Sealing ability of newer generation bonding agents in primary teeth - an in vivo study

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Abstract

Aim: The purpose of the study was to compare the ability of Xeno III (sixth generation dentin bonding agent) to iBond (seventh generation dentin bonding agent) in reducing microleakage around class V composite resin restorations in primary teeth.

Methods: Twelve healthy, cooperative children, between 8-11 years of age, with non-caries primary canines indicated for extraction for orthodontic purposes, were selected for this study. Each child had class V cavities prepared on the facial surfaces of his or her upper and/or lower canines. Xeno III was used in Group I (15 teeth) and iBond was used in Group II (15 teeth). All the cavities were restored using the same composite material (Esthet X). All teeth were extracted one month later, immersed in 2% basic fuchsin dye, sectioned and evaluated under stereomicroscope for dye penetration.

Results: No statistically significant difference was found in the degree of microleakage between the two materials.

Conclusion: The two adhesives tested in this in vivo study, Xeno III and iBond, performed equally well in terms of microleakage in primary teeth. Considering the single step application of iBond with similar efficacy, without requiring the additional mixing step of Xeno III, it would be more convenient to use the seventh generation adhesive for restorative treatment in pediatric patients.

KEYWORDS: Microleakage, self-etching adhesives, primary teeth

Introduction

The demands made of a restoration in the primary dentition are somewhat different from those in the permanent dentition. This is due in part, to the limited lifespan of the teeth themselves, to the variable levels of cooperation achieved by children and to the different morphology of primary molars. Composite resin is the most aesthetic restorative material currently available for restoring anterior teeth. However, problems still exist in terms of polymerization shrinkage and subsequent inadequate adhesion to cavity walls, which leads to microleakage.¹ In pediatric dentistry there is an increasing demand for the aesthetic benefits of adhesive dentistry.²,³ One of the advantages of the associated minimally invasive cavity designs omitting the traditional “extension for prevention” is to further preserve sound dental tissues.⁴,⁵

Composite resin restorations are technique sensitive and have been documented to have a high failure rate in primary teeth.²,⁵ This is partly due to lack of cooperation in small children, leading to inadequate tooth isolation and subsequent higher incidence of marginal leakage. Microleakage is defined as the clinically undetectable passage of bacteria, fluids, molecules or ions between a cavity wall and
The inability of a restorative material to adapt or adhere tightly to dental hard tissues is what creates the gaps allowing microleakage to occur. Microleakage at the tooth-restoration interface is considered to be a major factor influencing the longevity of a dental restoration. Some of the sequelae of microleakage include tooth discolouration, accelerated deterioration of restorative materials, secondary caries, pulp pathology and post operative tooth sensitivity.¹

The three step bonding systems are often considered to be too complicated and time consuming, especially in pediatric dentistry, and tend to be replaced by so-called "self-etching" or sixth generation adhesives. Self-etching agents are applied directly to the tooth without rinsing or drying, thus eliminating potential problems related to collagen fiber collapse after conditioning.⁸ Another advantage of the simultaneous etching and priming is the elimination of the possible contamination of an etched and unprimed dentin surface.⁹ These systems were also reported to reduce the incidence of post treatment sensitivity sometimes encountered in previous systems,¹⁰ even though the bond strength to enamel and dentin was lower than with the fourth-generation and fifth-generation systems.¹¹ A further modification was introduced combining etchant, primer, and adhesive in a single bottle, thus eliminating the additional mixing and/or placement step over the sixth generation systems. This new, simplified adhesive system is the seventh generation of adhesive materials.

When using the dentinal bonding systems, the problems of microleakage, postoperative sensitivity and inadequate adhesion of composite resins have been improved in the permanent dentition.¹² However, there still exists a problem with dentin bonding systems when used in primary teeth.¹³¹⁴

Most of the earlier generations of dental adhesive systems required several steps like etching, priming and bonding. Dental procedures by themselves generally tend to be stressful and technique sensitive. If some of the steps are eliminated or simplified it will result in saving treatment time and will maximize patient comfort. This is of great advantage in pediatric dentistry because children are less patient to time consuming procedures. The multiple steps of bonding procedure will make them even more impatient and since these materials are technique sensitive it can result in failure of the restoration.

The sixth generation adhesives provided better seals, in vitro, than the seventh generation adhesives in primary teeth.¹⁵ There are very few in vivo studies on dentin adhesives in primary teeth. It is imperative to have a clinical basis of the effectiveness and durability of the newer generations of dentin bonding agents before they are put into regular use in pediatric dentistry. The aim of this study was to compare the ability of Xeno III (sixth generation dentin bonding agent) to iBond (seventh generation dentin bonding agent) in reducing microleakage around class V composite resin restorations in primary teeth in vivo.

METHODS

PATIENT SELECTION

Twelve healthy, cooperative children, between 8-11 years of age, who reported in the Department of Pedodontics, Government Dental College, Trivandrum for routine dental examination and treatment were included in the study. Each selected child had at least two sound antimere primary canines indicated for serial extraction. The study included 30 non carious primary canine teeth from 12 patients. The selected teeth were divided into two experimental groups: Group I and Group II. Xeno III was used for the teeth in Group I and iBond was used for the teeth in Group II. In each patient, the cavity preparations on one side were restored using Xeno III and those on the antimere teeth were restored using iBond. Ethical approval for the study was obtained from the Medical College Ethical Committee, Trivandrum.

INCLUSION CRITERIA

Only those patients fulfilling the following criteria were included in the study:

1. Children between 8-11 years of age with Angle’s class I malocclusion with crowding in the maxillary and/or mandibular anterior regions.

2. Patient was in good general health and free of any systemic diseases including congenital heart disorders, bleeding disorders, etc.

3. The teeth included in the study were free of caries, hypoplastic defects or any malformations.

4. No appreciable mobility of the tooth to finger pressure and the tooth was free of any periodontal problems.

CAVITY PREPARATION

Class V cavities were prepared in the middle of the facial surface of antimeres maxillary and/or mandibular primary canines. Two maxillary canines were used in one child, two mandibular canines in eight children, and all four canines in the remaining three children. Oval cavities (2x1.5mm) with 1.5 mm depth were prepared using diamond burs in a high-speed handpiece with water cooling. The length of the bur was...
used as a guide for the cavity depth. A new bur was used for cavity preparations in each patient.

RESTORATION

Xeno III was used in Group I (15 teeth) and iBond was used in Group II (15 teeth). The adhesive systems were applied strictly according to the manufacturers' instructions. All the cavities were restored using the same composite material (Esthet X). The patients were kept under observation and recalled after four weeks.

MICROLEAKAGE EXAMINATION

The two antimere primary canines were extracted 4 weeks after restoration. The root apices were sealed with sticky wax. All the tooth surfaces except the restoration and a 1mm zone adjacent to its margins were covered with two coats of nail varnish. The teeth were immersed in 2% aqueous solution of Basic Fuchsin dye for 24 hours at room temperature. After removal from the dye, the teeth were washed, dried and sectioned labiolingually through the middle of the restoration using a water-cooled diamond disc. The sections were examined at Sree Chitra Tirunal Institute for Medical Sciences and Technology, Biomedical Technology Wing, Trivandrum, using a stereomicroscope (Leica, MZ6, Germany) at 40x magnification. Photographs were taken to assess dye penetration at the margins of each restoration. All the procedures were performed by the same investigator.

The degree of microleakage was evaluated and scored as follows:

Score 0 = no dye penetration (Fig. 1)

Score 1 = dye penetration along the incisal or gingival wall less than the total length of the wall (Fig. 2)

Score 2 = dye penetration along the entire length of the incisal or gingival wall (Fig. 3)

Score 3 = dye penetration along the entire length of the incisal or gingival wall as well as the axial wall (Fig. 4)

Both halves of the sectioned teeth were examined according to the above criteria. The half that exhibited the most leakage was scored. The degree of microleakage in the two groups was compared using the Mann-Whitney U test. The difference in the degree of microleakage between the incisal and gingival walls in the same group was tested using the Wilcoxon Signed Rank test. The level of significance used was set at p<0.05.

RESULTS

The frequency of the microleakage scores in Group I and Group II at the incisal and gingival walls are
shown in table 1 and table 2 respectively.

The degree of microleakage in the two groups was compared using the Mann-Whitney U test and the results are detailed in table 3. No statistically significant differences were found in microleakage between the two materials in the two groups (p>0.05). The difference in the degree of microleakage between the incisal and gingival walls in the same group was tested using the Wilcoxon Signed Rank test and the results are detailed in table 4. No statistically significant differences were found between the microleakage scores at the incisal and gingival walls in both groups (p>0.05).

**Table 1.** Microleakage scores for Group I (n = 15) at the incisal and gingival walls

<table>
<thead>
<tr>
<th>Site</th>
<th>Microleakage scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Incisal</td>
<td>11</td>
</tr>
<tr>
<td>Gingival</td>
<td>9</td>
</tr>
</tbody>
</table>

**Table 2.** Microleakage scores for Group II (n = 15) at the incisal and gingival walls

<table>
<thead>
<tr>
<th>Site</th>
<th>Microleakage scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Incisal</td>
<td>8</td>
</tr>
<tr>
<td>Gingival</td>
<td>7</td>
</tr>
</tbody>
</table>

**Table 3.** Comparison of microleakage scores between Group I and Group II at the incisal and gingival walls using the Mann-Whitney U test

<table>
<thead>
<tr>
<th>Site</th>
<th>U</th>
<th>P</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incisal</td>
<td>87.0</td>
<td>0.358</td>
<td>NS*</td>
</tr>
<tr>
<td>Gingival</td>
<td>87.5</td>
<td>0.399</td>
<td>NS*</td>
</tr>
</tbody>
</table>

**Table 4.** Comparison of degree of microleakage between incisal and gingival margins in Group I and Group II using the Wilcoxon Signed Rank test

<table>
<thead>
<tr>
<th>Group</th>
<th>Z</th>
<th>P</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>1.414</td>
<td>0.157</td>
<td>NS*</td>
</tr>
<tr>
<td>Group II</td>
<td>1.633</td>
<td>0.102</td>
<td>NS*</td>
</tr>
</tbody>
</table>

NS* - Not significant (p>0.05)

**DISCUSSION**

A major goal in restorative dentistry is the control of marginal leakage, which may occur because of dimensional changes or lack of adaptation of the restorative material to the cavity preparation. Microleakage mainly occurs as a result of polymerization shrinkage of the composite resin. Other factors, such as the difference in coefficient of thermal expansion between the resin and tooth structure or the presence of voids or porosities in the resin, may contribute to microleakage.

Microleakage is used by clinicians and researchers as a measure for assessing the performance of restorative materials in the oral environment. Numerous investigations have used a variety of research tools to evaluate the extent of microleakage and the marginal integrity of restorations. Dye penetration measured on sections of restored teeth is the most common technique for evaluating microleakage at the tooth-restoration interface.

Many controversies are found in the literature when comparing in vivo and in vitro microleakage testing and whether the results from in vitro investigations can be applied to clinical situations. In vitro studies are more prone to dye penetration at the resin-tooth interface than in vivo studies. However, in vitro studies are useful but may not reproduce the materials performance in vivo. The current study was performed in vivo to study the effect of the oral environment on the sealing ability of the two self-etching adhesive systems, Xeno III and iBond.

Three adhesion mechanisms are currently used in modern adhesive procedures, depending on the treatment of the smear layer produced during cavity preparation. In the first group, the smear layer is modified and incorporated in the bonding process. In the second group, the smear layer is completely removed. In the third group (self-etching primers), the smear layer and the underlying dentin surface are
partially demineralized without removing the dissolved smear layer remnants or unplugging the tubule orifices. In these systems, the bonding agent was mixed together with the self-etching primer before a single application (Xeno III). Recently, an innovation was introduced combining etchant, primer and adhesive in a single bottle (iBond).

Depending on the pH and etching aggressiveness, the self-etching effect can be classified as “strong”, “moderately strong” and “mild”. Some new adhesives such as Xeno III and iBond are referred to as “moderately strong” self-etch adhesives. Their pH is about 1.5. These adhesives are more acidic than the “mild” self-etch adhesives, so that a better micromechanical interlocking is achieved at the enamel and the dentin.

The present study revealed no statistically significant differences in the degree of microleakage between Xeno III and iBond. This finding is supported by another in vitro investigation, which has suggested that the margin-gap sealing of iBond, the seventh generation, one bottle dentin bonding agent, is similar to other latest-generation dentin adhesive systems.

Even though there were more microleakage scores at the gingival margins, no statistically significant differences were recorded in the degree of microleakage between the incisal and gingival margins for the two materials in the present study. This finding is in agreement with some authors who have reported similar findings in primary teeth, but contradicted the belief that cervical margin microleakage is always severe compared with enamel margins.

The two adhesive systems, Xeno III and iBond, evaluated in the present study were unable to completely prevent microleakage of the class V restorations. Both the incisal and gingival margins exhibited some degree of dye penetration, which indicated that a hermetic seal did not exist. This suggestion is supported by other studies which have reported the existence of microleakage in the evaluation of different dentinal bonding agents.

CONCLUSIONS

This in vivo study concluded that:

1. The two adhesives tested in this in vivo study, Xeno III and iBond, performed equally well in terms of microleakage in primary teeth.
2. Neither of the two adhesive systems was able to completely prevent microleakage around class V composite resin restorations.

For both Xeno III and iBond, there was similar degree of microleakage at the incisal and gingival margins of the class V cavities.

Considering the single step application of iBond with similar efficacy, without requiring the additional mixing step of Xeno III, it would be more convenient to use the seventh generation adhesive for restorative treatment in pediatric patients. Further long term clinical trials need to be carried out to assess the sealing efficacy of these new dentin adhesives.

REFERENCES


