed significant difference in debonding characteristics among the test groups of ARI ( $P < 0.05$ ). Failure occurred mainly in resin– bracket base and resin – adhesive interfaces ( $\chi^2 = 10.04$ ,  $df = 3$ ,  $P = 0.031$ ).

**Conclusion:** Moisture insensitive primer is effective in the presence/absence of moisture and has shown SBS value of more than 7.8 Mpa as stated by Reynolds, hence material is suitable for clinical use.

**Key words:** Adhesive remnant index, moisture insensitive primer, shear bond strength

## INTRODUCTION

In the evolution of fixed orthodontic appliances, aesthetics is one of the prime concerns for acceptance of any appliance by the patient. The time-consuming and un-esthetic procedure have been virtually discarded after the introduction of acid-etch direct bonding technique in 1955.<sup>[1]</sup> Newman<sup>[2]</sup> reported the first case of bonding orthodontic brackets in 1965. Over the past two decades, the evolution of adhesive techniques has transformed the scope of dental practice. The development of light-cured composite has opened new horizons in bonding orthodontic brackets. It has become increasingly popular for bonding orthodontic attachment. The unlimited working time of

the adhesive allows the orthodontist to manipulate the bracket position until polymerization is initiated by visible light source.<sup>[3]</sup> Several studies have been carried, which showed that the shear bond strength (SBS) of self-etching (SE) primer and resin system was significantly more or similar to the conventional system. Fritz *et al.*<sup>[4]</sup> reported that SE primers Clearfil Liner Bond and SE are as effective as conventional groups. Asgari *et al.*<sup>[5]</sup> reported a low bond failure rate of SE primer (SEP) (0.57%) compared to the conventional group (4.60%). Buyukyilmaz *et al.*<sup>[6]</sup> reported bond strength of SEP ( $16 \pm 4.5$  MPa), which is significantly higher than control acid etched groups. Cacciafesta *et al.*,<sup>[7]</sup> Vicente *et al.*<sup>[8]</sup> and Dorminey *et al.*<sup>[9]</sup> had reported same

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bond strength when SEP and control acid etched group were compared. Bishara *et al.*<sup>[10]</sup> used a heavily filled adhesive with Transbond Plus SE primer to bond brackets and reported bond strength of  $10.4 \pm 4.4$  MPa. However, they found much lower bond strength of  $5.9 \pm 5.6$  MPa with a lightly filled adhesive. In a subsequent study, they reported very low bond strength of  $2.8 \pm 1.9$  MPa that was not clinically acceptable. In more recent study however, he reported SBS of  $7.1 \pm 4.4$  MPa with Transbond Plus, which is clinically acceptable.

Seventh generation bonding agent (moisture insensitive primer, [MIP]) is the latest entrant and the first no-mix bonding adhesive, which sets in the presence of moisture giving effective bond strength. It has been difficult for operators to make moisture free oral environment during bonding. Many procedures where isolation is a problem like bonding on impacted teeth etc., MIP is totally insensitive to moisture and is giving a very good result.<sup>[4]</sup>

Though many studies have been carried out in the past regarding SBS of various orthodontic bonding agents, scarcity of knowledge still exists regarding SBS of MIPs. Hence, study was conducted to compare mean SBS of MIP in presence and absence of saliva for orthodontic bonding purpose.

### The Null Hypothesis

This study was undertaken with a null hypothesis that there would not be any statistically significant difference between means SBS of MIP used for bonding orthodontic brackets in the presence and absence of saliva.

## MATERIALS AND METHODS

This study was conducted at Department of Orthodontics, Peoples Dental College and Hospital and Corps Dental unit, Bhopal. This study had ethical approval from Ethical Committee of Peoples Dental College and Hospital, Bhopal India. Sixty extracted noncarious human premolars with sound buccal surfaces were collected.<sup>[11]</sup> The teeth were rinsed with water to clean blood and soft tissue debris and then decontaminated with 0.5% thymol. Then the teeth were stored in distilled water at 37°C for 2 weeks. Each tooth was placed in a mold and roots were embedded in self-curing acrylic resin block (diameter = 15 mm; height = 20 mm) up to 1 mm apical of CE junction. The long axis of the teeth was kept parallel to the long axis of the acrylic blocks. Crowns were kept exposed to facilitate surface treatment and adhesive bonding on buccal surfaces. The acrylic resin blocks were color coded to differentiate the two groups of thirty teeth each.

Group I - 30 teeth were embedded in green colored acrylic resin blocks for bonding using MIP and light cure composite in the absence of saliva (Transbond MIP and Transbond XT, 3M Unitek, Monrovia, CA, USA) [Figure 1].

Group II - 30 teeth were embedded in pink colored acrylic resin blocks for bonding using MIP and light cure composite in the



**Figure 1:** Moisture insensitive primer and light cure composite (3M Unitek, Monrovia, Calif)

presence of saliva (Transbond MIP and Transbond XT, 3M Unitek, Monrovia, CA, USA) [Figure 1].

Orthodontic preadjusted edge-wise appliances metal brackets having  $0.022 \times 0.028$  MBT slot for maxillary premolar (Gemini 3M, Unitek, Monrovia, CA, USA) were used the surface area of the bracket being  $10.61 \text{ mm}^2$ . All the brackets were bonded on the buccal surfaces following the instructions of the manufacturer. Operators' saliva was used during the bonding under moist condition. All the brackets were bonded by single operator to avoid inter operator variation [Figure 2a-d].

### Shear Bond Strength and Adhesive Remnant Index

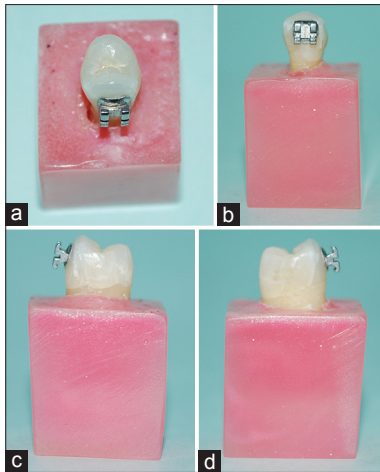
The shear bond strength tests were done using Instron universal testing machine no. 3382 at cross-head speed of 1 mm/min force passing parallel to the buccal surface [Figure 3]. A custom made rod was locally fabricated for debonding of brackets [Figure 4]. Each block was fixed in a metal jig and the machine applied a force parallel to the tooth surface in an occlusal-apical direction. The force required to debond each bracket was registered in Newtons, and converted into Megapascals by using the following formula.

$$\text{Bond strength Mpa} = \frac{\text{Force in Newtons}}{\text{surface area of the bracket in mm}^2}$$

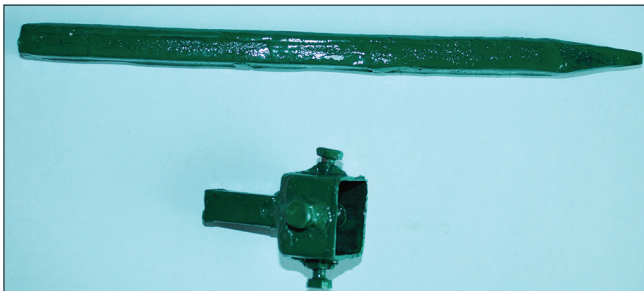
After debonding, all the specimens were examined under a stereomicroscope at  $\times 40$  magnification in order to assess adhesive remnants on tooth surfaces using the adhesive remnant index (ARI).<sup>[10]</sup>

The ARI scale has a range of 1-5:

- 1 = The entire composite with an impression of the bracket base remained on the tooth surface
- 2 = More than 90% of the composite remained
- 3 = More than 10% but <90% of the composite remained on the tooth surface



**Figure 2:** (a) Individual block showing buccal view of the bracket bonded to buccal surface. (b) Individual block showing mesial view of the bracket bonded to buccal surface. (c) Individual block showing distal view of the bracket bonded to buccal surface. (d) Individual block showing occlusal view of the bracket bonded to buccal surface



**Figure 4:** Metal zig with push rod

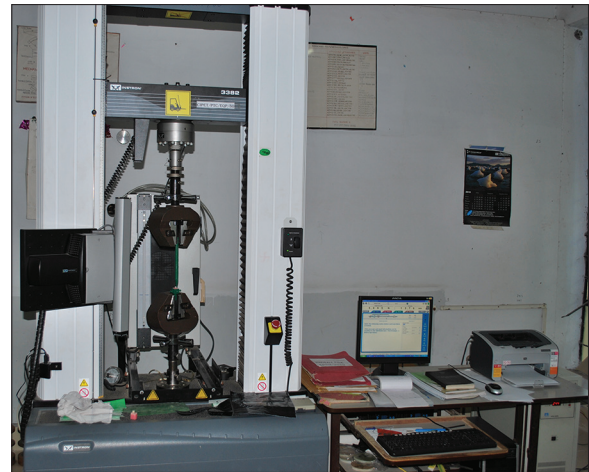
- 4 = Less than 10% of composite remained on the tooth surface
- 5 = No composite remained on the enamel surface.

### Statistical Analysis

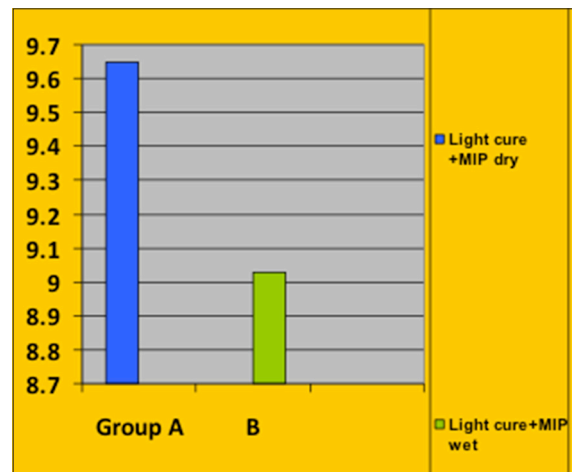
Mean SBS of the two groups was determined using Student's *t*-test. The level of significance (*P* value) was kept at 0.05. Comparison between the groups was done using the Chi-square test for ARI.

### RESULT

Group I (light cure and MIP) without the presence of saliva was showing mean (SD) SBS of 9.65 (0.90). Group II (light cure and MIP) with the presence of saliva was SD SBS of 9.03 (1.14). The difference between the two groups was statistically significant ( $P < 0.05$ ). As confirmed by paired *t*-test [Table 1 and Figure 5]. Comparison between ARI scores of the two groups was done using the Chi-square test [Table 2]. In-Group I, the ARI scores showed that more than half of the adhesive was left over the tooth surface (score 3 and 4). In Group II, ARI scores showed that there was no or slight amount of adhesive left over the tooth surface (score 5). Most of the failures in-Group II was between the tooth surface and adhesive, whereas in the



**Figure 3:** Instron universal testing machine no. 3382



**Figure 5:** Comparison of shear bond strength of both the groups

case of Group I it occurred within the resin leaving more than half of the adhesive on the teeth. Chi-square test showed a significant difference in debonding characteristics among the test groups ( $P < 0.05$ ). bond failure occurred mainly in resin– bracket base and resin– adhesive interfaces ( $\chi^2 = 10.04$ ,  $df = 3$ ,  $P = 0.031$ ).

### DISCUSSION

The direct bonding of orthodontic brackets has revolutionized and improved the clinical practice of orthodontics. However, there is a need to improve the bonding procedure by saving time and need to minimize enamel loss without jeopardizing the ability to maintain clinically useful bond strength.

Previous *in vitro* studies conducted by Mehmet have used incisors for measuring SBS whereas canine, premolar, or molars have been used for measurement of SBS by Corel and McInnes *et al.*<sup>[12]</sup> Use of premolars in the present investigation was followed by extensive review of literatures mentioning its use in the study conducted by Fajen *et al.*<sup>[13]</sup> and also by McCourt,<sup>[14]</sup> which further supported their use in this study. An



**Table 1: Comparison of SBS between both the groups**

Group	Mean SBS±SD in Mpa	t value	P (P<0.05)	Significant/nonsignificant
Group I (light cure and MIP) without the presence of saliva	9.65±0.90	2.43	0.021	Significant
Group II (light cure and MIP) with the presence of saliva	9.03±1.14	2.32	0.041	Significant

SBS – Shear bond strength; SD – Standard deviation; MIP – Moisture insensitive primer

**Table 2: ARI**

ARI score	Group I	Group II
1	1 (3.33)	-
2	1 (1.67)	-
3	6 (18.33)	3 (6.67)
4	14 (48.33)	7 (23.33)
5	8 (28.33)	20 (68.33)
Total	30 (100.00)	30 (100.00)

ARI – Adhesive remnant index

added advantage is the easy availability of these teeth in our institution as the sample size was very high in number and premolars are the most commonly extracted healthy teeth in the field of orthodontics for treatment purpose. Thus, a bigger sample size was used in the present study.

Stainless steel preadjusted premolar brackets without hook were preferred to reduce any biased values while measuring the SBS with the Instron machine since during testing hooks may interfere with the force delivering machine attachment. Meehan *et al.*<sup>[15]</sup> Rix *et al.*<sup>[16]</sup> have also favored its use.

Distilled water with 0.1% (weight/volume) thymol was used for storage of teeth during collection and after bonding in the present investigation. This storage medium does not alter the properties of the tooth surface and at the same time maintains the hydration level of the teeth. Further addition of 0.1% (weight/volume) thymol is reported to inhibit the bacterial growth. Similar storage media were used by studies conducted by Cacciafesta *et al.*,<sup>[7]</sup> Hajrassie and Khier.<sup>[17]</sup> Use of the autoclave and other chemicals like peroxides, glutaraldehyde, or normal saline were avoided as they can alter the properties of enamel and can give bias results as reported by Eliades and Brantley in their study.<sup>[18]</sup>

The brackets were debonded with a shear load by means of instron testing machine having a cross-head speed of 1 mm/min. The bracket was positioned parallel to the plunger of the testing machine. The loading of the bracket was done on the wings rather than close to the base. This was attributed to the fact that application of load on the wings may be more representative of the *in vivo* loading and may ensure a more consistent application of the debonding force. This debonding procedure was in accordance with the study conducted by Katona for the measurement of SBS of various orthodontic adhesives.<sup>[19]</sup>

The current study evaluated the SBS and used ARIs to assess the bond failure problem with MIP used for orthodontic bonding in presence and absence of saliva. In-Group I, ARI scores showed that more than half of the adhesive was left over the tooth surface (score 3 and 4). This indicates that failure occurred cohesively within bonding agent showing adequate bonding at junction of the enamel and bonding agents, hence higher bond strength. In Group II, ARI scores showed that there was no or slight amount of adhesive left over the tooth surface (score 5). It indicates failure of adequate bonding at junction of enamel and bonding agent when using MIP in presence of saliva.

The classification system (ARI) that was used did not allow to record any reason for bond failure in terms of etching procedure or technical procedure. Further studies using different bracket types and surface treatment methods with simultaneous use of manufacturer's debonding instructions are needed. These studies should evaluate before and after debonding images.<sup>[20]</sup>

Pickett *et al.*<sup>[21]</sup> and Arnold *et al.*<sup>[22]</sup> reported SBSs of 11.2 and 9.7 MPa, for conventional acid-etch adhesive and Transbond XT, respectively. However, Scougall Vilchis *et al.*<sup>[23]</sup> compared Transbond XT (control group) with Transbond plus and other three SE adhesives and found that the SBS of Transbond XT was highest (19.0 MPa) followed by Transbond Plus (16.6 MPa) and three other SE adhesives.

Cacciafesta *et al.*,<sup>[7]</sup> measured SBS of orthodontic brackets in moisture contamination after application of MIP and after enamel priming, all showed adequate and acceptable SBS.

The findings of this study indicate that the Group I (light cure and MIP) in the absence of saliva was showing more mean SBS than Group II (light cure and MIP) in the presence of saliva. The two groups also showed significant differences in their SBS and statistically similar to the study done by Rajagopal *et al.*,<sup>[24]</sup> Schaneveldt and Foley<sup>[25]</sup> and Zeppieri *et al.*<sup>[26]</sup>

In the study, the mean SBS of MIP in dry condition was more than in wet condition. It may be because of the large amount of contaminated components, organic and inorganic substrates in saliva remained on the etched surface and prevented complete penetration of the primer.

## CONCLUSION

Based on the data recorded from the present study following conclusions, may be drawn.

- Group I (light cure and MIP) in the absence of saliva was SD SBS of 9.65 ± 0.90. Group II (light cure and MIP) in the presence of saliva was SD SBS of 9.03 ± 1.14. The difference between the two groups was statistically significant as confirmed by paired *t*-test (*P* < 0.05)
- MIP is a very good option where isolation is a problem. It is effective in the presence of moisture also, and both

conditions have shown SBS value of more than 7.8 Mpa as stated by Reynolds,<sup>[27]</sup> hence the material is suitable for clinical use

- Most of the failures in Group II were between the tooth surface and adhesive, whereas in the case of Group I it occurred within the resin leaving more than half of the adhesive on the teeth
- In the study, the mean SBS of MIP in dry condition was more than in wet condition.

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