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EFFECT OF DIFFERENT CAVITY LINING MATERIALS ON MARGINAL SEALING OF PACKABLE COMPOSITE RESIN RESTORATIONS- AN IN VITRO STUDY.

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Abstract:

Aim: To assess the effect of three lining materials; flowable composite, flowable compomer, and light-curing glass ionomer cement (LCGIC) on microleakage in Class V restoration using packable composite restorations.

Materials and Methods: A standardized class V cavity was prepared on buccal surface of 40 young premolar teeth with the cervical margin extending 0.5 mm below the cementoenamel junction, into the dentin. All the samples were randomly divided into 4 groups according to the lining material used: Group I- Control; Group II- flowable composite; Group III- LCGIC and Group IV- flowable compomer. The restored teeth were thermocycled and immersed in 2% methylene blue solution for 24 hours. Each tooth was then sectioned along buccolingual direction. The dye penetration of the occlusal and gingival margins of each section was evaluated by a single observer using a stereomicroscope and statistically analyzed using Kruskal Walis Test and Mann-Whitney U Test.

Result: Maximum dye penetration score for Group 1, Group 2 was 3 and Group 3, Group 4 was 1. ($p<0.05$)

Conclusion: Flowable compomer and light cure glass ionomer cement as intermediate lining material can reduce microleakage under packable composite.

Keywords: Compomer, flowable composite, light-curing glass ionomer cement, microleakage, packable composite.

Introduction:

Composite resin has always been the most popular restorative material in anterior teeth owing to its aesthetically pleasing nature. However, increased concern among patients for tooth colored restorations and conservative cavity designs has increased the interest in posterior composites.[1]

The shrinkage of composite during polymerization threatens the marginal integrity, leading to microleakage due to marginal gap formation. This leads to failure of restoration in the form of postoperative sensitivity, secondary caries, fracture, marginal deterioration and discoloration. Therefore, adequate marginal seal is of utmost importance for provision of desired longevity of the restorations.[2,3]

Despite significant improvements in the properties, microleakage still remains a curse for composite. When the restoration margins are in enamel, microleakage is not a major problem as bonding with enamel is reliable. But when they lie on dentin or cementum, a complete and long-lasting seal is difficult to obtain.[4,5]

Packable composites with high viscosity do not adapt well to the cavity margins. Therefore, flowable resin-based materials with low elastic modulus have been recommended as a liner beneath packable composites.[6] But the use of liners has been debatable for a protracted period.[7,8]

Literature documents very few studies comparing efficiency of Light cure glass ionomer cement and compomer to reduce microleakage.

Hence, the aim of the current study was to test the null hypothesis that lining materials do not reduce the microleakage caused by polymerization shrinkage of packable composites.

Materials and methods:

Forty premolars with no carious lesions, previous restorations, cracks or defects; extracted for orthodontic purpose were selected. Scaling and root planning of samples was done to remove the residual organic tissue. The teeth were then immersed in 2.6% sodium hypochlorite solution and rinsed.

Table 1: Materials utilized in the study

Materials	Description	Manufacturer
Tetric N Ceram	Light-activated packable resin composite	Ivoclar Vivadent, AG
Tetric N flow	Light-activated flowable resin composite	Ivoclar Vivadent, AG
Dyract flow	Light-activated flowable compomer	Dentsply, Germany
Gold Label 2 LC	Light-curing glass ionomer cement	GC, America
Tetric N Bond	Light-curing adhesive	Ivoclar Vivadent, AG
GC dentin conditioner	Dentin conditioner	GC, America

Samples were divided equally into 4 groups depending upon liner used:

Group I- Control (no liner)

Group II- flowable composite liner

Group III- light-curing glass ionomer cement liner

Group IV- flowable compomer liner

A standardized Class V cavity preparation (3 mm mesial-distal, 2 mm occlusal-gingival, and 1.5 mm depth) was prepared on buccal surface of all the samples using number 245 tungsten carbide bur using a high-speed drill with water spray. Burs were changed after every 10 preparations. Cavity standardisation was done using a transparent matrix into which window of required dimensions, measured by Williams probe was cut. The cementoenamel junction was marked with a marker and cervical margins of cavities were extended 0.5 mm beyond this marking. These dimensions were transferred on buccal surfaces of the samples with the help of the transparent matrix. Depth was standardized by marking bur at 1.5mm. Enamel margins were bevelled.

Group I- Control:

The prepared cavities were cleaned using water spray and dried using compressed dry air.

Total etching was done for 15 seconds & then rinsed with vigorous water spray.

Conditioned area was then dried with a cotton pellet without pressure to avoid desiccation of dentin.

An evenly brushed coat of Tetric N bond on the prepared surfaces was then cured with halogen light (600 mW/cm^3 for 10 seconds).

Necessary amount of Tetric N Ceram was condensed into cavities using Teflon-coated condensers.

Transparent matrix was applied on top of the restorative material & light cured for 40 seconds.

Group II- flowable composite liner:

Cavity cleaning, etching, and adhesive material application was performed as mentioned previously.

Tetric N flow was applied directly into the cavity, limited to dentin only (approx 0.5 mm), contoured with a condenser then light cured for 15 seconds.

Cavity was then restored with Tetric N Ceram and cured for 40 seconds.

Group III- light-curing glass ionomer cement liner

The prepared cavity was washed and dried without desiccation.

GC dentin conditioner was applied for 20 seconds for removal of smear layer using a cotton pellet, rinsed with water and dried with cotton pellet.

Gold Label 2 LC was mixed according to manufacturer's instructions and transferred to cavity using a suitable instrument to line dentin only (approx 0.5mm), then light cured for 20 seconds.

Etching and bonding were followed by restoration using Tetric N Ceram and cured for 40 seconds.

Group IV- flowable compomer liner

Cavity cleaning, etching, and adhesive material application was done.

Dyract flow was applied directly into the cavity, limited to dentin only (approx 0.5 mm), contoured with a condenser then light cured for 20 seconds.

Final restoration was done using Tetric N Ceram and cured for 40 seconds.

- All the restored samples were followed by final finishing & polishing (Shofu polishing kit).
- The restored teeth were stored in saline for 24 hours and thermocycled for 500 cycles between 5°C and 55°C with a dwell time of 30 seconds in each bath.
- The apices of the specimens were sealed with impression compound.

- All tooth surfaces were covered with three coats of nail varnish with the exception of 1 mm around the tooth-restoration margins and allowed to air dry.
- Samples were immersed in methylene blue dye for 24 hours.
- The teeth were sectioned along the buccolingual direction, coincident with the centre of the restoration, with a sectioning diamond disc.
- The dye penetration at occlusal and gingival margins of each section was evaluated by an observer using a stereo-microscope (Magnus) at a magnification of 20× as shown in figure 1. Microleakage score at occlusal and gingival level were recorded based on the criteria given in Table 2.[9]
- The scores thus obtained from the samples were then subjected to statistical analysis.

Table 2: Scoring criteria for dye penetration

SCORE	CRITERIA
Score 0	No dye penetration
Score 1	Dye penetration to less than half of the cavity depth
Score 2	Dye penetration to more than half of the cavity depth
Score 3	Dye penetration to the axial wall and beyond

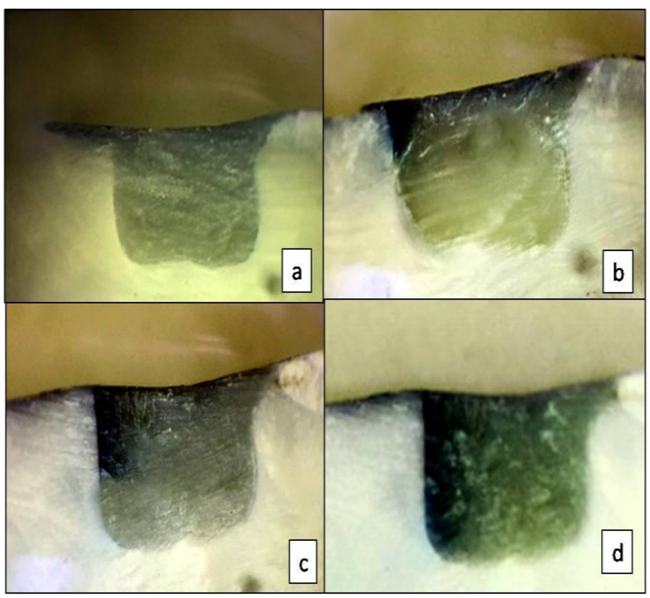

Figure 1: Stereomicroscopic images depicting scoring criteria:

(a) score 0
(b) score 1
(c) score 2
(d) score 3

Statistical analysis: The collected data were recorded, tabulated, and statistically analyzed using the SPSS (version 20.0, SPSS Inc., USA). Kruskal–Wallis and Mann–Whitney tests were used for statistical analysis.

Results:

Table 3: Comparison between study groups based on occlusal microleakage score

Occlusal Microleakage	Without liner N (%)	Flowable Composite N (%)	LCGIC N (%)	Compomer N (%)	p-value (Kruskal Walis Test)
Score 0	10 (100)	8 (80)	9 (90)	9 (90)	0.539
Score 1	0	2 (2)	1 (10)	1 (10)	
Score 2	0	0	0	0	
Score 3	0	0	0	0	
Total	10 (100)	10 (100)	10 (100)	10 (100)	

(No statistical Significance between groups)

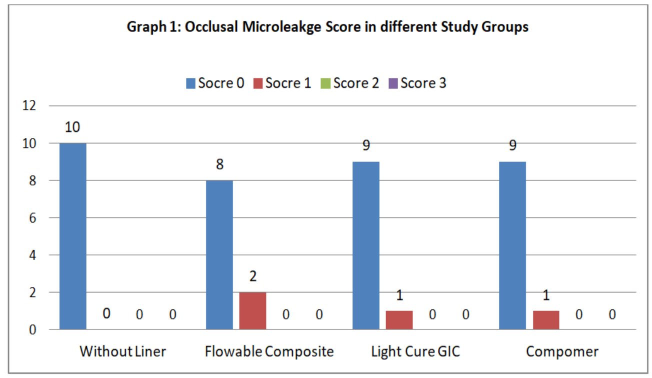

Table 3 and Graph 1 show the scoring and comparison of study groups based on the occlusal microleakage. On comparison by Kruskal Walis Test, the difference between occulsal microleakage scores of the four study groups was found statistically insignificant with p value-0.539.

Table 4: Comparison within study groups based on Occlusal Microleakage

Study Groups	p-value (Mann-Whitney U Test)
Without Liner v/s Flowable Composite	0.146
Without Liner v/s LCGIC	0.317
Without Liner v/s Compomer	0.317
Flowable Composite v/s LCGIC	0.542
Flowable Composite v/s Compomer	0.542
LCGIC v/s Compomer	0.954

(No Statistical Significance within groups; p>0.05)

Table 4 shows the comparison of occlusal microleakage within the groups. This comparison was done using Mann-Whitney U Test and it showed that there was no statistically significant difference in occlusal microleakage within any of the study groups as p-value of all individual comparisons was more than 0.05.

Table 5: Comparison between study groups based on Gingival microleakage score

Occlusal Microleakage	Without liner N (%)	Flowable Composite N (%)	LCGIC N (%)	Compomer N (%)	p-value (Kruskal Walis Test)
Score 0	0 (00)	0 (00)	4 (40)	3 (30)	0.002*
Score 1	5 (50)	7 (70)	6 (60)	7 (70)	
Score 2	2 (20)	1 (10)	0 (00)	0 (00)	
Score 3	3 (30)	2 (20)	0 (00)	0 (00)	
Total	10 (100)	10 (100)	10 (100)	10 (100)	

*Statistically Significant Difference (p<0.05)

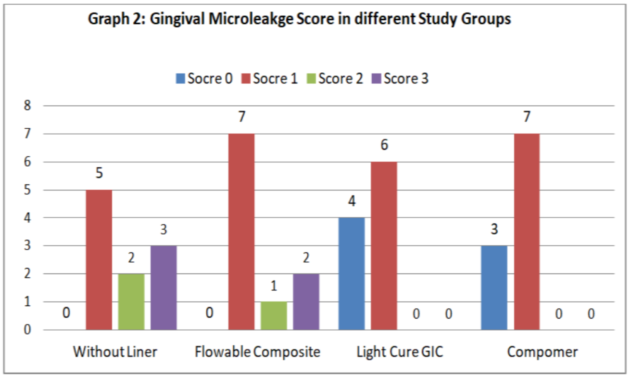

Table 5 and graph 2 show the values and comparison of study groups based on gingival micro leakage score. On comparison by Kruskal Walis Test, the difference between gingival microleakage scores of the four study groups was found statistically significant with p vale-0.002.

Table 6: Comparison within study groups based on Gingival Microleakage

Study Groups	p-value (Mann-Whitney U Test)
Without Liner v/s Flowable Composite	0.412
Without Liner v/s LCGIC	0.004*
Without Liner v/s Compomer	0.005*
Flowable Composite v/s LCGIC	0.010*
Flowable Composite v/s Compomer	0.017*
LCGIC v/s Compomer	0.648

*Statistically Significant Difference ($p<0.05$)

Table 6 shows the comparison of gingival microleakage scores within the four study groups. On comparison within different study groups using Mann-Whitney U test; it was observed that the difference in gingival microleakage score within without liner and LCGIC, without liner and compomer, flowable composite and LCGIC and flowable composite and compomer was statistically significant with $p<0.05$ in each of the comparison groups. However, the difference within without liner and flowable composite as well as LCGIC and compomer was statistically not significant.

Discussion:

The composite resin has been the most rapidly evolving material in the history of dentistry but microleakage remains a nuisance.

Methods to study the microleakage in vitro includes compressed air, neutron activation, electrochemical, fluid filtration, and dye penetration tests. Dye penetration tests are commonly used due to its simplicity, quick action, ability to reproduce and visualize depth of penetration. Since methylene blue dye can diffuse easily through the interface, detected easily and does not get absorbed by dentinal matrix apatite crystals, it was used for assessment of microleakage in this study. It passes through microscopic interfaces easily as it has molecular size 1.2 nm in diameter. The dye penetration was determined after sectioning of the specimens and viewing under magnifying aid. The specimen immersion time in this dye ranging from 1 h to 2 weeks in several studies, seems to have no influence on the microleakage results, so the samples were immersed for 24 h.[10]

Thermocycling of restored sample was done to simulate temperature changes in the oral cavity.[11]

Class V cavity has high C factor [12] therefore study was designed on class V cavity with margins located in enamel and dentin/cementum.

The three-step, total-etch system was used as it is still considered the gold standard.[13]

Satisfactory adhesion was found between packable composite and enamel margins although some samples demonstrated dye penetration. This was due to polymerization shrinkage forming marginal gap and ultimately microleakage.

Adhesion to enamel is better due to its greater mineral content while water content in dentin and more organic composition of cementum hinder micromechanical retention.

Packable composite without liner showed highest microleakage gingivally. This is in accordance with previous studies.[14,15] Packable composite with high modulus of elasticity stress the adhesive surface and inadequate bond strength interrupts the marginal seal leading to microleakage.

Incorporation of an "elastic" basal layer may act as stress breakers, which may resist polymerization or flexural stresses placed on the composite restoration. Materials with low elastic modulus are more flowable and tend to slip into nooks and crannies, compensating for stresses caused by polymerization shrinkage, thereby maintaining adhesive bond.[16-18]

There was no decrease in microleakage on using flowable composite as liner when cavity margins lie on dentin/cementum. Flowable composites contains significant amount of unfilled resin demonstrating more polymerization shrinkage. These results are in agreement with other studies.[19,20] However, Leevailoj et al. concluded that flowable composite liners help to reduce microleakage but the cavity margins in that study were placed 0.5 mm above CEJ.

LCGIC has ability to both micromechanically and chemically interact with dentin. It has favourable elastic modulus and coefficient of thermal expansion. It is dual-setting cement that gives it maximum flexibility to absorb stresses from the adjacent shrinking composite for an extended period.

Also, it undergoes controlled hygroscopic expansion after complete polymerization in a humid environment and this allows additional compensation for the polymerization shrinkage.[21]

Flowable composite has modulus of elasticity significantly higher than that of LCGIC thereby reduced effectiveness at counteracting polymerization shrinkage.

In this study, flowable compomer as lining material showed least microleakage. It bonds through the ion reaction of the carboxyl groups to the calcium ions in enamel and dentin. Compomer has reduced filler content with coefficient of thermal expansion similar to that of tooth structure which may contribute to decreased microleakage. The kinetics of polymerisation and lower elastic modulus are the reasons of reduced polymerization shrinkage stress during setting of compomer.[21]

Marginal integrity is inversely related to the elastic modulus therefore, materials with a high elastic modulus produce high shrinkage stresses and less deformation if strained equally. On the contrary, compomer possess a lower modulus of elasticity, which could be responsible for reduced contraction stress during curing and also provide an additional buffer during masticatory loading.[22]

So, the null hypothesis was rejected.

There are few limitations of this in-vitro study. Only vertical sectioning was performed in the buccolingual direction. It has been proposed that a more accurate way to evaluate the total leakage is to completely remove the restoration and evaluate the total amount of leakage, as this can vary from different sections. Mechanical loading was also not done to simulate the intra-oral conditions.

Conclusion:

Microleakage is a rule rather than exception. Light cure glass ionomer cement and compomer as lining materials underneath packable composites significantly reduce microleakage.

Further research is required to overcome gingival microleakage completely.

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