Microleakage in Open-Sandwich Class II Dental Restorations

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INTRODUCTION

One of the key functions of a dental restoration is to seal the exposed dentin from the oral environment, to prevent pulpal damage and further decay. Therefore, the microleakage at the tooth-restorative interface is a major concern influencing the clinical longevity of the restorations. The integrity and durability of the marginal seal has always been of prime concern in the investigation of dental restorative materials performance. In order to overcome the inherent composites disadvantages such as the polymerisation shrinkage and the weaker adhesion at the composite-dentin interfaces several solutions were proposed. The step-by-step incremental technique, transparent matrices, reflecting wedges and improved adhesive systems solved only partially these problems. The technique, so-called "Sandwich" as an effective technique for both anterior and posterior resin based restorations. The open-sandwich technique was proposed, which consists in a gingival layer of another class of material prior to resin composite insertion in class II cavities [1]. The aim of the present study is to assess the microleakage between different restorative materials and the dentine gingival margin used in the open sandwich technique in class II cavities.

EXPERIMENTAL METHODS

Forty upper permanent premolar teeth were used and class II box-like cavities (3 millimeter (mm) width x 1.5 mm depth) with gingival margins ended 1mm below CEJ were prepared and filled in each tooth. The teeth were randomly divided into four groups each containing ten teeth. The prepared cavities were filled as follows: Group I: Silver Amalgam/Silverfil® with Panavia F amalgam bonding (Kuraray) + CR/composite resin; Group II: RMGI/resin modified glass ionomer Ketac N100 nanoionomer (3M-ESPE) + CR; Group III: GI/glass ionomer conventional Fuji II™ (GC Corp) + CR and Group IV: full composite filling using incremental technique. The composite used was Filtek Z350 XT (3M-ESPE). Dental tissues were etched with 37% phosphoric acid and a Scotchbond™ Universal Adhesive bonding agent (3M-ESPE) was applied and cured. The gingival increment in the open sandwich technique as well as the first composite increment for the composite fillings was 2 mm thick. The specimens were thermocycled between 5° to 55° C with 30 second dwell time for 500 cycles. The samples were then immersed in 0.5% Rhodamine B dye for 10 hours and were sectioned longitudinally. Dye penetration at the gingival margin was quantified under confocal laser scanning microscopy/CLSM (Leica, TCS SP2) at 10x magnification.

Data were analyzed using the Mann-Whitney tests and Kruskal-Wallis with a P value of ≤ 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

For the dentin-material Kruskal-Wallis test showed statistically significant differences among groups ($p<0.05$, $\alpha=0.0177$). The mean gap widths and standard deviations (µm) obtained from each experimental group between dentin and the materials tested are shown in Table 1.

Group	Mean gap width (µm)
1. Silverfil® with Panavia F amalgam bonding + CR	4.6 ± 2.2*
2. Ketac N100 nanoionomer RMGI + CR	5.2 ± 2.7*
3. Conventional Fuji II™ GIC+ CR	20.6 ± 6.9
4. Full CR Filtek Z350 XT	3.8 ± 2.1*

Table 1 show the mean gap widths and SD (µm) obtained from each experimental group between dentin and the materials tested.
* Indicate no significant difference *(p>0.05)*.

The least microleakage between dentin-material interfaces was obtained using composite resin, but the results showed that there was not any statistically significant difference of microgaps in the interfaces between Z350XT® composites with Silverfil® and Ketac N100 nanoionomer (Groups 1, 2 and 4), while conventional glass ionomer (Group 3) exhibited the contrary.

CONCLUSION

Nanohybrid composite resin Filtek Z350 XT®, Silverfil® amalgam and resin modified nanoinomer Ketac N100 restorative materials were produced similar results in microleakage between dentin-material interfaces at gingival margin of class II open-sandwich restorations. All materials used in this study were not able to totally eliminate microleakage on dentin.

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Interface Assessment of Silver Amalgam and Resin Modified Glass Ionomer in Sandwich Composite Resin Restorations of Class II cavities: SEM Study

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INTRODUCTION

Teeth restored using composite resins are especially prone to this phenomenon due to stress generated within the tooth-restoration interface following resin contraction during polymerization, known as polymerization shrinkage. Thereby, both shrinkage and quality of the bond seem to be responsible for the degradation of marginal adaptation [1]. Microleakage is strongly controlled by marginal adaptation and is thought to be one of the major disadvantages of resin composite restorations Amalgam surface corrosion and deposition of oxides improve marginal auto-sealing over time. In contrast to composite resins, amalgam is dimensionally stable. Sandwich technique was proposed as an effective technique as a means for pulpal protection from the acid-etch and a mechanism for sealing the cavity in the absence of good dentin adhesion. SDR®/Smart Dentine Replacement is the first bulk fill composite, simplifies the procedure for placing adhesive posterior composite fillings, even in extended class II cavities [2]. The aim of this study is to compare materials-composite resin interface characterization on nano glass ionomer, silver amalgam and dentin replacement materials in the proximal box of open sandwich combined with composite resin restorations in class II cavities by using SEM.

EXPERIMENTAL METHODS

Cavities were prepared in 45 extracted first permanent maxillary with carbide bur. Mesio-occlusal (MO) box-like cavities (3 millimeter (mm) width x 1.5 mm depth) with gingival margins ended 1mm below CEJ were prepared and filled in each tooth. The teeth selected were non carious, without any restoration or cracks. The teeth were divided randomly into 3 groups of 15 teeth. The prepared cavities were filled as follows: Group I: RMGI/resin modified glass ionomer Ketac N100 nanoionomer (3M-ESPE); Group II: Silver Amalgam/ Silverfil® with Panavia F amalgam bonding (Kuraray); Group III: SDR®/Smart Dentine Replacement (Dentsply). The composite used was Filtek Z350 XT (3M-ESPE). Dental tissues were etched with 37% phosphoric acid and a Scotchbond™ Universal Adhesive bonding agent (3M-ESPE) was applied and cured. The gingival increment in the open sandwich technique as well as the first composite increment for the composite fillings was 2 mm thick. The restored teeth were thermocycled between 5° to 55° C with 30 second dwell time for 500 cycles to stimulate the temperature changes under clinical conditions. Teeth were longitudinally broken mesio-distally Specimens were then metalized with fine gold overlay using gold sputter machine (Leica EM SCD005, Germany). The specimens were photographed at different sections and evaluated for gap present, if any, between base materials and resin composite/CR using SEM (FEI Quanta FEG 450) at 250 magnifications. Adaptation was evaluated at the following interfaces: Nanoionomer-composite resin (A); silver amalgam/ Silverfil®-composite resin (B) and SDR®-composite resin (C). Microleakage was evaluated by means gap between materials and CR.

RESULTS AND DISCUSSION

The mean gap between the two materials in group A was highest 3.54µm followed by group B i.e. 2.72µm, then by group C showed least mean gap i.e. 2.05µm. At 5% probability level, mean gap of group A was higher than all the other groups, but no significant difference was observed between mean gap of group A and group B and group C.

Group	No. of samples	Mean gap (µm)	Range (µm)	S.D.
A	15	3.54	6.84	1.43
B	15	2.72	5.29	1.37
C	15	2.05	4.48	1.32

Table 1 showed gap measured between test materials and composite resin.

Although the bonding mechanism between amalgam and composite has not yet been completely explained, Silverfil®/CR interface exhibited similar microleakage gap compared with Ketac nanoionomer/CR and SDR® dentin replacement material/CR.

CONCLUSION

Since Silverfil®/CR interface exhibited similar microleakage scores than nanoionomer/CR and SDR®/CR, sandwich restorations can be considered as a biological and aesthetic alternative to conventional Class II composite or amalgam restorations.

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Microleakage in Open-Sandwich Class II Dental Restorations

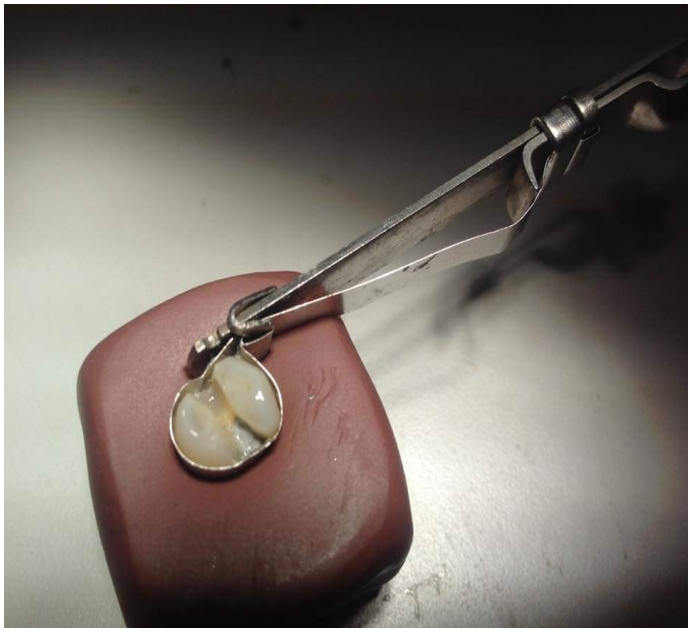
In a Cl. 11 cavity, the proximal part of cavity (near gingival margin) is first filled with `Silverfil' as well as over the occlusal floor of cavity.

The proximal wall of Silverfil will not be visible as it is approximated against the wall of adjacent tooth). Aesthetically not compromised.

Placement of a layer of Silverfil amalgam in a MOD Cavity.

Good proximal marginally adaptation can be achieved, as Silverfil can be compacted (unlike resin material).

Once filled with resin material, Silverfil color is not clinically visible.



Appearance of a Cl. 1 Sandwich Restoration with SilverFil as the base filling material.

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www.silverfilusa.com

SILVERFIL® USA
ZERO Free Mercury Amalgam

Sandwich Restoration Procedure

The use of SilverFil Amalgam as the cavity foundation will serve two main purposes for a composite restoration:
** SilverFil will prevent any effect due to moisture contamination especially in Cl. II cavities where the base of cavity is near the gingival (gum) margins.

** Also the layer of SilverFil will provide good seal, thereby preventing any seepage/leakage of **BPA (Bisphenol -A)** from Composites (due to uncured portions of Composite).

1

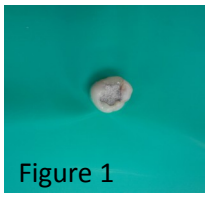
Figure 1

Figure 1:
After placing a cavity liner over the floor of tooth cavity, Silverfil is packed to form a base for the sandwich restoration.


Figure 1-A

The Ratio of 10% SilverFil base should be applied. The serrated amalgam plugger will provide serrated surface for mechanical retention with the Resin material.

2

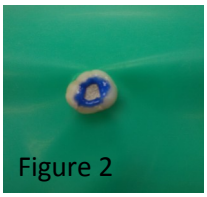
Figure 2

Figure 2:
Immediately after step 1 , the etching agent is applied along the walls of the cavity in order to etch the exposed walls of the tooth cavity. The cavity is then flushed well with water spray and thoroughly dried.

3

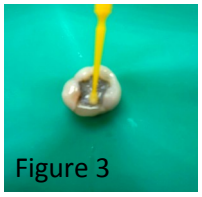
Figure 3

Figure 3:
After the cavity is dried, apply the bonding agent over the surface of the Silverfil base as well as along the side walls of cavity.

4

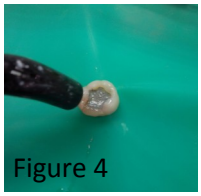
Figure 4

Figure 4:
Then the bonding agent is cured. The cured bonding agent shall for a mechanical bond with the surface of Silverfil due to (the serrations produced by the serrated amalgam pluggers/condensers) as well as with exposed tooth cavity.

5

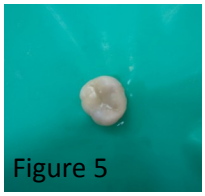
Figure 5

Figure 5:
Appearance of Filled Composite Resin over the base of Silverfil. The resin shall chemically bond with the bonding agent which is already mechanically `locked' with the surface of Silverfil

WHY is it an advantage to use SilverFil as the foundation for a composite/resin filling?

Because…

1. It will form a sound base and reduce (and most likely eliminate) any leakage of Bisphenol -A (BPA) into the dental pulp. Tests have proven that SilverFil will provide a good marginal seal.
2. The anti-bacterial/anti-microbial properties of Silverfil would have added advantage of the layer being closer to the cavity of tooth.
3. In Class II situations, where moisture from gum margins (gingival fluids) invariably have an adverse affect on the resins and glass ionomers. The use of Silverfil will eliminate this issue.
4. No compromise on aesthetics, the restoration will appear tooth coloured.
5. There is `Zero mercury' and reduced if not Zero BPA

Available in 3 sizes

Blue= 1 sp Green= 2 sp Yellow= 3 sp