Microleakage of Flowable Composite as Class I Restorative Materials

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Abstract

Aims: Evaluate the ability of different a bulk-fill flowable composite sealing around class I cavities compared to conventional composite. Materials and Method: Forty upper premolar teeth prepared with an ideal class I, then distributed according to types of composite resin into four groups (n=10): group I= filling with SDR, group II= filling with Saremco flowable composite resin, group III= filling with Tg flowable composite resin, finally group IV= filling with Valux plus composite resin (as a control) polymerized by LED light cure unit, varnished and placed in 2% methylene blue then sectioned bucco-palatally. The Micro-leakage was determined by stereomicroscope. Results: There was a significant difference (p<0.05) in mean micro-leakage values between SDR (group I) and Saremco (group II) while there was no significant difference (p>0.05) in micro-leakage values between SDR (group I) and Tg (group III) and Valux plus (group IV). Conclusion: SDR can be applied in 4 mm as a lone layer without negative effect on micro-leakage.

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INTRODUCTION

Since the first introduction of composite resin material by Bowen, producers improved the mechanical and physical properties of resin base material (1). However, the polymerization contraction continues to represent the major drawback in using direct composite resin restoratives. The shrinkage of composite resin could induce stresses at interface tooth-restoration if the stress exceeds the bond strength would be formed marginal gaps thus opening a path for leakage of microorganisms resulting in marginal micro-leakage (2). Several materials have become advocated to reduce this gap (1). Adhesive system produced a hybrid layer between composite and dentin wall to better seal margin because of bonding technology and the use of acidic. Additional produce marginal gap is the use of an intermediate elastic layer between the composite and bond that may compensate for the polymerization shrinkage stresses (3).

The Flowable composite was introduced has a filler size the same as hybrid composite but filler content lesser "60%_70% by weight and 60%_75% by volume". The reduced filler packing enhances flow and reduced modulus of elasticity. The low modulus of elasticity enables the flowable composites to bend with the tooth structure could act as a stressbreaker (4). Seeing recent advances in the content of fillers or organic matrix, a new generation of flowable composite has been presented as bulk-fill flowable composite. It is little polymerization shrinkage accordingly lessen micro-leakage arising from this polymerization shrinkage (5).

SDR had been developed especially for dentine replacement and curing increments up to 4mm depth the polymerization shrinkage had been reduced by 50% or more compared to conventional composite resins (6).

SDR is "a one-component, fluoride containing visible light cured, radiopaque resin composite restorative material". It is designed to be used beneath posterior composite restorations. SDR is flowable material that can be placed 4mm in thickness and light cured for 20seconds, and leave at least 2mm on the occlusal surface for ordered viscosity of composite. SDR materials are designed to be covered with a layer of standard composite for replacing missing enamel structure (7). Bulk fill flowable composite makes the restorative procedure simpler, as it reduces the application time by reducing the clinical steps and does not need to pack them, therefore they have been desired by the clinicians (8).

The present study compared micro-leakage in class I was restored with flowable compostites compared to a traditional hybrid composite resin (used as a control).
MATERIALS AND METHODS

The materials selected in this study, types, manufacturers’ information and application are listed in (Table1).

<table>
<thead>
<tr>
<th>Materials</th>
<th>Manufacturer</th>
<th>Types</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDR</td>
<td>Dentsply/USA</td>
<td>Flowable composite</td>
<td>4mm in one increment was left for a few seconds before it was cured by light (40 seconds), placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer</td>
</tr>
<tr>
<td>Sarmco</td>
<td>Dental AG/Switzerland</td>
<td>Flowable composite</td>
<td>placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer</td>
</tr>
<tr>
<td>Tg</td>
<td>Technical and General Ltd, London, UK.</td>
<td>Flowable composite</td>
<td>placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer</td>
</tr>
<tr>
<td>Valux Plus</td>
<td>3M/USA</td>
<td>hybrid composite</td>
<td>placed in 2 mm increments into a cavity preparation and light-cured for 20 seconds, leaving 2 mm increment for the final composite layer</td>
</tr>
<tr>
<td>Xeno V</td>
<td>Dentsply/USA</td>
<td>Bonding agent</td>
<td>a one step self-etching adhesive, was applied using the same method. excess solvent was removed using an air spray and polymerization was again performed led light source for 10 sec</td>
</tr>
</tbody>
</table>

Specimens' preparation:

Forty caries - free human upper premolar teeth recently extracted for orthodontic purposes were selected for this study. After being stored in distal water at room temperature (23±2°C), teeth were cleaned with pumice stone and water. Class I cavities were prepared in each tooth (2 mm wide, 3 mm length, and 4 mm deep) using diamond burs in a high-speed, water-cooled. Prepared teeth were distributed into four groups randomly, with "n=10" teeth per group. Three groups were using different flowable composite resins, group I= filling with SDR showing in figure1, group II= filling with Sarmco flowable composite resin, group III= filling with Tg flowable composite resin, while the final group filling with Valux plus conventional composite resin as a control, the teeth were filled using one bonding agent XenoV (Figure1) and cured by LED curing unit according to manufacture, then finished and polished with (TDV, Brazil) in a low-speed handpiece."
Microleakage evaluation:

The teeth were stored in distal water for 7 days at room temperature. After this time, thermocycled for (500 cycles) with baths held between (5°C and 55°C) and a dwell time (30 sec), the apices of root were sealed by a cold-cure acrylic and three layers of nail varnish were useful on the tooth surfaces within (1 mm) away from restoration margin (10). All specimens were placed in 2% methylene blue solution for 24 hours, then rinsed under running water (11). Specimens were inserted in a phenolic ring with epoxy resin and were segmented longitudinally in a buccopalatal direction showing (Figure 2) with minitome (Figure 3b) then the lengths in millimeters of the dye penetration were examined with a stereomicroscope (motic images plus 2 program) (12) (Figure 3a).

A non-parametric one-way ANOVA test was conducted (P < 0.05) and the least significant difference (LSD) was performed to test for any significant between all the groups using the SPSS software to statistically analyze the microleakage length.

Figure 1: smart dentine replacement

Figure 2: Specimen sectioned longitudinally in a buccopalatal direction
RESULTS

The mean and SD of micro-leakage are showed in (Table2) and (Figure4) a significant difference (p<0.05) between SDR (group I) and saremco (group II) and no significant difference (p>0.05) between SDR (group I) and Tg (group III) and valux plus (group IV) in values of micro-leakage by using ANOVA test (Table3). When the mean values of microleakage of the groups compared by LSD test (Table 4).

Table 2: Descriptive Analysis: Mean and SD of micro-leakage(mm) for all groups.

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>10</td>
<td>.5910</td>
<td>.38130</td>
<td>.17</td>
<td>1.45</td>
</tr>
<tr>
<td>SDR</td>
<td>10</td>
<td>.3950</td>
<td>.20898</td>
<td>.17</td>
<td>.73</td>
</tr>
<tr>
<td>VALUX</td>
<td>10</td>
<td>.5870</td>
<td>.27681</td>
<td>.19</td>
<td>.99</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>10</td>
<td>.7060</td>
<td>.41719</td>
<td>.26</td>
<td>1.31</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>.5698</td>
<td>.33802</td>
<td>.17</td>
<td>1.45</td>
</tr>
</tbody>
</table>

Table 3: One Way- ANOVA Test for all groups.

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>.499</td>
<td>.166</td>
<td>1.512</td>
<td>.228</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3.958</td>
<td>.110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4.456</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4: comparison among groups ( micro-leakage (mm))

<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>MATERIALS</th>
<th>Sig.</th>
<th>Level of significant</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDR</td>
<td>TG</td>
<td>.195</td>
<td>NS</td>
</tr>
<tr>
<td>SDR</td>
<td>VALUX</td>
<td>.979</td>
<td>NS</td>
</tr>
<tr>
<td>SDR</td>
<td>SAREMCO</td>
<td>.443</td>
<td>NS</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>TG</td>
<td>.195</td>
<td>NS</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>VALUX</td>
<td>.204</td>
<td>NS</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>SAREMCO</td>
<td>.043</td>
<td>S</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>SDR</td>
<td>.043</td>
<td>S</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>VALUX</td>
<td>.428</td>
<td>NS</td>
</tr>
<tr>
<td>SAREMCO</td>
<td>TG</td>
<td>.443</td>
<td>NS</td>
</tr>
</tbody>
</table>
DISCUSSION

Demand for posterior composite restorations has increased dramatically, still stress and the polymerization shrinkage a major drawback of dental composite materials (13).

The polymerization shrinkage of a composite can cause contraction forces that may decrease the bond to the cavity walls leading to marginal failure and subsequent micro-leakage (14,15,16). The micro-leakage causes post-operative sensitivity, marginal discoloration and secondary caries (17).

In this study, according to (Figure 4), there was lower micro-leakage in a group restored with SDR composite than other composites tested in the study, when groups SDR and Saremco were compared the results were statistically significant ($P<0.05$), SDR composite had significantly lower micro-leakage than Saremco composite. The probable reason for this is that the SDR is based on ‘Stress Decreasing Resin technology’ the SDR has less polymerization stress this will minimize negativities like micro-leakage arising from polymerization stress. According to the manufacturer, SDR contains a substance described as a “Polymerization Modulator was chemically embedded in the polymerizable resin backbone of the SDR resin monomer forms a relaxed network and provides lower polymerization stress than any other conventional resin, Through the use of the Polymerization Modulator” (18).

In addition, the SDR contains an SDR patented urethane di-methacrylate resin that is responsible for the reduction in polymerization shrinkage and stress. This SDR technology, as it is referred to by the manufacturer, is a combination of a large molecular structured resin, SDR resin with a molecular weight (849 g/mol) substance called a “polymerization modulator” chemically integrated into the center of the SDR resin monomer (19).
The lowered shrinkage stress claimed by the manufacturer has been confirmed by Ilie et al., who found "the SDR showed the lowest contraction stress (1.1±0.01MPa) not only when compared to the flowable materials but also when compared to nano- and micro-hybrid composites or even with the low shrinkage silorane-based material". They found that SDR showing the highest gel point and lowest shrinkage-rate consequently shrinkage stress would be reduced.

According to, Burgess et al., (21) the SDR is planned to reduce shrinkage stress by increasing flow with an exclusive chemistry that slows the polymerization rate, thereby reducing shrinkage stress.

Koltisko et al., (22) concluded that the polymerization shrinkage stress was lower for SDR than other resin composites tested.

Another important detail to be considered is that the SDR has a self-leveling characteristic and excellent adhesion to the preparation walls because of its flowable nature, fill all the crevices and reducing the potential for voids formation.

The results of the present-day study agreed with Scotti, et al., (23) who revealed that at dentinal margins, the Surefil SDR has less micro-leakage due to its lower stress owing to the low elastic modulus, and its lower wettability.

Koyuturk et al., (24) reported successful results about the SDR micro-leakage in their study which they compared posterior composite and SDR with self and total etch adhesive systems.

In the study of Alkhudhairy FI and Ahmad ZH, (25) SDR showed better micro-leakage quality as urethane with incorporated photoactive groups can control the polymerization kinetics.

Elhawary et al., (26) shown that SDR flowable composite recorded the value of micro-leakage lowest scores among the four groups in both occlusal and cervical margin.

In the study of Jawaed et al., (27) the SDR one-step technique demonstrated significantly less leakage value than the traditional incremental technique. Observations under stereomicroscope showed a better marginal adaptation in SDR technique specimens.

The results of the study by Kapoor et al., (28) showed the SDR composite resin demonstrated the best adaptability and less gap formation than incrementally filled composites.

The authors recognize that the generally results of this current study can be used to clinical performance. However, the authors advocate invasive Class I composite restorations be restored using flowable composites have been validated in long-term controlled clinical trials.

CONCLUSION

Microleakage varied substantially, among the material groups tested. Bulk-fill SDR composite resin can be applied 4 mm in a single layer without a negative
effect on micro-leakage. Moreover SDR can reduce micro-leakage used with its manufacturer’s recommended bonding agent, leaked significantly less than a wide variety of flowable composites used with same bonding agents.

**Conflict of interest: none**

**Ethical statements:** the avoidance of the risk of plagiarism and respect for intellectual property; Respect for the rights of human subjects in research; The identification of and dealing with allegations of research misconduct; The identification of and dealing with manipulations of citations; The disclosure of any conflicts of interest.

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**REFERENCES**


