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Microleakage Estimation Underneath Different Primers

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ABSTRACT

Aim: This study assessed and compared the microleakage under orthodontic metal brackets using three widely used primer systems.

Materials and Method: Seventy-five maxillary premolar teeth were divided into 3 groups of 25 teeth each: Group A-Transbond XT light cure adhesive primer3M, Group B-Transbond plus Self-etch primer3M and Group C-Transbond Moisture insensitive primer3M(MIP). These primers were applied on the prepared premolars before bonding the brackets with Transbond XT light cure adhesive paste. The premolars were extracted after 48hours of bonding, washed and immersed in NaClO for 30min to remove the adhered tissue. The premolars were dried and mounted on acrylic blocks and immersed in freshly prepared 0.5% basic fuchsine solution for 24 hours and sectioned longitudinally. Sectioned specimens were examined under a digital stereomicroscope (15x) for microleakage in the enamel-adhesive and bracket-adhesive interfaces at the occlusal and gingival margins. The scores were evaluated using Kruskal Wallis-'H' test, and the significance of the mean difference between the groups was calculated using the Mann-Whitney U test.

Results: The range of microleakage observed was between 0.497mm-0.065mm; least in group C and maximum in group A. Kruskal Wallis 'H' test revealed significant differences between group B - group A and between-group B - group C.

Conclusions: The least amount of microleakage observed with Conventional primer followed by Transbond plus self-Etch primer3M and Transbond Moisture insensitive primer3M. Maximum micro leakages were found on the occlusal area at the Enamel -adhesive interface.

Keywords: Microleakage, Metal Brackets, Primers, Self-Etching, Moisture Insensitive Primer.

INTRODUCTION

Microleakage is one of the significant issues, which interferes with the bond between orthodontic attachment and tooth enamel resulting in compromised finishing and detailing owing to repeated bond failures. Hence it is imperative to have a reliable adhesive bond between an orthodontic bracket and tooth surface to ensure success. [18, 2]In orthodontics, bonding with light cure adhesive resin is popular because of the extended working time and precise bracket placement, which can only be accomplished with on-demand polymerization.[1] Microleakage under

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orthodontic brackets has been studied extensively using different bracket systems, light curing units, bonding methods and adhesives. In previous study nanocomposites showed more microleakage than conventional at both occlusal and gingival sides of the bracket. [11] In another study degree of microleakage was more significant in the occlusal front than the gingival side. [2] It was reported that there was no statistically significant difference when microleakage between three self-etch adhesive systems were compared.[3] TSEP (Transbond plus Self-etch primer3M) showed more microleakage than other conventional adhesives.[16] Yagciet et al. observed that type of bonding method (direct versus indirect) did not significantly affect the amount of microleakage at the enamel–composite–bracket complex.[20]Halogen the light source showed similar microleakage at the gingival and occlusal sides between both adhesive interfaces.[17]

In spite of advances in bonding techniques over the years, the risk of caries under the vicinity of the fixed orthodontic appliances remains unchanged. Therefore the purpose of the study was to assess the microleakage between three popularly used primers.

Hypothesis: The bonding procedure conducted with Transbond XT light cure adhesive, Transbond plus Self-etch and Transbond Moisture insensitive primers show no significant microleakage. Hence this study is being undertaken to prove/disapprove the statement.

The objective of the study is to evaluate and compare the microleakage of three widely used primers and Aim is to assess the efficiency of these three primers.

MATERIALS & METHODS

Seventy-five maxillary premolars were randomly divided into 3 groups of 25 teeth each: Group A-Transbond XT light cure adhesive primer3M, Group B-Transbond plus Self-etch primer3M and Group C-Transbond Moisture insensitive primer3M. Following standard bonding protocols, these primers were applied on the prepared premolars before bonding the brackets with Transbond XT light cure adhesive paste. [21, 14] Premolars were extracted after 48hours of bonding, washed in running water and immersed up to the root surface for 30min in NaClO to remove the adhered tissue (Figure-1).

Fig 1: Surface Preparation & Bonding with primer.

The premolars were dried in dried and mounted on acrylic blocks. Prior to dye preparation, the teeth apices were sealed with modelling wax & teeth were rinsed and drained.

Fig 2: Samples after bonding sealed with sticky wax of group A, B &C.

Fig 3: Samples after dying embedded in acrylic in group A, B&C.

Nail varnish was then applied to the entire surface of the tooth, except for approximately 1mm away from the restoration; the teeth were replaced in water as soon as the nail polish has dried (Figure-2, 3).

The teeth were immersed in a 0.5% solution of basic fuchsine for 24 hours at room temperature. After being removed from the solution, the teeth were rinsed and superficial dye is removed with a brush and dried.

The longitudinal section was made through the occlusal and gingival surface with a low-speed diamond saw in Bucco/lingual direction. Each section was examined for microleakage under a stereomicroscope of 15 x magnification. These images were scored for microleakage at the enamel-adhesive and bracket-adhesive interfaces at both occlusal and gingival margin and enamel-adhesive-bracket interfaces. Data is tabulated in the excel sheet and microleakage was scored in mm (Figure – 4, 5,6).

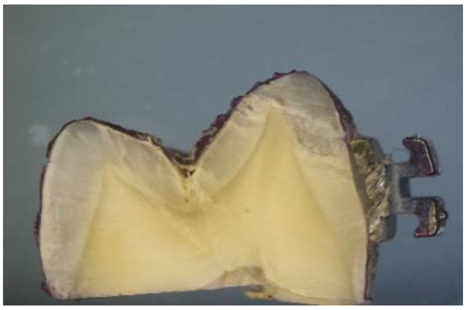

Fig 4: Cut section of the tooth under stereomicroscopy for assessing microleakage.

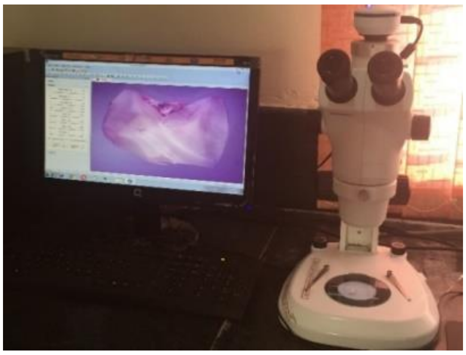

Fig 5: Digital Stereomicroscope (Model -SMZ25 Nikon - 15 X)

Fig 6: Microleakage observed & scored in mm

Statistical Analysis

Microleakage data were summarized as mean ± standard error of the mean and comparison using Kruskal Wallis 'H' test and the significance of the mean difference between (inter) the groups were done using Turkey's honestly significance difference post hoc test after ascertaining normality by using Shapiro – Wilk test and homogeneity of variance between groups by using Mann – Whitney U test. A p-value of (< 0.05) was considered significant. The analysis was performed on SPSS Statistics 16.0(SPSSInc software, Chicago).

RESULTS

Occlusal Surface

1) Enamel-Adhesive Interface

Statistical comparison of microleakage among three groups at the enamel-adhesive interface was shown in Table -1. According to analysis microleakage under occlusal side at this interface showed no significant difference ($p>0.05$). However, Mann-Whitney test used for pairwise individual comparison revealed that Group B showed higher microleakage, whereas minimum microleakage was observed in group C (Table-1).

2) **Adhesive-Bracket Interface**

Statistical significant differences ($p \sim 0.02$) were found at the occlusal side between adhesive-bracket among the groups and pairwise individual comparison showed significant difference under occlusal at adhesive-bracket interface between group A and group C ($p \sim 0.04$), group B and C. ($p \sim 0.008$) (Table- 2).

Gingival surface:

1) Enamel-Adhesive Interface

Microleakage at this interface showed no significant difference ($p>0.05$).among three groups (Table-3). Mann- Whitney test to find a pairwise individual comparison, also showed no significant difference. It was found that Group C had higher microleakage than Group A & B (Table- 3).

2) **Adhesive-Bracket Interface**

Table 1: Comparison of micro leakage under orthodontic brackets (Metal brackets) bonded to teeth using three different types of primers (Group A - Conventional, Group B – Self-etching, Group C – Moisture Insensitive Primer) respectively at the occlusal adhesive interface.

Enamel- adhesive Interface (occlusal)	Mean	SD	p
GroupA (Conventional)	0.124	0.417	0.278
GroupB(Selfetching)	0.137	0.353	
Group C(Moisture Insensitive)0	0.039	0.151	
Mann Whitney test to find a pairwise individual comparison			
Group	Comparison Group	Mean Difference	p
Group A (Conventional)	Group B (Self etching)	0.013	0.979
	Group C (MoisturInsensitive)	0.085	0.397
Group B (Selfetching)	Group C(Moisture Insensitive)	0.098	0.294

***p<0.05 – significant difference** ****p<0.001 – highly significant difference**

Table 2: Comparison of microleakage under orthodontic brackets (Metal Brackets) bonded to teeth using three different types of primers (Group A - Conventional , Group B – Self-etching, Group C – Moisture Insensitive Primer) respectively at occlusal adhesive –bracket interface

Adhesive - bracket Interface (occlusal)	Mean	S.D	p-value
GroupA (Conventional)	0.0066	0.046	0.028*
GroupB(Self etching)	0.00	0.00	
Group C (MoistureInsensitive)	0.027	0.107	
Tukey's post hoc test to find a pairwise individual comparison			
Group	Comparison Group	Mean Difference	p
Group A (Conventional)	Group B (Self etching)	0.0066	0.878
	Group C (Moisture Insensitive)	0.02	0.041*

Group B (Self-etching)	Group C (Moisture Insensitive)	0.27	0.008*

*p<0.05 – significant difference **p<0.001 – highly significant difference

Table 3: Comparison of microleakage under orthodontic brackets (Metal brackets) bonded to teeth using three different types of primers (Group A - Conventional , GroupB – Self-etching, Group C – Moisture Insensitive Primer) respectively at gingival enamel- adhesive interface.

Enamel - Adhesive Interface (Gingival)	Mean	S.D	p-value,
Group A (Conventional)	0.116	0.334	p =0.867,NS
Group B (Self etching)	0.087	0.270	
Group C (Moisture Insensitive)	0.123	0.349	

Tukey's post hoc test to find a pairwise individual comparison			
Group	Comparison Group	Mean Difference	p-value
Group A (Conventional)	Group B (Self etching)	0.029	0.892,NS
	Group C (Moisture Insensitive)	0.007	0.993,NS
Group B (Selfetching)	Group C (Moisture Insensitive)	0.036	0.838,NS

*p<0.05 – significant difference **p<0.001 – highly significant difference

Table 4: Comparison of microleakage under orthodontic brackets (Metal brackets) bonded to teeth using three different types of primers (Group A - Conventional , Group B – Self-etching, Group C – Moisture Insensitive Primer) respectively at gingival adhesive –bracket interface.

Enamel - Adhesive Interface (Gingival)	Mean	S.D	p-value,
Group A (Conventional)	0.016	0.06	0.551,NS
Group B (Self etching)	0.0048	0.033	
Group C (Moisture Insensitive)	0.01	0.041	
Tukey's post hoc test to find pair wise individual comparison			
Group	Comparison Group	Mean Difference	p value

Group A (Conventional)	Group B (Self-etching)	0.011	0.481
	Group C (Moisture Insensitive)	0.006	0 811
Group B (Self-etching)	Group C (Moisture Insensitive)	0.005	0.855

*p<0.05 – significant difference **p<0.001 – highly significant difference

There was no statistically significant difference (p>0.05) among the three groups at gingival adhesive – bracket interface (Table 4) On using Mann- Whitney test to find pairwise individual comparison; it was found that Group C had higher microleakage (Table-4).

DISCUSSION

Microleakage is defined as the seeping and leaking of fluids and bacteria between the tooth-adhesive interfaces.[9] The photopolymerization shrinkage of the adhesive material may cause gaps between the adhesive-enamel interfaces leading to microleakage.

Thermal expansion is another factor that affects adhesion between the adhesive material and enamel surface.[12] The difference in coefficients within the bracket-adhesive-enamel mixed results in different dimensional changes during temperature variations that may produce fractures, cracks resulting in microleakage. Microleakage increases the likelihood of recurrent caries, postoperative sensitivity, and white spot lesions and decreases the bond strength. So, it's important to assess the microleakage to overcome the complications. Results of this study showed that some amount of microleakage was found in all three groups on all sides and interfaces. However, on pairwise individual comparison microleakage under occlusal side at enamel -adhesive- interface, group B showed higher microleakage than group A and group C. The mean difference of group B is 0.013 with group A &0.098 with group C.

Conventional bonding is most commonly used procedure for bonding but, it is time-consuming procedure because of series of steps that have to be followed for its execution, namely acid etching, primer application, and the bonding itself.[15,4-7]To simplify the procedure and to reduce the time self-etching primer (SEP) products which use a mixture combining acid and primer into one solution are introduced. According to White [19], SEPs are easily manipulated and used, resulting in comfort for the patients and decreasing the chair time by 65%. Transbond Plus Self-Etching Primer (TPSEP, 3M Unitek, Monrovia, Calif) is a sixth-generation adhesive composite developed for orthodontic bonding whose chemical formulation is similar to that of phosphoric acid, although its solid matrix is formed by two chains. The same monomer that causes acid etching also allows for primer penetration. This results in the careful preparation of the enamel with the placement of the primer into the demineralized region at the same time. [19] In addition; the penetration involves the entire area of the previously etched enamel without requiring the traditional washing after acid application. [7]

The presence of resin tags prepared at the enamel surface by acid etching is an important factor to fight microleakage. [8]The minimal etch obtained by Self-etching primer gives lower bond strength and greater microleakage. The etching pattern is not deep enough to obtain good penetration of bonding resin. [21] Resin tag penetration in self-etching is less, i.e. approximately 5µm wherein conventional primer has a shallow etching pattern with resin penetration depth 10-25 µm. [8]

A study conducted by Tancan et al.,[18] in 2008,where microleakage was assessed under metal and ceramic brackets using self- etching primer system in which, self -etching primer system revealed significant higher microleakage at the enamel-adhesive interface of the gingival side.[18] These findings coincided with the present study

On pair wise individual comparison mean microleakage at occlusal adhesive-bracket interface was compared between group A, group B, group C there was a statistically significant difference (p~0.041 and p~0.008) among the three groups. Where group C showed the highest microleakage, followed by group A and least in group B.

Although the direct bonding of Orthodontic attachments has improved the clinical practice of an Orthodontist, moisture contamination still is a problem, especially while bonding posterior teeth and in case of surgically exposed impacted teeth.[14]A reduction in bond strength of resins to etched enamel after moisture and saliva contamination has been reported by several researchers.[3] Bond strength is significantly lower under wet conditions, and the advent of Hydrophilic primers such as Moisture-Insensitive primer overcame this difficulty Moisture insensitive primer has hydrophilic components such as HEMA, which allow a lower contact angle and extension of the molecule, which readily bonds to the resin composite. It offered adequate bond strength under contaminated conditions.

In the present study, bond strength was not assessed. However, bond strength is inversely related to microleakage, i.e. more bond strength less microleakage. An ideal adhesive which provides high bond strength should show less microleakage.

A study conducted by Rajagopal et al. in 2004, [14] differed from the present study, which evaluated and compared the shear bond strength of self-etch primer (Transbond plus), MIP, and conventional (Transbond XT) primer under both dry and contaminated conditions. He concluded in his study that MIP and self-etching primer offered adequate bond strength under contaminated conditions also. Self-etch primer displayed superior performance under dry compared with contaminated conditions

When microleakage at the gingival enamel-adhesive interface was compared between groups using Mann-Whitney test for pairwise individual comparison, it was observed that Moisture insensitive primer 3M showed more microleakage (0.043 mm) than other two groups but the difference was not found to be statistically significant.

Microleakage is observed in the present study, but they are no literature evidence to support the microleakage assessment of MIP, as numerous studies have evaluated only the bond strength of MIP.

When there is a pairwise individual comparison of microleakage using Mann Whitney test between at gingival adhesive- bracket interface Moisture insensitive primer 3M showed more microleakage than other two groups, but the difference was not found to be statistically significant.

CONCLUSION

The three primers Transbond XT light cure adhesive primer 3M, Transbond plus self-etch primer 3M, Transbond Moisture insensitive primer 3M have given satisfactory comparative results for microleakage.

Based on the observational analysis, this study reports maximum microleakage incidences with Transbond Moisture insensitive primer 3M followed by Transbond plus self-etch primer 3M and Conventional Transbond XT light cure adhesive primer3M.

Clinical relevance

Three primers are ideal for bonding as required in different clinical circumstances; care should be taken to minimize the possibility of microleakage by strictly following the recommended protocols.

CONFLICTS OF INTEREST

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

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