Original Article

The efficacy of lining materials in the reduction of microleakage in class II composite resin restoration using the sandwich technique: A stereomicroscopic study

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Abstract

Background: The sealing ability of different liners under composite restorations in the reduction of microleakage.

Aim: To evaluate the effects of three different liners in sandwich techniques on gingival microleakage of class II composite restorations.

Materials and Methods: Standardized Class II box cavities were prepared on forty premolar teeth and randomly divided into four groups, *n* = 10: Group A, no liner (control); Group B, Polofil NHT Flow; Group C, Ionolux; and Group D, Fuji VII. The etching, bonding, and process for restoring the whole remaining mass of the cavities with G-aenial composite were the same, with the sandwich material expectations. Dye penetration was evaluated using a stereomicroscope.

Statistical Analysis: Duncan's *Post hoc* analysis and Friedman's test.

Results: Group A showed the highest microleakage followed by Group D, Group C, and Group B.

Conclusion: Polofil NHT Flow seems to be a promising liner for gingivally deep class II cavities.

Keywords: Fuji VII; Ionolux; Polofil NHT Flow

INTRODUCTION

Resin-based composites continue to gain popularity among clinicians, in the restoration of posterior teeth, and the demand for such aesthetic restorations is increasing. In fact, the most aesthetic alternative to dental amalgam is resin composite.[1] Resin-based composite composed mainly of the organic resin matrix, inorganic filler, and coupling agent.[2] Resin monomers and an initiator/catalyst system are the primary constituents for polymerization.[3]

The ability of resin composite to bond with enamel is a major benefit of implementing it as a restorative material when compared with amalgam. This micromechanical retention is evidenced to be simple to develop and is the strongest adhesion in the oral cavity.[4] Composite has also been shown to have less cusp fracture rates of 2.29%.[5] Advancements in resin composite technologies have wear

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rates of 110–149 μm after 3 years, similar to those of human enamel structure at 122 μm after 3 years.[6,7]

Although composite resins are the most widely used tooth-colored restorative materials, they still challenge when used as posterior restorations. Composite undergoes contraction during curing, and the resulting shrinkage causes debonding of the restoration from the tooth structure. Hence, marginal adaptation remains a problem for composite, especially at the dentinal gingival floor of Class II restorations. Poor marginal sealing causes bacterial, liquid, and molecular penetration through the cavity–material interface, resulting in marginal staining, postoperative sensitivity, secondary caries, pulp pathosis, and finally, restoration failure.[8]

When a carious lesion extends near to or apical to the cementoenamel junction, the sandwich technique can be used. The sandwich technique is the layering of materials with the optimal combination of desired properties during restoration. There are two variants of this type of restoration – open and closed sandwich techniques.[9] Mc Lean and Wilson first introduced the technique of using glass ionomer liners/base as a dentine substitute with a composite to replace enamel.[10] In the open sandwich technique, the glass ionomer cement (GIC) lining is exposed to the oral environment at the cervical margin, Whereas in the closed sandwich technique, the GIC lining is totally enclosed by composite resin.[11]

In the present study, the Fuji VII liner is evaluated for microleakage along with other liners like Polofil NHT Flow, and Ionolux which are sandwiched with G-aenial composite in gingivally deep class II cavities.

MATERIALS AND METHODS

A total of forty freshly extracted sound human premolars were used. The teeth were stored in 0.01% (w/v) thymol at 4°C. The teeth were vertically embedded 2 mm below CEJ in a cylindrical auto-polymerizing acrylic resin. Class II box cavity preparation in one of the proximal areas of each tooth was prepared by using no. 245 carbide bur. The dimensions of the cavities measured 4 mm buccolingual in width and 2 mm in axial depth at the axiopulpal line angle. The gingival margin was located 0.5 mm below the CEJ with nearly 1.0 mm depth. The teeth were randomly divided into four groups with 10 samples each.

Group A (control)

In this group, etching was done with 37% phosphoric acid for 30 s, rinsed with water for 20 s, and the cavity was air dried. The dentin bonding agent (Solare Universal Bond) was applied according to the manufacturer's instructions and cured for 20 s. The cavity was restored with light-cured composite (G-aenial) by gingivo-occlusal incremental technique. While the first increment was 1 mm thick, others were placed parallel to the gingival floor up to 2 mm in thickness. Each increment was light-cured from the occlusal aspect for 40 s with LED curing unit.

The etching, bonding step, and the process for restoring the whole remaining mass of the cavities in Groups B, C, and D were the same as described for Group A, with the sandwich materials exceptions.

Group B

In this group, etching was done with 37% phosphoric acid for 30 s, rinsed with water for 20 s, and the cavity was air dried. The dentin bonding agent (Solare Universal Bond) was applied according to the manufacturer's instructions and cured for 20 s. A Polofil NHT Flow measuring 1 mm in thickness was placed and light cured from the occlusal for 40 s. G-aenial composite was placed in 2 mm thickness and light cured for 40 s.

Group C

In this group, A Ionolux measuring 1 mm in thickness was placed and light cured from the occlusal for 40 s. Etching was done with 37% phosphoric acid for 30 s, rinsed with water for 20 s, and the cavity was air dried. The dentin bonding agent (Solare Universal Bond) was applied according to the manufacturer's instructions and light cured for 20 s. G-aenial composite was placed 2 mm thickness and light cured for 40 s.

Group D

In this group, etching was done with 37% phosphoric acid for 30 s, rinsed with water for 20 s, and the cavity was air dried. The dentin bonding agent (Solare Universal Bond) was applied according to the manufacturer's instructions and cured for 20 s. A Fuji VII measuring 1 mm in thickness was placed and light cured from the occlusal for 40 s. G-aenial composite was placed in 2 mm thickness and light cured for 40 s.

All the restorations were finished with diamond finishing burs and polished with polishing disks. Then, thermocycling was conducted between 5°C and 55°C for 1000 cycles. The immersion time bath and the interval time were 30 s. The teeth were then coated with two coats of nail varnish 1 mm beyond the margins of restorations and immersed in a solution of 0.5% basic fuchsin dye at 37°C for 24 h. Roots were cut and the crowns were embedded in slow-cure epoxy resin. Two cuts were made in a mesiodistal direction along the long axes of the teeth with a 1 mm thickness diamond disc cooled with water. The cuts were 0.5 mm away from the buccal and lingual sides of the gingival floor. Therefore three sections and four surfaces were provided by two cuts per tooth for the evaluation of gingival

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microleakage. Each restoration was examined under a stereomicroscope at ×40 and then scored. The severity of dye penetration was analyzed according to a 0–3 scale as given by Loguercio *et al*.[12]

Microleakage scores:
0 – No dye penetration.
1 – Dye penetration up to one-half of the gingival floor.
2 – Dye penetration up to more than one-half of the gingival floor.
3 – Dye penetration up to the axial wall.

Statistical analysis

Statistical analysis was done using Duncan's *post hoc* analysis and Friedman's test.

RESULTS

Comparison of mean microleakage scores between different cut surfaces in each study group [Table 1 and Figure 1a]. The results infer that there was no significant difference between different cut surfaces in each study group.

Multiple comparisons of mean difference in the microleakage Scores between 4 groups [Table 2 and Figure 1b]. The results infer that Group B showed significantly least mean microleakage scores, followed by Group C, Group D and highest with Group A [Figure 2].

DISCUSSION

The popularity of tooth-colored restorations, cosmetic dental procedures, and conservation of tooth structure together with advancement in the field of adhesive technology has given rise to the placement of direct composite restorations.[13]

Though, resin composite materials undergo volumetric polymerization contraction of at least 2% resulting in gap formation for the passage of salivary fluid along the tooth restoration interface, resulting in microleakage.[13]

Microleakage is defined as the clinically undetectable passage of bacteria, fluids, molecules, or ions between a cavity wall and the restorative material.[14]

Microleakage at the gingival margin of proximal boxes is one of the detrimental aspects of Class II composite resin restorations. The absence of enamel at gingival margins results in a less stable cementum dentin substrate for bonding. The orientation of dentinal tubules' can

Table 1: Comparison of mean microleakage scores between different cut-surfaces in each study group using Friedman's Test

Groups	CS	*n*	Mean	SD	Minimum	Maximum	*P*
Group A	CS1	10	2.50	0.53	2	3	0.72
	CS2	10	2.60	0.52	2	3	
	CS3	10	2.60	0.52	2	3	
	CS4	10	2.40	0.52	2	3	
Group B	CS1	10	0.80	0.79	0	2	0.93
	CS2	10	0.80	0.63	0	2	
	CS3	10	0.90	0.74	0	2	
	CS4	10	0.90	0.74	0	2	
Group C	CS1	10	1.30	0.68	0	2	0.17
	CS2	10	1.40	0.70	0	2	
	CS3	10	1.70	0.68	1	3	
	CS4	10	1.60	0.52	1	2	
Group D	CS1	10	2.20	0.63	1	3	0.57
	CS2	10	2.00	0.47	1	3	
	CS3	10	2.30	0.68	1	3	
	CS4	10	2.10	0.32	2	3	

CSs: Cut surfaces, SD: Standard deviation

Table 2: Multiple comparison of mean difference in microleakage scores between different groups using Duncan's *post hoc* analysis

Groups (I)	Groups (J)	Mean difference (I−J)	95% CI for the difference		*P*
			Lower	Upper	
Group A	Group B	1.80	1.13	2.47	<0.001*
	Group C	1.00	0.33	1.67	0.002*
	Group D	0.50	−0.17	1.17	0.02*
Group B	Group C	−0.80	−1.47	−0.13	0.02*
	Group D	−1.30	−1.97	−0.63	0.001*
Group C	Group D	−0.50	−1.17	0.17	0.02*

*Statistically significant. CI: Confidence interval

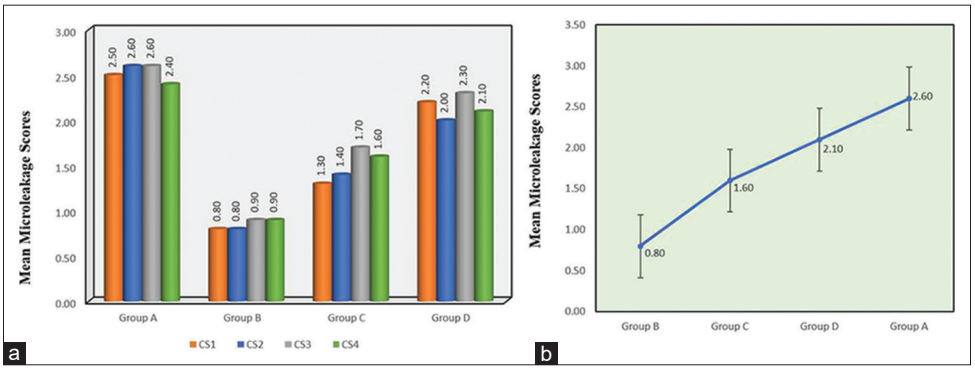


Figure 1: (a) Mean microleakage scores between different cut surfaces in each study group, (b) Mean microleakage scores between different study group

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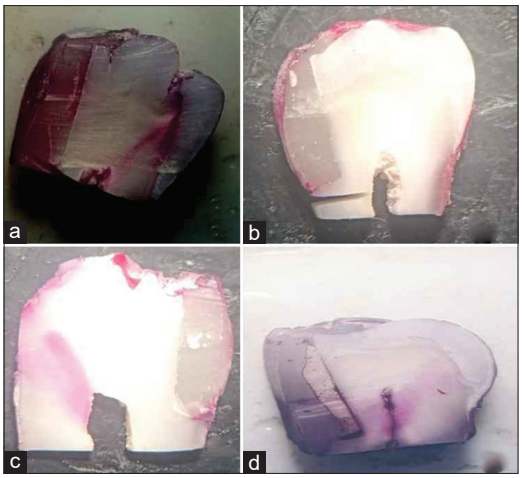


Figure 2: (a) Stereomicroscopic microleakage image of the control group without liner (×40), (b) Stereomicroscopic microleakage image of Polofil NHT Flow (×40), (c) Stereomicroscopic microleakage image of Ionolux (×40), (d) Stereomicroscopic microleakage image of Fuji VII (×40)

negatively affect the quality of hybridization and thus favor leakage in resin-based restorations in deep interproximal boxes.[15]

Polymerization shrinkage is reduced by the use of diverse materials and techniques like nonshrinking resins, modifying filler particles, using low elastic modulus liners, various layering techniques, and altering the degree of conversion of monomer systems by varying curing source and technique.[16]

Stress factors in resin composite restoration can be minimized, the layer of flexible material is placed in between the restoration and cavity walls to amplify the compliance of the bonding substrate, and the stress distribution is more even and uniform in a low elastic modulus layer.[17]

In the present study, four cut surfaces were used to find the probable gingival floor microleakage pattern which renders the dye penetration evaluation more quantitative. However, this study does not reveal any significant difference in the microleakage values between cut surfaces in each group.

In the present study, all the testing groups showed some degree of microleakage. On evaluating the results of the study, the highest microleakage scores were seen in composite restoration placed directly on the dentine without any liner (Group A – control). Lower microleakage scores in other Groups (Groups B, C, and D) were attributed to the presence of a liner when compared to Group A (no liner).

The results of the study infer that Group A (no liner) and Group D (Fuji VII) showed the highest amount of microleakage. Group B (Polofil NHT Flow) showed significantly least microleakage followed by Group C (Ionolux).

In the present study, Fuji VII showed the highest microleakage. This could be attributed to inadequate chemical bonding between the base and restorative systems as Fuji VII does not contain any resin and the elastic wall effect was not sufficient to relieve the stresses during polymerization shrinkage of the restorative systems.

Ganesh and Shobha compared the evaluation of the marginal sealing ability of Fuji VII® and Concise® as Pit and Fissure Sealants and concluded that Fuji VII showed a higher degree of microleakage. This difference in leakage pattern could be due to the weakness of glass ionomer at the tooth-sealant interface resulting in the inability to resist leakage of the test dye.[18]

In the present study, Polofil NHT Flow showed the least microleakage. Polofil NHT Flow is a light-curing, nanohybrid flowable composite liner with a filler content of more than 83% w/w. Greater the filler particles provide increased wear resistance, more curing depth, and reduces polymerization shrinkage.[19] Lesser microleakage of Polofil NHT Flow, when compared with other liners, might be due to a lower modulus of elasticity resulting in more stress-buffering capacity than is offered by hybrid composite resins. The marginal seal of flowable composite is improved because of the interaction between parameters of polymerization contraction and modulus of elasticity.[20] Good adaptation of flowable composite to the prepared tooth structure provides an intimate union with the microstructural defects of the cavity preparation. To the best of our knowledge, no published data on Polofil NHT Flow as a liner under class II composite microleakage evaluation.

In the present study, Ionolux also showed lesser microleakage as compared to Fuji VII but higher microleakage when compared to Polofil NHT Flow.

Ozcan *et al*. (2013) evaluated *in vitro* marginal adaptation of class II resin composite restorations with and without a liner and concluded that Ionolux (resin-modified glass ionomer group) showed less microleakage than the other liner groups. The better performance of Ionolux is due to the double adhesion mechanism or better mechanical properties. Adhesion is believed to occur through a combination of a dynamic ion exchange process and micromechanical bonding. The improved mechanical properties are due to the fact that the resin act as a reinforcing agent, which leads to significantly better initial properties, reduced moisture sensitivity and increased strength, and decreases microleakage.[21] Furthermore, the setting mechanism of the resin-modified GIC may be effective, because the setting reaction of resin-modified GIC occurs slowly, and it can tolerate shrinkage stress from a composite resin.[22] Fuji VII does not contain any resin and the elastic wall effect was not sufficient to relieve the

stresses during polymerization shrinkage of the restorative systems. Therefore ionolux showed lesser microleakage when compared with Fuji VII.

In the present study, microleakage was evaluated using the dye penetration method under a stereomicroscope. Dye penetration was chosen as a measure of microleakage for the present study because it was simple and fast, no reactive chemicals are used along with no radiation.[23]

Stereomicroscope is a simple and effective method that enables to view of objects by enhanced visibility from the illumination option.[24] The sectioned samples were observed under a stereomicroscope at ×40 to evaluate the amount of microleakage that occurred in different groups.

CONCLUSION

Within the limitations of the present study, it can be concluded that liners placed under class II composite restorations reduced microleakage significantly, compared to the control group, reinstating the implications of the sandwich technique for the longevity of class II composite restorations.

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Conflicts of interest
There are no conflicts of interest.

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