In-vivo evaluation of microleakage of nano-filled resin composite using two different restorative techniques
IN-VIVO EVALUATION OF MICROLEAKAGE OF NANO-FILLED RESIN COMPOSITE USING TWO DIFFERENT RESTORATIVE TECHNIQUES

¹FARIHA NAZ, BDS, FCPS  
²SHAHID MAHMOOD, MDS  
³BENA NAQI, BDS

ABSTRACT

The study was carried out to evaluate and compare dentine margin microleakage of nano-filled resin composite restorations placed with a RMGIC using the co-cure technique and those placed with an ‘all-in-one’ self-etch DBA. In premolar teeth, that had to be extracted for orthodontic reasons, two proximal boxes with gingival margins placed in dentine were prepared. Restorations were inserted using co-cure method with RMGIC plus a nano-filled resin composite in one proximal box, and self-etch DBA plus nano-filled resin composite in other proximal box. After two weeks, teeth were extracted and after sealing their root apices, were placed in 2% aqueous methylene blue dye for 48 hours. Each tooth was sectioned mesio-distally. The dye leakage length was measured using a stereomicroscope. The mean value of microleakage for co-cure technique was found to be lesser than that for all-in-one dentine bonding agent. Co-cure technique was found significantly superior to all-in-one DBA in its sealing ability at gingival margin.

Key words: Co-Cure, RMGIC, nano-composite, class II composite

INTRODUCTION

Dental composite is a valuable restorative material because of its excellent esthetic properties. Continuous research resulted in formulating the dental composites with improved wear resistance and better strength for its use as a posterior restorative material. D Composites being acrylic in nature, have the inherent property of polymerization shrinkage. This polymerization shrinkage results in microleakage. Microleakage is thought to be responsible for dentinal sensitivity, recurrent caries, and pulp inflammation. The composite materials with nanotechnology results in decrease polymerization shrinkage, better esthetics and good handling characteristics.

In clinical practice, a major problem is encountered when using composites in class II cavities having gingival margin entirely within dentine. Studies show that the bond on gingival margins is not as effective as on axial and occlusal margins in Class II restorations. Dentine bonding is more difficult as compared to enamel as the heterogeneous nature of tissue requires the bonding system to accommodate simultaneously the properties of hydroxyl-apatite, collagen, smear layer, dentinal tubules and fluids. Different techniques are adopted to increase the seal between composite restoration and gingival margin in class II restorations. Though, it is not possible to totally avoid polymerization shrinkage, but a careful insertion and curing technique can minimize the stresses resulting from this phenomenon.

Flowable composites or RMGI liner under a composite restoration in root surface area may reduce potential microleakage. Moreover, RMGI can be used as a base material in co-cure technique where it is cured together with first increment of composite placed upon it. This may result in some chemical bonding between two materials that enhances the seal with micro-mechanical bonding. The evolution of adhesive systems led to the development adhesives needing single step of application by one-bottle system of sixth generation dentine bonding agent.
Because of increased use of posterior composite resins on dentin, methods are needed to minimize leakage for more successful restoration. Literature shows measurement of microleakage in vitro. However, it is justified to assume that in-vitro studies do not necessarily replicate the in-vivo situation. So a need arises to conduct a study where the selected restorative materials undergo natural intra-oral thermal changes and occlusal loads before the degree of microleakage is measured. Therefore this study was planned to examine whether the Co-cure technique is better than the use of self-etch DBA in vivo when restoring proximal lesions in terms of microleakage at restoration-cavity interface.

**METHODOLOGY**

Thirty patients (15-30 years age) requiring extractions of premolar teeth for orthodontic reasons were selected for restorations after taking an informed consent.

In selected premolar teeth, two proximal boxes with gingival margins placed in dentine were prepared. Slot style cavity was prepared having buccal and lingual walls parallel to each other and at right angle to axial wall and gingival floor in each tooth with flat cylindrical straight fissure bur. No bevels were used in cavity preparations and metallic matrix band with retainer was placed along wooden wedge insertion.

In one proximal box, self-etch dentine bonding agent (Adper Prompt L Pop; 3M ESPE, St. Paul, MN, USA) was applied for 15 seconds and after gently air drying the cavity, light curing with LED light was done for 20 seconds. Two coats of the adhesive were applied. Nano-filled composite (Filtek Supreme, 3M-ESPE, St. Paul, MN, USA) was placed by incremental technique and each increment was cured for 40 seconds.

In other proximal box, co-cure technique was used and cavity was etched with 40% phosphoric acid. After rinsing and air-dried, resin modified glass ionomer cement (FujiBOND LC; GC Int., Tokyo, Japan) was mixed and placed over gingival floor. First increment of nano-filled composite was placed and was light cured together with RMGIC for 40 seconds. The fifth generation dentine bonding agent (BC Plus ™; Vericom Co. Ltd.) with primer and adhesive in one bottle was applied over cavity walls and cavo-surface margins and then cured for 20 seconds. The remaining restoration was done by nano-filled composite using incremental technique. Confounding variables were controlled through matching. Patients were recalled after 2 weeks, and careful extractions of restored teeth were done. The extracted teeth were stored in 0.12% thymol solution for two months.

Each tooth from the solution was gently rinsed in water and air dried. The root apices were sealed with sticky wax and root surfaces were coated with two layers of nail varnish within 1.0 mm of the restoration margins. All teeth were then placed in 2% aqueous methylene blue dye (buffered to pH 7.0) for 48 hours at room temperature.

Following washing in water, each tooth was mounted on a mould and sectioned mesio-distally through the centre in to two equal halves with a water-cooled slow-speed diamond saw (Isomet; Buehler Ltd, Lake Bluff, IL, USA).

The length of dye leakage at the restoration/preparation interface was measured in micrometers by using a stereomicroscope (Olympus; 2x10 magnifications). The degree of microleakage was evaluated for both mesial and distal groups.

The mean and standard deviation were calculated and mean gingival margin microleakage measurement for each mesial and distal proximal surface of each tooth was compared between the two groups using independent Student’s t-test (SPSS V12). The probability level was set at p<0.05 for statistical significance.

**RESULTS**

Microleakage was found in all the samples. The mean value of microleakage for co-cure technique was found 305.833um ± 82.7 and for all-in-one dentine bonding agent was 364.17um ± 94.4.

The restorations placed with co-cure technique showed lesser degree of microleakage as compared to those with all-in-one dentine bonding agent. After applying the paired samples t-test, difference of mean values between the two groups was found statistically significant (p<0.05).

**TABLE 1: DESCRIPTIVE STATISTICS FOR DATA ON MICROLEAKAGE**

<table>
<thead>
<tr>
<th>Restorative technique</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-cure</td>
<td>30</td>
<td>75</td>
<td>425</td>
<td>305.83</td>
<td>82.7031</td>
</tr>
<tr>
<td>All-in-one DBA</td>
<td>30</td>
<td>100</td>
<td>500</td>
<td>364.17</td>
<td>94.386</td>
</tr>
</tbody>
</table>
In-vivo evaluation of microleakage of nano-filled resin composite

DISCUSSION

The microleakage in present study was assessed by using the dye penetration method but other methods are, use of radioactive isotopes, neutron activation analysis, scanning electron microscopy, chemical tracers, open restoration method and air pressure method. However, the dye penetration method is used more frequently because it is easiest and most feasible one. Nano-composite used in this study was found efficacious for clinical use in stress-bearing posterior cavities by Ernst et al.

In this study restorations were placed in-vivo. Most of the microleakage studies are in-vitro studies. However, the proper testing of any restorative material is not complete without undertaking the in-vivo studies or checking the clinical performance of the material. In all specimens, the dye penetrated to a considerable depth between restoration and tooth structure in the area of dentin but no dye was found in interface in area of enamel. These high dye penetration values may be attributed to the location of restorations. Stockton in his study of microleakage in deep proximal cavities demonstrated that despite more favorable conditions, moderate to considerable amounts of leakage occurred with all methods of composite restoration. His study was an in-vitro where moisture control and cavity access were easier to achieve as compared to working intra-orally but none of the methods could give absolute seal.

The higher microleakage values seen with Prompt L-Pop were in accordance with other studies done on this material. Oztas and Olmez found that composite restorations with Prompt-L-Pop presented larger and more frequent interfacial gaps than control restorations bonded with conventional adhesive system. Similarly, Li et al and Yacizi et al found more microleakage with Prompt L-Pop compared to fifth generation adhesive systems. This might be due to lack of separate primer that reduce infiltration depth or wettability of dentin adhesives thereby reducing adhesion and sealing capacity of Prompt L-Pop. However, though number of studies showed quite high values of microleakage with all-in-one DBA but in the present study falling of most of the samples in the highest values showed the failure of this technique in proximal composite fillings. This may be due the study being in-vivo as compared to the other studies which are in-vitro. Co-cure technique resulted in lesser values of microleakage but couldn't succeed in its complete arrest. Knight et al in their vitro study on co-cure technique found very high bond strengths at tooth and restoration interface. They modified technique by placing auto-cure GIC and painted the very liquid consistency of RMGIC over it. The restoration efficacy is justified by the extent of microleakage in real life and those values may not be coincident with bond strengths.

In in-vitro studies isolation and access to cavity are not difficult. In clinical situations the access to the site is not easy. This is especially difficult when the cavities were made for the study purposes in which the dimensions of the cavities had to be controlled for standardization. Also in proximal restorations adhesives are also not easy to be used. The contributory factors are the difficult accessibility of the corners of the deep proximal box; the adherence of materials to metal matrix bands, which creates a potentially higher C factor; and air drying, which may produce air voids within the hybrid layer during the process of solvent removal. Also in the gingival areas the direction of the tubules is almost horizontal and mechanical bonding through resin penetration into dentinal tubules is negligible. Other factors that affect the marginal seal

<table>
<thead>
<tr>
<th>TABLE 2: PAIRED SAMPLES TEST</th>
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<tbody>
<tr>
<td>Paired differences Mean</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
<tr>
<td>All-in-one DBA &amp; co-cure</td>
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</tbody>
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<table>
<thead>
<tr>
<th>TABLE 3: COMPARISON OF RANGES OF MICROLEAKAGE VALUES OF TWO TECHNIQUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microleakage in um</td>
</tr>
<tr>
<td>No. of samples</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>&lt; 125</td>
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<tr>
<td>125-325</td>
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<tr>
<td>&gt; 325</td>
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</table>
are contraction of the composite material, stresses at tooth-restoration interface, stiffness and other mechanical properties of composite. 31 Usually bond between enamel and composite survive these stresses while failures are observed at composite-dentine or composite-cementum interfaces. 32

In spite of all problems encountered in this study, co-cure technique showed better performance in sealing ability as compared to all-in-one dentine bonding agent. However, none of methods could eliminate microleakage in dentine region shows that microleakage along dentinal margins remains an important issue.

CONCLUSION

Co-cure technique seems to be better option for class II composite restorations that may produce a good chemical adhesion between two materials.

REFERENCES