

Evaluation of shear bond strength using three different types of adhesive primers under non-contaminated and contaminated conditions – An in vitro study

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ABSTRACT

Aim: This study was carried to evaluate whether SEP and MIP primers produce clinically acceptable shear bond strength when they are used to bond orthodontic brackets in both dry and wet environments.

Materials and Method: 105 extracted premolar teeth were used in this study. The teeth were divided into 7 groups of 15 teeth each. After bonding, all the samples were stored in distilled water at room temperature and bond strength was tested after 7 days by testing machine.

Results: Moisture insensitive primer and self-etch primer produces clinically acceptable shear bond strength in dry as well as moist environment.

Conclusion: SEP reduces the bonding steps by etching and priming simultaneously and saves the clinician's time. The only limitation of SEP is the cost effectiveness.

Key words: Bond Strength, Conventional Primer, Self etch Primer, Moisture Insensitive Primer

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INTRODUCTION:

In recent years, there have been numerous advances in dental materials. Newer adhesive bonding formulations have also been developed. Bonding in orthodontics, requires utmost precision and the newer adhesive materials are tending to make it more operator friendly. In orthodontics one of the most important steps in bonding technique is moisture control. Many times it is difficult to achieve adequate isolation in areas like partially erupted teeth and second molars. It is also necessary to reduce the number of steps in bonding procedure as it aids in better moisture control and makes the clinician's job easier and less time consuming.

Recently, to overcome such problems, two new primers have been introduced, namely self-etch primer (SEP) and moisture-insensitive primer (MIP). Manufactures claim that these new primers have the potential to produce clinically sufficient bond strength of orthodontic stainless steel brackets in dry as well as wet mediums.

This study was undertaken to evaluate and compare the shear bond strength of SEP, MIP, and conventional primer under both dry and contaminated conditions.

Materials and Method:

Bonding system: Transbond XT was the adhesive used.

Primers: Three types of primers were tested under both dry and contaminated conditions.

Conventional primer: Transbond XT (3M Unitek);
Moisture-insensitive primer (MIP): Transbond MIP (3M Unitek);
Self-etching primer(SEP): Transbond plus (3M Unitek).

105 extracted premolar teeth were used in this study. All the teeth selected had intact buccal enamel surfaces with no cracks, caries or developmental defects and were stored in distilled water at room temperature.

Customized square metal block of 2.5 X 2.5cm was

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prepared so that all the teeth could be mounted in a square block of dental plaster.

Before bonding the stainless steel brackets on the tooth, the buccal surface of each tooth was cleaned.

Groups:

The teeth were divided into 7 groups of 15 teeth each. After bonding, all the samples were stored in distilled water at room temperature and bond strength was tested after 7 days .1

Figure: 1

Shows bonding procedure steps.

- Group 1)** Conventional primers in dry environment (Control):
Etching > Conventional primer > Adhesive paste > brackets
- Group 2)** Self-Etch Primer in dry environment :
SEP > adhesive paste > Bracket
- Group 3)** Moisture insensitive primer (MIP) in dry environment:
Etching > MIP > adhesive paste > brackets
- Group 4)** Conventional primer in wet condition:
Etching > conventional primer > Saliva > adhesive paste > Bracket
- Group 5)** Self etch Primer in wet condition:
SEP > saliva > SEP > Adhesive paste > Brackets
- Group 6)** Moisture insensitive primer under wet environment.S1:
Etching > MIP > Saliva > MIP > Adhesive paste > Bracket
- Group 7)** Moisture insensitive primer under wet environment.S2:
Etching > saliva > MIP > adhesive paste > Bracket

Application method:

Etching - with 37% phosphoric acid gel for 15 seconds.

Conventional primer - A thin coat application with brush tip and light curing for 10 seconds.

Adhesive paste - Transbond XT composite resin,3M Unitek, light curing on all 4 sides of the brackets for 10 seconds.

Self etch primer - gently rubbing on the enamel for 3 seconds with a applicator brush.

Saliva - A thin coat of artificial saliva (Wet mouth) was applied with brush tip.

Bracket - Lewis stainless steel brackets with a mesh base.

Measuring the shear bond strength:

Instron testing machine 3365 was used to measure the shear bond strength.

The cross head of the testing machine moved at a speed of 5mm/min until the bracket sheared.

Statistical analysis & Results:

The means of the various groups were then subjected to unpaired t-test and analysis of variance (ANOVA), for comparison of their shear bond strength. All the values after comparison by ANOVA statistical analysis indicate that mean shear bond strengths observed in all the 7 groups were statistically significant (p=0.000).

In the first 3 groups, the bonding was done in dry field using conventional primer, self-etch primer and moisture-insensitive primer. The conventional primer group was considered as the control group. In the other 4 groups bonding was done in wet field using the same primers (Conventional, SEP, MIP). Again the conventional primer group was used as the control group.

The 6th and 7th group where MIP was used as the bonding agent, the procedure of bonding differed in the manner in which contamination was conducted. All groups contained 15 teeth each and shear bond strength was measured for all groups in megapascals (MPa). None of the teeth showed enamel fracture on debonding after testing under Instron machine.

Table No. 1

Shows mean bond strength, standard deviation and range for each group.

GROUPS	BOND STRENGTH (Mpa)		
	MEAN	SD	RANGE
1. ETCH, DRY, XT (control)	14.18	01.00	12.35-15.80
2. DRY, SEP	12.93	02.79	07.10-18.85
3. ETCH, DRY, MIP	10.24	01.32	08.45-12.55
4. ETCH, XT, WET	04.01	01.43	01.90-07.20
5. DRY, SEP, WET, SEP	09.35	02.90	04.10-13.95
6. ETCH, DRY, MIP, WET, MIP - S1	06.87	01.52	02.90-08.30
7. ETCH, DRY, WET, MIP -S2	02.82	01.25	00.15-05.35

Following results were obtained:-

In Dry Field:

Conventional Primer shows the highest mean shear

bond strength of 14.18 ± 01.00 MPa. MIP shows lower mean bond strength (10.24 ± 01.32 MPa) than the other two groups.

The above bond strength values indicate that all three primers provide adequate bond strength in dry conditions. The conventional primer amongst the three seems to be the best with regards to the bond strength when used in dry environment.

In Wet Field:

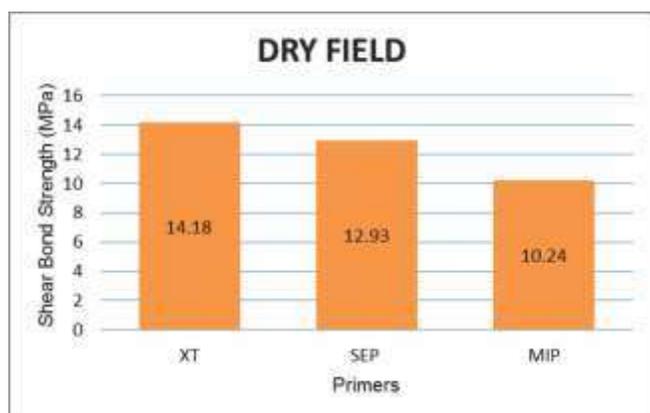
Conventional primer shows significantly low mean shear bond strength of 04.01 ± 01.43 MPa. SEP shows mean shear bond strength of 09.35 ± 02.90 MPa.

MIP-S1 shows mean shear bond strength of 06.87 ± 01.52 MPa.

MIP-S2 shows mean shear bond strength of 02.82 ± 01.25 MPa.

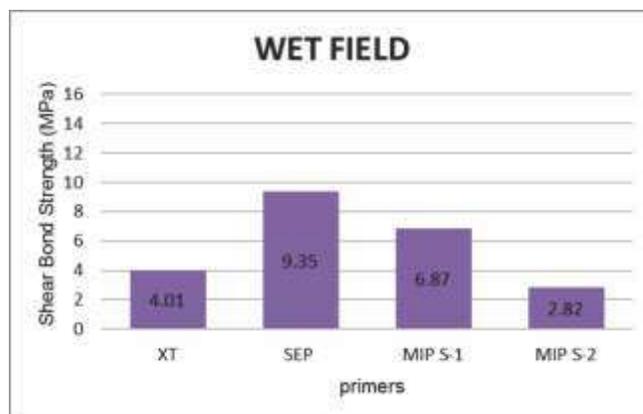
The above values on observation indicate that SEP and MIP are effective bonding agents in wet field, though MIP is not clinically reliable if moisture contamination occurs before application of the primer. This in effect may limit the use of MIP.

Figure 2.



Bar diagram of comparison of mean shear bond strength achieved with conventional primer, SEP and MIP in dry medium.

Figure 3.



Bar diagram of comparison of mean shear bond strength achieved with conventional primer, SEP and MIP in wet medium.

Discussion:

The conventional phosphoric acid etching technique etches the enamel by selectively dissolving calcium from the enamel structure, and the calcium then gets washed away when the tooth is rinsed. Similarly, self-etch primer (SEP) dissolves the calcium and removes it from hydroxyapatite. Calcium then forms a complex with the phosphate group and is incorporated into the network when the primer polymerizes.² The acid group is neutralized by the reaction with calcium and hence rinsing the tooth surface is not required as no etchant remains on the enamel.

Moisture-insensitive primer (MIP) is hydrophilic because it contains 2-hydroxyethyl methacrylate, polyalkenote copolymers with carboxylate groups, and ethanol.^{1,3} MIP can counteract the negative effect of saliva on bond strength.⁴

From the above table, it is seen that the mean shear bond strengths in dry field, using different primer, were higher than the clinically acceptable limit of bond strength, which is proposed to be in the range of 6-8 MPa as recommended by Reynolds.⁵

The results showed that the highest mean shear bond strength of 14.18 ± 01.00 MPa was achieved with adhesive when it was used with conventional hydrophobic primer.

These findings indicate that Transbond XT adhesive provides stronger bond with Transbond XT primer than self-etch primer and moisture-insensitive primer in dry field.

The results also show that SEP had adequate shear bond strength in dry field with reduction of steps of bonding procedure.

This study shows that the mean shear bond strength when conventional primer is used is more than the mean shear bond strength when MIP is used in dry conditions.

SEP shows slightly higher mean shear bond strength as compared to MIP in dry field.

These results contradict the findings of Zeppieri IL et al³ and Bishara SE et al^{6,7} who found that MIP had a higher shear bond strength of 20.70 ± 00.05 Mpa in dry field. However the mean shear bond strength of SEP in dry field in our study was comparable to Zeppieri IL et al³ and Bishara SE et al^{6,7}.

The mean shear bond strength of SEP in wet environment is adequate and clinically acceptable as recommended by Reynolds IR⁵. These findings are similar to Zeppieri IL et al³ where they stated that saliva contamination did not affect the bond strength of SEP when SEP was reapplied.

This study shows no significant difference between SEP and MIP mean bond strengths in wet field when contamination occurs after application of primer and if the primers were reapplied after contamination.

Conventional primer shows significantly low mean shear bond strength in wet field which is similar to that observed by Cacciafesta V et al⁸.

MIP-S1 group where saliva contamination was introduced after application of primer followed by repriming of the enamel surface, the mean shear bond strength was higher than MIP-S2 where contamination was introduced before application of primer. Rajagopal R. et al⁹, Hobson RS et al¹⁰ also showed comparable mean shear bond strength when the enamel was reprimed after moisture contamination.

Thus, the results indicate that SEP and MIP both perform significantly well in dry and moisture contaminated fields, though MIP does not perform well if it is not reapplied after contamination.

Taking into consideration the above results and discussion, the use of SEP seems to be less technique sensitive. SEP will definitely reduce chair side time as it etches and primes simultaneously and thus may offer a better alternative to bonding with conventional primer, as it would reduce the bonding steps and thus be more comfortable to the patient. However, the use of SEP is limited to a single patient and therefore would be more expensive.

MIP would be a better alternative when isolation is difficult, as may occur in conditions of impacted canines and second molars. This is because MIP is more cost effective in comparison to SEP and shows comparable bond strength to SEP in wet environment.

Conclusions:

Moisture insensitive primer and self-etch primer produces clinically acceptable shear bond strength in dry as well as moist environment. SEP reduces the bonding steps by etching and priming

simultaneously and saves the clinician's time by making the job simpler. Also it is observed that self-etch primer is less technique sensitive, requires less

chair side and thus increases comfort of the patient. The only limitation of SEP in comparison with MIP is the cost effectiveness.

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