A MICROLEAKAGE STUDY OF CLASS V RESTORATIONS USING THREE SELF-ETCHING ADHESIVES AND MICROFILL COMPOSITE RESIN—AN IN VITRO STEREO MICROSCOPIC STUDY

1 Vivekananda Reddy K  
2 Vamsi Krishna D V V  
3 Madhusudhana K

1, 3 Department of Endodontics, 2 Department of Prosthodontics, Narayana Dental College and Hospital, Nellore, Andhra Pradesh, India

ABSTRACT:  Aim: This study evaluates marginal sealing ability of currently available three self-etching adhesives in class V micro fill composite restorations. Materials and methods: Forty five human central incisors, divided in to three groups and class V cavities were prepared on the facial surface of teeth with occlusal margin in enamel and gingival margin in dentin/cementum. The cavities were restored with microfill composite in two increments using three different adhesives, Adper prompt (3M Dental products), AdheSE (Ivoclar Vicadent) and I-Bond (Heraeus Kulzer). Each group containing fifteen teeth were subjected to thermocycling and dye penetration. The teeth were milled and sectioned buccolingually with a hard tissue microtome, the two sections from each tooth obtained from the both mesial and distal acute angles of the cavity preparation, examined under stereomicroscope. The values were analyzed with Chi-Square test and Fisher exact. Results: The results show less leakage in enamel and dentin margin for AdheSE. This is significantly less than Adper Prompt and I-Bond which showed no statistically significant difference. Conclusion: At enamel and dentin/ cementum margins, two step self etch adhesive AdheSE performed better than one step self etch adhesives Adper Prompt and I-Bond.

KEYWORDS: Microleakage, self etch adhesives, Microfill composites

INTRODUCTION

The elimination for leakage around the restorations has long been a goal of dentistry. Microleakage, the marginal permeability to bacteria, chemical, and the molecular invasion at the interface between the teeth and restorative materials, remain a problem with composite resin restorations. The most significant factor in determining resistance to recurrent caries, post operative sensitivity, marginal staining, and pulpal damage is the ability of a restorative material and adhesive to seal the restorative interface with the adjacent tooth substrate. Gap formation and concomitant leakage of bacterial fluids, molecules and ions are brought about by dimensional changes such as polymerization contraction, thermal expansion and incomplete hygroscopic expansion. Microleakage at enamel and restoration interface has been practically eliminated since the introduction of acid etching by Buonocore in 1995. But sealing of dentin margins still remains a challenge.

Resin composites are widely used for restoring cervical lesions, as they are esthetic, mercury free and bond to tooth structure with the use of bonding system. Unfortunately, the coefficient of linear thermal expansion of resin composites is three or four times that of tooth structure. In addition to the differences in the thermal expansion of resin composites is three or four times that of tooth structure. In addition to the difference in the thermal expansion coefficients, the shrinkage of composites during curing induces stresses at the tooth/restoration interface and generally results in gap formation. Therefore, polymerization shrinkage and the thermal expansion coefficient of these restorative materials have been suggested as major causes of microleakage. Micro fill resin based composites have been recommended for class V restorations. The relatively low young’s modulus of microfill resin based composite may allow plastic deformation to compensate for induced strain, avoiding restoration displacement and maintaining the seal the margins.

Most bonding systems use acidic conditioners, these are generally designed to remove the smear layer and demineralize the dentin surface, it would see desirable to reduce the acid concentration and/or the application time to the minimum required to obtain maximum microleakage. When dentin is conditioned, the superficial dentin is decalcified, leaving a rich organic area primarily collagen.

Primer materials used after, or in conjunction with, acid conditioners are essentials for achieving good wetting and penetration through demineralized area. A
modern approach to dentin adhesion is the use of acidic primers. Also called self etching primers. These primers simplify clinical adhesive procedures by combining the acid conditioning of dentin with priming step. Thus, with self etching dentin primers, the acid and primer are combined in one solution to form an acidic monomer.12,13.

Theoretically, in these systems, the acidic part of the primers dissolves an incorporates the smear layer in to the mixture, as it demineralize and dentin and encapsulates the collagen fibers and hydroxyapatite crystals.14. The aim of the study was to evaluate marginal sealing ability of currently available three self etching adhesives in class V micro fill composite restorations.

Materials and Methods

Forty five caries free extracted human maxillary central incisors were selected for this study. The age group of the patients is 30-40 years, and the reason for extraction being periodontal compromised teeth. The teeth were cleaned of gross debris and stored in 0.5% chloramines solution for infection control purposes, except for 24 hours before beginning the experiment, and then they were kept in distilled water. (Fig.1)

A class V cavity preparation was cut on the facial surface, centered at the cement enamel junction using a #271 carbide bur at high and 1.5 mm deep. Each bur is replaced every 5 cavity preparations (Fig.2). The preparations were located half in enamel and half in Dentin/Cementum. The incisal margin was in enamel and the gingival margin was in Dentin/Cementum. The incisal margin on the enamel was beveled (45°, 0.5mm ) with fine tapered diamond point. After preparation, the teeth were randomly assigned in to three groups of 15 specimens each. The bonding system used: adper prompt (3M Dental products), AdheSE (Ivoclar Vivadent) and I-Bond (Heraeus Kulzer). All adhesive systems used were according to manufacturer’s recommendations. The preparations were restored with a microfill composite (Ivoclar Vicadent) in two increments with incisal increment place first. Each composite increment was for 40 seconds with a selector LA 500 visible-light-curing unit (APOZA Enterprise Ltd.). The restorations were finished with a foot ball finishing bur and shofu super snap mini kit (shofu). To prevent any possible leakage, the apices of the teeth were sealed with cold cure acrylic resin.
The samples were coated with a nail polish except for the restorations and a 1 mm rim of tooth structure around the restorations. The specimens were placed in distilled water at 37°C for 48 hours and then thermo cycled 500 times in a thermo cycling machine. The cycles consisted of 26 seconds in baths of 50°C and 55°C with an exchange time of 13 seconds between baths. (Fig.3) After 48 hours, the specimens were immersed in methylene blue for 24 hour. Following the removal from the solution, the specimens were rinsed in tap water for 5 minutes to remove excess dye. The teeth were mounted in a cold cure acrylic resin and sectioned labiolingually with a hard tissue microtome (Leice SP 1600) to obtain two sections of approximately 1000 microns (Fig.4). The two sections from each tooth obtained from both mesial and distal acute angles of the cavity preparation. All sections were examined under a stereomicroscope at 30 x magnification. (Fig.5, Fig.6 and Fig.7) The values were analyzed with chi-square test and fisher exact. The degree of dye penetration was scored according to criteria described by Khera and Chan:

1. Less than and up to half of the depth of the cavity preparations.
2. More than one half of the depth of the cavity preparation.
3. Leakage up to but not including the axial wall.
4. Leakage involving axial.

Results

‘No leakage’ in AdheSE is significantly more when compared to I Bond (P=0.038) and No leakage is also more in AdheSE. When compared to Adper prompt with p=0.176. No significant difference between ADPER PROMPT AND I Bond with p=0.671. No significant difference between Adper prompt and I Bond with p=0.671 are shown in Table 1. No leakage in AdheSE is significantly more when compared to I Bond (P=0.044) and No leakage is also more in AdheSE when compared to Adper prompt with p=0.301. No significantly difference between Adper Prompt and I Bond with p=0.612 are shown in Table 2. Comparison of enamel and dentin between three self etch adhesives is shown in Table 3.

Discussion

Restoration of class V cervical lesion is indicated to treat caries and loss of tooth structure through mechanical abrasion, erosion and abfraction. Restoration cervical lesions with resin composites have always been a problem, especially where no enamel is present for bonding to the gingival margin. The higher organic component, tubular structure, fluid pressure and the lower surface energy of dentin make bonding to dentin more difficult than enamel.

Poor adhesion between dentin and restorative material predisposes gap formation. Marginal gap leads to leakage, which may be responsible for secondary caries, marginal discoloration, pulpal inflammation and hypersensitivity. The evaluation of dentin bonding agents in mixed class V cavity preparations is very challenging, because generally the stronger enamel bonds compete with bond to dentin. The difference in polymerization shrinkage and coefficient of expansion can exert significant forces at restorative material/tooth interface resulting in bond failure and gap formation.
Table I. Comparison of three materials for enamel

<table>
<thead>
<tr>
<th>Enamel</th>
<th>Adper Prompt (n=30)</th>
<th>AdheSE (n=30)</th>
<th>I BOND (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Leakage</td>
<td>4 (12.90)</td>
<td>8 (26.67)</td>
<td>2 (6067)</td>
</tr>
<tr>
<td>Leakage upto half of the cavity</td>
<td>4 (12.90)</td>
<td>12 (40.00)</td>
<td>6 (20.00)</td>
</tr>
<tr>
<td>Leakage more than half of the cavity</td>
<td>9 (30.00)</td>
<td>5 (16.67)</td>
<td>9 (30.00)</td>
</tr>
<tr>
<td>Leakage upto Axial wall</td>
<td>10 (32.26)</td>
<td>3 (10.00)</td>
<td>8 (26.67)</td>
</tr>
<tr>
<td>Leakage involving Axial wall</td>
<td>3 (9.67)</td>
<td>2 (6067)</td>
<td>5 (16.67)</td>
</tr>
</tbody>
</table>

Inference: ‘No leakage’ in AdheSE is significantly more when compared to I Bond (P=0.038) and No leakage is also more in AdheSE when compared to Adper Prompt with p=0.176. No significant difference between Adper Prompt and I Bond with p=0.671.

Table II. Comparison of three materials for dentin

<table>
<thead>
<tr>
<th>Enamel</th>
<th>Adper Prompt (n=30)</th>
<th>AdheSE (n=30)</th>
<th>I BOND (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Leakage</td>
<td>3 (9.67)</td>
<td>6 (20.00)</td>
<td>1 (3033)</td>
</tr>
<tr>
<td>Leakage up to half of the cavity</td>
<td>7 (23.33)</td>
<td>6 (20.00)</td>
<td>7 (23.33)</td>
</tr>
<tr>
<td>Leakage more than half of the cavity</td>
<td>10 (32.26)</td>
<td>11 (36.67)</td>
<td>7 (23.33)</td>
</tr>
<tr>
<td>Leakage up to Axial wall</td>
<td>7 (23.33)</td>
<td>2 (6.67)</td>
<td>9 (30.00)</td>
</tr>
<tr>
<td>Leakage involving Axial wall</td>
<td>3 (9.67)</td>
<td>-</td>
<td>5 (16.67)</td>
</tr>
</tbody>
</table>

Inference: ‘No leakage’ in AdheSE is significantly more when compared to I Bond (P=0.044) and No leakage is also more in AdheSE when compared to Adper Prompt with p=0.301. No significant difference between Adper Prompt and I Bond with p=0.612.

Table III. Comparison of enamel and dentin between three self etch adhesives

<table>
<thead>
<tr>
<th>Enamel</th>
<th>Adper Prompt (n=30)</th>
<th>AdheSE (n=30)</th>
<th>I BOND (n=30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Leakage</td>
<td>4 (12.90)</td>
<td>8 (26.67)</td>
<td>2 (6067)</td>
</tr>
<tr>
<td>Leakage up to half of the cavity</td>
<td>4 (1.90)</td>
<td>12 (40.00)</td>
<td>6 (20.00)</td>
</tr>
<tr>
<td>Leakage more than half of the cavity</td>
<td>9 (30.00)</td>
<td>5 (16.67)</td>
<td>9 (30.00)</td>
</tr>
<tr>
<td>Leakage up to Axial wall</td>
<td>10 (32.26)</td>
<td>3 (10.00)</td>
<td>8 (26.67)</td>
</tr>
<tr>
<td>Leakage involving Axial wall</td>
<td>3 (9.67)</td>
<td>2 (6.67)</td>
<td>5 (16.67)</td>
</tr>
</tbody>
</table>
Microleakage has been defined as being defined by siddu and Henderson14 as “The clinical undetectable passage of bacterial fluids, molecules or ions between a cavity wall and the restorative material applied to it”. According to Khara and Chair16 the acute angles of cavo surface margin had dramatically more marginal leakage than the middle of the cavity I class V restorations.

The use of organic dye as tracer is one of the most common methods of detecting micro leakage invivo. The same was followed in this study and micro leakage was evaluated taking two sections from the acute angle of the restorations.

Over the last decade, the classic concept of three step bonding to dental tissues has developed rapidly and has become more user-friendly with simplified adhesive systems. These comprise the two step etch and rinse, two step self etch and on e step self etch adhesives. The last category of adhesive has been further reduced to single bottle system for simpler and faster application. The adhesion mechanism of self etching bonding agent is based on smear layer penetration, demineralization of superficial underlying substrate and monomer diffusion enhancement in to dematerialized dentin, facilitating hybrid layer formation. Therefore fewer steps are necessary to perform adhesive restoration. Multiple treatment steps are routinely required with many dental adhesive systems. Combining the conditioning and priming steps in to a single treatment step for both enamel and dentin is an obvious improvement in adhesive dentistry. The time saved and clinical efficiency of combined conditioner and primer is certainly as significant advantage, when compared to the multiple step adhesive systems currently available.

The purpose of the present invitro study was to evaluate the marginal seal of three self etching adhesives on class V micro filled composite restorations. The three adhesive systems used were 1) Adper prompt 2) AdheSE 3) I-Bond in class V cavity in a human central incisor. Adper prompt and I-Bond are one step self etch adhesives.

In enamels margins, AdheSE showed less degree of micro leakage when compared to Adper prompt and I-Bond. Three was statically significant difference between AdheSE & Adper prompt and AdheSE and I-Bond. But there is no statically significant difference between Adper prompt and I-Bond. It is probable attributed to the fact that the one step self etch adhesives are more susceptible for water sorption. In the absence of a coupling hydrophobic bonding agent, they behave as permeable membrane after polymerization17,18. This may expedite water sorption between the partially demineralized enamel and restorative material, plasticizing and eventually weakening the bonded enamel interfaces.

Because of the high concentration of hydrophilic and acidic resin monomers, low film thickness, and lack of more hydrophobic coupling resin layers, one step self etch adhesives has been reported to behave as permeable etch membrane after polymerization.

Although Adper prompt creates hybrid layers that approach the thickness of those created by adhesive systems that utilize phosphoric acid etching, lack of frank resin tags is responsible for their compromised marginal quality. I-Bond, ability to etch completely through the enamel smear layer produced thin, incomplete hybridization of the subsurface prismatic enamel.

In dentin margins, the present study demonstrated statically significant difference between Adper prompt & AdheSE and AdheSE & I-Bond. There is no statistically difference between Adper prompt and I-Bond. The two step adhesive system AdheSE showed less leakage than one step adhesives Adper Prompt and I-Bond. This may be due to differential water movement across the cured adhesive layer which occur in the presence of increased concentrations of dissolved electrolytes, such as calcium and phosphorous ions derived from the self etching process, uncured, water soluble hydrophilic resin monomers, or dissolved collagen/ proteoglycans components that are concentrated along the oxygen inhibition layer of the cured adhesive. This concentration difference may establish an osmotic pressure gradient, causing water movement form a region of low solute concentration (dental tubule in hydrated dentin substrate) to a region of high soute concentration (the adhesive composite interface). This in turn, may result in osmotic blistering of microscopic water droplets beneath the uncured hydrophobic composites21. “Water trees” (i.e., inter connecting water filled channels) were absent in the interfaces created by two step self etch adhesives. This is probable because the water containing self etch primer component was air thinned, dehydrated and subsequently, covered with a usually solvent free, less hydrophilic intermediate layer, which renders two step self etch adhesives considerably less permeable than the simplified on step systems20. The nanoleakage that was seen in the hybrid layers of the latest simplified self etch adhesives may be attributed to the combined adverse effect of evaporative, osmotic, and possibly convective water fluxes that result in an outward fluid movement from both intertubular dentin and dentinal tubules22. When HEMA is absent, phase separation of the adhesive components occurs on the addition of water to an adhesive layers of dentin bonded with the latest no-HEMA containing single bottle type, one step self etch adhesives23,24. The hydrophilicity and permeability of one step self etch adhesives may also hasten the rate of water sorption, hydrolytic degradation of the hydrophilic resin components and challenge the longevity of bonds made by adhesives.
CONCLUSION

Within limits of this study, the following conclusions were drawn.

- All adhesive under investigation exhibited a certain amount of microleakage in enamel and dentin.
- At both enamel and dentin margins, two steps self etch adhesive AdherSe performed better than one step self etch adhesives Adper prompt and I-Bond.

At both enamel and dentin margins, there is no significant difference in micro leakage between Adper prompt and I-Bond.

References


Corresponding Author

Dr. K. Vivekananda Reddy, MDS
Reader, Department of Conservative Dentistry and Endodontics,
Narayana Dental college, Nellore, Andhra Pradesh-625104
Email: vivek_bds@yahoo.com
Phone No: 91 9908322007