Comparison of Micro leakage Evaluation of Direct Composite Restoration and Direct Composite Inlay System: An in-vitro Study
Annapurna Kini, Manjunatha .M, Sunil Kumar.V.C

Abstract
Background: The use of composite inlay techniques has proved to be an elegant approach to improve the marginal seal and adaptation of esthetic posterior restorations by greatly restricting the volume of composite resin to be simultaneously cured and bonded to tooth. Aims & Objectives: To compare the micro leakage of direct composite restorations with direct composite inlay restorations in Class II cavities at the cervical margin.

Materials & Methods: Forty whole extracted molars were collected and stored in water at room temperature. Class II cavity preparations were prepared and restored with direct composite technique in twenty teeth and direct inlay technique in remaining teeth. Specimens were thermocycled and immersed in 0.5% basic fuschin dye. Teeth were then sectioned and evaluated for dye penetration using a stereomicroscope at 16X magnification. The data was analysed using Mann-Whitney test. Results: Direct restorative group showed greater amount of leakage there was no statistically significant difference between the two groups. Conclusion: By using composite inlay, adaptation and bonding of composite to dentine can be improved.

Key Words: Micro leakage; Composite Restoration; Inlays

Introduction
Currently, tooth colored posterior restorations are the first choice of the patients. However, micro leakage is one of the major concerns associated with composite resins especially in the Class II cervical margins. Cervical micro leakage contributes to high incidence of secondary caries and accounts for clinically failed restoration.(1) Polymerization shrinkage remains one of the main shortcomings of resin composites. Composite when placed in a large cavity, the mass to be polymerized is so large that the shrinkage forces win out, producing marginal defects and gaps, despite careful application and use of adhesive techniques.(2)

The use of composite inlay techniques has proved to be an elegant approach to improve the marginal seal and adaptation of esthetic posterior restorations by greatly restricting the volume of composite resin to be simultaneously cured and bonded to tooth. A composite inlay restoration is cured by secondary application of heat or light outside the mouth and cemented into the prepared cavity. It may be completed by two techniques; first is direct technique i.e. chair-side procedure. The second is an indirect technique in which composite inlay is fabricated on a stone die.(3)

Composite inlays originated in early 1980 and were based on heat and pressure cured micro filled composites made indirectly on a die. In 1987, an inlay system was introduced based on a light cured hybrid composite formed directly in a prepared tooth. This post curing in direct and indirect composite inlays resulted in a higher stress relaxation and conversion compared to direct placement of light cured composite. Related to overall increase in conversion, improved mechanical and physical properties have been reported in secondary cured resin composites, such as improved tensile strength, elastic modulus, fracture toughness, flexural strength and hardness.(4)

The objective of the present study was to compare the micro leakage of direct composite restorations with direct composite inlay restorations in Class II cavities at the cervical margin.

Material and Methods
Forty maxillary and mandibular first and second molars, which were extracted for periodontal reasons, free of restorations and caries were selected. Teeth were stored in water at room temperature until use. They were assigned randomly into two groups of twenty each.

Group I – Direct composite restoration (20Teeth)

Group II – Direct inlay (20Teeth)

Standardized mesio-occlusal cavities were prepared using a turbine hand piece (NSK PANA AIR, CE 0197, Japan) with water spray coolant. The completed preparations had a minimal occlusal depth of approximately 1.5 mm. Parallel preparations were made for direct restorative technique and occlusally divergent preparations for inlay technique. The other dimensions of the cavities were axial depth of 2 mm, proximo-facial-lingual width of 4mm. For the direct restorations the cavities were prepared with No.245 carbide bur and No.271 carbide bur was used to prepare inlay
cavities. The gingival cavosurface margins were situated 1mm occlusal to CEJ. The cavosurface margins were finished to butt-joint. After completion of the preparations, the teeth were thoroughly rinsed with water to remove debris and dried with air.

Direct restorative technique

After completion of the preparations, 37% phosphoric acid was applied on enamel for 15 seconds and after 15 seconds the etchant was applied on dentin, for a total etching time of 30 seconds for enamel and 15 seconds for dentin. The cavity was then thoroughly rinsed with water for 30seconds and gently air dried. Dentin bonding agent was applied according to manufacturer’s instructions. First a proximal layer of composite resins was placed at the bottom of the cavity and polymerized from an apical direction. Second increment was placed buccally to the level of crest and polymerized through the cusp. Third increment obturated the proximal preparation. Finally, the remaining occlusal cavity was restored with fourth increment. Each layer was light cured for 40seconds.

Direct inlay technique

Following cavity preparation and application of separating medium oblique incremental packing of composite resin and polymerization techniques were employed. Each of the layers inserted into the prepared cavities were initially cured from a gingival direction (40 seconds) and then from occlusal direction (40 seconds). The composite inlay was removed from the tooth and post curing was carried out for 104 seconds). The composite inlay was removed from the layers inserted into the prepared cavities were initially cured from a gingival direction (40 seconds) and then from occlusal direction (40 seconds). The composite inlay was removed from the tooth and post curing was carried out for 104 seconds. Finishing was done with a super-fine finishing diamond point. All restorations were finished with discs, 24 hours after cementation.

Teeth were thermocycled 100 times between 60°C and 550°C for 10 seconds at each temperature. The apices were sealed with green compound and the teeth coated with two layers of nail varnish, except for restorations and their margins. The teeth were maintained in water at 37°C for an additional 7 days and then immersed in 0.5% basic fuchsine dye at 37°C for 24 hours, rinsed and dried. Each tooth was longitudinally sectioned mesio-distally along the center of the restoration, using a slow speed diamond disk. Each specimen was examined for dye penetration at the gingival seat using a light stereomicroscope at X16 magnification.

Micro leakage evaluation score(5):
0 – No micro leakage
1 – Micro leakage along the enamel not reaching the dentinal junction
2 - Micro leakage extending beyond the enamel-dentin junction
3 – Micro leakage along the floor of the cavity
4 – Micro leakage reaching the pulp

The results were statistically analyzed with Mann-Whitney test. In this test P value less than 0.05 were taken to be statistically significant.

Results

The micro leakage of the composite inlay restoration tooth interface at the gingival margin was evaluated using linear dye penetration method. The distributions of micro leakage scores for dye penetration are detailed in Table1, Table 2, Table 3.

<table>
<thead>
<tr>
<th>Method</th>
<th>Total Micro leakage Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct restoration</td>
<td>N</td>
</tr>
<tr>
<td>Direct inlay</td>
<td>N</td>
</tr>
<tr>
<td>Total</td>
<td>N</td>
</tr>
</tbody>
</table>

Table 1 Distribution of microleakage scores at the gingival margin

Of 20 total samples in each group, 15 (75%) samples in direct restorative group and 17 (85%) samples in direct inlay group showed 0 score (no leakage) of dye penetration. 5 (25%) teeth in direct restorative and 2 (10%) teeth in inlay group showed micro leakage score 1, and 1 sample (5%) in direct restorative group showed a micro leakage score of 2. The mean scores of micro leakage of two groups showed 0.25±0.44 and 0.20±0.52 respectively. The mean scores obtained were not statistically significant (p>0.05) (Table2).

<table>
<thead>
<tr>
<th>Method</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct restoration</td>
<td>20</td>
<td>0.25</td>
<td>0.44</td>
<td>0.00</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Direct inlay</td>
<td>20</td>
<td>0.20</td>
<td>0.52</td>
<td>0.00</td>
<td>0.00</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Table 2 Comparison of mean values of micro leakage scores
Therefore, micro leakage, post-operative sensitivity polymerization shrinkage occurs outside the mouth. the tooth and the resin bond is reduced since the improved before cementation. Stresses placed on the mouth, hence inadequate contact areas can be advantage is that the inlay can be finished outside applied restorative material.(11)
molecules or ions between the cavity wall and the clinically undetectable passage of bacteria, fluids, isotopes, air pressure, bacteria, neutron activation analysis, scanning electron microscopy, artificial caries technique, autoradiography and elective conductivity. According to Myers margins of restoration possess dynamic micro crevices that contain a busy traffic of ions and molecules.(12, 13)

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Sum of Scores</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restorative</td>
<td>20</td>
<td>427.50</td>
<td>21.3750</td>
</tr>
<tr>
<td>Inlay</td>
<td>20</td>
<td>392.50</td>
<td>19.6250</td>
</tr>
</tbody>
</table>

Table 3 Result of Mann Whitney test

The results indicate that composite inlay group had more samples of no dye penetration than direct restorative group. Statistical analysis suggests that, there is no significant difference between the two groups (P value is >0.05).

Discussion
Marginal adaptation of restorative materials is a matter of key concern in dentistry.(5) Direct posterior composite restorations have a disadvantage of not completely polymerizing and adequately sealing the relatively inaccessible gingival wall. At this site the enamel wall is thin, lacks regular prismatic configuration or is entirely missing and micro leakage is prevalent in this area.(6-8) Two major factors that determine for marginal gaps to develop are polymerization shrinkage and competing composite tooth adhesive bond. (5)

One of the major advantages of inlay technique is that polymerization shrinkage can be controlled and hence better marginal shrinkage can be expected than direct restorations.(2) With the use of inlay technique higher degree of cross-linking and stress relaxation can be obtained, since the application of light and heat may initiate new centers of polymerization.(4,9,10). Another advantage is that the inlay can be finished outside the mouth, hence inadequate contact areas can be improved before cementation. Stresses placed on the tooth and the resin bond is reduced since the polymerization shrinkage occurs outside the mouth. Therefore, micro leakage, post-operative sensitivity and secondary caries will be reduced.(4)

Micro leakage has been a major concern in restorative dentistry and is used as a measure by which clinicians and researchers can predict the performance of restorative materials in oral environment. Kidd has defined micro leakage as clinically undetectable passage of bacteria, fluids, molecules or ions between the cavity wall and the applied restorative material.(11)

Several techniques have been devised to test the micro leakage of restorations in vitro. In vitro studies include the use of stains, radioactive isotopes, air pressure, bacteria, neutron activation analysis, scanning electron microscopy, artificial caries technique, autoradiography and elective conductivity. According to Myers margins of restoration possess dynamic micro crevices that contain a busy traffic of ions and molecules.(12, 13)

In this study micro leakage at the gingival margin of Class II direct composite and direct inlay restorations was evaluated using dye penetration study. The gingival margin was placed in enamel and no bevels were placed during the cavity preparation. D.Dietschi showed that composite inlays proved to be superior with respect to marginal seal and adaptation quality when butt preparations were used.(14) The polymerization shrinkage in the composite inlay techniques is limited to the luting cement layer.(3)

Since adhesive inlays are inserted into the cavities with resin cement, the luting gap is always susceptible to increased wear as the resin cement is less wear resistant than the post-cured composite inlays.(15) When the interface of luting cement is covered with a glycerin gel, oxygen inhibition during polymerization is prevented. Another beneficial effect is in the prevention of excessive early wear of the luting resin composites. Better marginal adaptation and improved wear resistance have been reported.(16)

The results obtained in present study showed no statistically significant difference for micro leakage between the two groups. The leakage seen in inlay group could be attributed to shrinkage stresses from the composite cement, air bubbles incorporated at the interface or incomplete bonding.(5) Long-term clinical evaluations are needed to further evaluate the efficiency of this restorative technique.

Conclusion
Based on dye penetration tests of the restorations, it was concluded that composite inlay technique can be used as one of the methods to overcome micro leakage at the gingival margins. However statistical analysis showed no significant difference in micro leakage scores of the two groups.

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