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EVALUATION OF MICROLEAKAGE USING ACTIVA BIOACTIVE, FILTECH FLOW, RMGIC AS LINERS IN CLASS II COMPOSITE RESTORATIONS - AN IN VITRO STUDY

Dental Science

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ABSTRACT

Introduction: Microleakage is the most frequently encountered problem especially at the gingival margins in deep class II cavities. Use of flowable composite as a liner provided reduction in microleakage. In co-curing, a thin layer of flowable composite is applied to cavity floor which is immediately followed by packable composite increment and light cured which offers advantage of two different composites, include intimate adaptation of filling and improved handling properties. **Aim:** The aim of this study is to compare and analyse the microleakage of class-II composite restorations using different curing techniques and lining materials with gingival margin placed above cement enamel junction (CEJ). **Materials and Methods:** 50 intact human molars were taken and divided into five groups. Standardized mesi-occlusal (MO) and disto-occlusal (DO) Class II tooth preparations with gingival seat above CEJ were prepared. Thermocycling was done. Samples were immersed in methylene blue and sectioned mesio-distally, followed by stereomicroscopic evaluation. **Results:** The techniques used in all groups did not completely eliminate the microleakage. Group 5 shows least microleakage when compared with all other groups. **Conclusion:** Activa Bioactive liner shows least microleakage compared to other groups. Co-cure technique has better marginal sealing when compared to pre-cure technique.

KEYWORDS

Flowable resin composite; intermediate layers; marginal microleakage; packable composite; resin modified glass ionomer; Activa Bioactive.

INTRODUCTION

One of the weak links with class II composite resin restorations is microleakage at the gingival margin of the proximal box which contributes to postoperative sensitivity, high incidence of secondary caries accounting for many clinically failed restorations. These can cause numerous unfavorable effects, such as interfacial staining, hypersensitivity and secondary caries; eventually leading to pulpal pathology. To minimize polymerization shrinkage and microleakage in the composite material, number of techniques and modifications have been proposed which include changes in filler content, use of glass and fiber inserts, use of expanding resin matrices. In curing technique modifications like soft, dual, ramp and delayed curing. Numerous materials like glass ionomer, self-curing composites and more recently the flowable composites were experimented as stress absorbing liners.[1]

Later "packable" or "condensable composites" was introduced[2] which help in restoring good contacts due to their packability.[3] Initially, their use as a posterior restorative material which had several limitations in terms of strength, dimensional stability and wear resistance that led to the failure of restorations such as occurrence of secondary caries and loss of anatomic form.[1] Future research led to improvements in strength of composites and wear resistance, but the problem of polymerization shrinkage remained. GIC or resin-modified glass-ionomer cement (RMGIC) is placed between the dentin cervical margins and occlusal composite restoration which can dissolve over time in the oral environment and less able to seal margins.[4] During light curing Resin component, it would have undergone different rates of polymerization shrinkage, which will lead to gap formation at tooth restoration inter phase.[5]

To address this concern, Flowable resin composites used as liners in areas of difficult access,by reducing the filler content[3] It also acts as a flexible intermediate layer that help to relieve stresses during polymerization shrinkage and reduction in microleakage.[4]

A new material ACTIVA BioACTIVE liner has been introduced in 2014.These are the first dental resins with a reactive ionomer glass fillers, shock absorbing rubberized resin component and strong bioactive ionic resin matrix that will not chip or crumble. It continuously releases and recharges with calcium, phosphate and fluoride ions. It is more durable and fracture resistance. Self sealing ability against bacterial leakage of this new improved generation of self adhesive resin has not been fully investigated.[6,7] The present in vitro study evaluates the microleakage in class II composite restorations using different curing techniques and lining materials.

AIM OFTHE STUDY

The aim of this study is to compare and analyse the microleakage of class-II composite restorations using different curing techniques and lining materials with gingival margin placed above CEJ.

METHODOLOGY

Fifty intact extracted human molars free of caries and restorations were collected and stored in normal saline. Hundred standardized mesio occlusal and disto occlusal box only class II cavities were prepared. The dimension of each cavity was bucco-lingual width 4mm, mesio distal width 2mm and occluso gingival wall was placed 1mm above the CEJ. All the prepared cavities were rinsed with water using a syringe, for 30 seconds and dried with absorbent paper for 15 seconds, before the restoration of the cavities. Prior to filling, sectional matrix band was placed which was stabilized with G-rings and wooden wedges inserted interproximally. A sharp explorer was used to confirm the fitness between the metal matrix and cervical margin. All the specimens were etched for 15 seconds with 35% phosphoric acid, washed thoroughly with water for 15 seconds and air blasted followed by the application of the two layers of single bond to the whole cavity surface and each layer was cured with curing light for 10 seconds.

RESTORATIVE PROCEDURE:

The cavities were restored using different curing techniques i.e. pre-curing and co-curing and lining materials which were grouped as follows.

Group I: Cavity preparations were restored with posterior composite alone i.e. P_{60} incrementally and each increment was cured for 20 seconds.

Group II: Flowable composite (Filtek flow) will be injected onto gingival floor with a thickness of 1mm and light cured for 20seconds. The rest of the cavity will be restored with posterior composite incrementally.

Group III: Cavity preparations were lined with flowable composite (filtek flow) to about 1mm occluso gingival thickness, then 1mm thick posterior composite (P_{60}) was inserted and packed to expel a part of flowable composite, the expelled flowable composite was carefully cleaned with microbrush. Both the layers of resins were then co-cured for 20 seconds. Remaining cavity was incrementally filled with posterior composite (P_{60}).

Group IV: After conditioning the cavity with 10% polyacrylic acid for 10 seconds, RMGIC was placed on the cavity floor to a thickness of

approximately 1mm and light cured. Then the cavity was etched, bonded and restored with packable composite.

Group V: ACTIVA Bio-ACTIVE liner was injected onto gingival floor of the thickness 1mm and light cured for 20seconds. The rest of the cavity was restored with posterior composite.
After the matrix band removal the restorations were cured via buccal and lingual aspects for 20 seconds, and then finished and polished with a fine diamond point and a series of abrasive discs. The teeth were placed in isotonic saline in a water bath at 37^{0}C for 24 hours and thermocycled for 1500 cycles with temperature range of 5^{0}C to 60±5 ^{0}C with a dwell time of 20 seconds for each temperature.

INTERFACE MICROLEAKAGE EVALUATION

The root apices were sealed with sticky wax and all the surfaces coated with two layers of nail varnish from beyond 1mm of the gingival margins of the restorations. The teeth were soaked in 0.1% methylene blue dye in a 37^{0}C water bath for 24hrs. After removal from the dye solution, they were thoroughly washed under tap water and sectioned mesiodistally into halves along their long axis. Each group included 20 sectioned halves with 40 specimens and each half both on mesial and distal restorations. The sections were mounted on slides and the depth of dye penetration was examined under Stereomicroscope at 10X magnification. The amount of microleakage was evaluated according to scores mentioned below for the degree of dye penetration. Stereomicroscopic evaluation of specimens was carried out in the Department of Oral and maxillofacial pathology, G Pulla Reddy Dental College and Hospital, Kurnool, Andhra Pradesh, India. The amount of microleakage was scored according to the extent of dye penetration and these are mentioned below.

Scoring criteria for micro leakage (figure 1):
Score 0 = no dye penetration
Score 1 = dye penetration limited to enamel
Score 2 = Dye penetration beyond the dentino enamel junction but limited to 2/3rds of the cervical wall length
Score 3 = Dye penetration beyond 2/3rds of the cervical wall length but not to the pulpal wall
Score 4 = Dye penetration to the pulpal wall.[13]

RESULTS

The cervical marginal microleakage were analyzed using Kruskal-Wallis test and Mann-whitney test with p = 0.05 significance level.

Table 1:- Comparison of score between the study groups

Group	N	Mean (SD)	Range	Median (Q1-Q3)	Kruskal wallis test	
					U statistic	p-value
Group 1	20	0.65 (0.88)	0 – 3	0 (0 - 1)	7.35	0.12 (NS)
Group 2	20	0.4 (0.82)	0 – 3	0 (0 - 0.75)		
Group 3	20	0.35 (0.81)	0 – 3	0 (0 - 0)		
Group 4	20	0.55 (0.83)	0 – 3	0 (0 - 1)		
Group 5	20	0.15 (0.49)	0 – 2	0 (0 - 0)		

*p<0.05 statistically significant, p>0.05 Non Significant, NS

INTERFERENCE: Group I (P60) showed more microleakage compared to Group II, Group III, Group IV, Group V. Co-cured specimens (Group III) showed less microleakage compared to pre-cure groups (Group II). Activa Bioactive lining specimens (Group V) showed least microleakage when compared to Filtek flow, RMGIC lining specimens. There was no statistical difference between Group II and Group IV (figure 2).

DISCUSSION

Microleakage is one of the most common problems of composite resin restorations, especially at the margins of the proximal box of class II cavities.[9,10] The primary deficiency of resin composites is Polymerization shrinkage, as it complicates the use of resin restorative material. Polymerization shrinkage creates contraction stresses in the resin composite restoration ultimately leads to microleakage and internal stress in the surrounding tooth structure. Polymerization shrinkage reduction which has become an important issue with the use of dental resin composites. Thus, in spite of much advancement seen in the composite restoratives and bonding agents, reliable adhesion without marginal gap formation has proven elusive.[3,11,9,4]

In a study reported that Adper Single Bond is a single bottle fifth generation consists of silica nanofillers. In single bottle systems, silica fillers are also used as a viscosity and thickness enhancement agent to prevent overthinning and lacking polymerization due to oxygen inhibition. So, in the present study Adper single bond is used.[13]

Packable composites feature increased filler with increased particle size range of 0.1-3.5 μm[3] within a composite material. This reduces the amount of polymerization contraction, which may result in decreased amounts of microleakage. On a more practical note, these are more viscous and less sticky which ultimately leads to less displacement and better adaptation which may result in decrease marginal void formation and possible microleakage.[13]

Due to less polymerization shrinkage and improved handling properties, packable composites are indicated for posterior stress-bearing areas.[5] So, packable/condensable composites were developed by densely loading the fillers into the hybrid composites with all mechanical properties except flowability.[14] In the present study, p60 is used as a restorative material for all the groups.

To improve marginal sealing and reduce microleakage of composite restorations many clinical techniques have been tested. These include incremental techniques, various light curing techniques, various liners, new generation dentin bonding agents, etc. have been proposed.[63] In the present study, different liners and curing techniques with class II restorations were used to evaluate the cervical marginal microleakage.[15] The liners used in the present study are Flowable composite (filtek flow), RMGIC, Activa bio-active liner.

RMGIC showed early resistance to moisture contamination and it can be photocured. According to some reports of resin composite restorations lined with RMGIC shows a 41% reduction in the volumetric contraction.[64] Severe degradation will occur if conventional GIC is extended till external cavosurface margin. The low viscosity materials which were introduced in 1996 are continually being developed such as flowable resin composites. Flowable resin composites have 2 desirable clinical handling characteristics that previously available materials did not have nonstickiness, fluid injectability.[17]

A study evaluated the interfacial integrity of Class II resin composite restorations. The enamel etching and influence of a flowable composite was also evaluated. The authors concluded that Flowable composites are recommended for gap-free resin-dentin interfaces, however, in this study, Flowable composite did not produce gap-free resin margins.[18] A study evaluated the use of Flowable resin composite beneath a condensable resin composite significantly reduced microleakage and thus supported the use of Flowable composite resins as a liner or as an extended base.[19]

In the present study Flowable liner although not statistically significant, minimized the effects of the polymerization shrinkage leads to a reduction of microleakage. In a study evaluated and compare marginal microleakage in deep class II cavities restored with various techniques using different composites. The authors finally concluded that the placement of a flowable composite liner with micro hybrid or packable composites reduces the marginal microleakage.[3] In a study reported that the use of Filtek Flow as a liner when light-cured separately exhibited better behavior regarding gap formation. So, in this study filtek flow is used as a liner.[20]

A new concept in dentistry is Bioactive restorative materials which have been introduced into the dental market. In a study conducted by M Kaushik and M Yadav evaluate the microleakage in class V lesions restored with Activa Bioactive restorative and nanohybrid composite resin using two different bonding agents and concluded that Activa Bioactive restorative showed lesser microleakage in comparison to other groups and considered as a good restorative option.[21]

A study compared marginal leakage in preparations with gingival margins in enamel or dentin/cementum (sub-CEJ and supra-CEJ). The results of this study indicated that supra-CEJ (with gingival margins in enamel) restorations with 2 mm thick Flowable resin composite gingival increments demonstrated significantly less leakage. So in this study margins are placed supragingivally.[17]

Current flowable materials can be easily syringed into the cavity air gets entrapped while removing it. Sometimes these materials are difficult to manipulate because of their stickiness. So, these materials must be applied carefully with a gentle releasing motion in one direction.[4] It was thought that sealing will be improved at the margin by cocuring the flowable liner and the overlying composite together. It would help to penetrate uncured liner better due to the hydraulic pressure of heavier viscosity composite.[5]

In a study compared class II composite restoration using flowable composites as lining with various thickness and curing techniques by evaluating cervical marginal microleakage. The authors concluded that there was an improved cervical marginal seal by combining packable (P60) and an ultrathin flowable lining of 0.5 to 1 mm (Filtek flow). It was also proved that co-cured composite restorations showed better marginal adaptation than pre-cured composite restorations. So, in the present study co-cure technique is used.[22]

LED units were considered to be similar or better as compared to QTH units regarding the microleakage at enamel and dentin margins; The LED light showed less microleakage than the QTH lights. So, in the present study, the restorations are cured using LED light.[23]

The specimens were subjected to Thermocycling in this study to simulate the clinical setting. In the thermal cycling the extreme differences of temperature, compatible to the oral cavity, induce differences in expansion and contraction of the restorative material and dental structure leading to "percolation" and, therefore, micro infiltration. Thermal cycling influences in the marginal infiltration of restoration that have a high coefficient of linear expansion and high thermal infusibility. It is suggested that the thermal cycling have an effect on the influence the microleakage of composite resin, even though it may not replicate the exact intraoral conditions.[14]

Methylene blue was used for dye penetration in this study because it was simple, inexpensive and does not require complex laboratory procedure.[3] It has many advantages over other techniques i.e., no reactive chemicals are used along with no radiation, technique is highly feasible and easily reproducible.[72] Methylene blue provides easy visualization in the digital images of the prepared cavity and it providing a clear reference point from which to score for the evaluators and provides an excellent contrast.[55] Also, the particle size of this dye is less than the internal diameter of the dentinal tubules (1- 4 μm), so it is able to show dentin permeability.[5] So, methylene blue dye is used in this study for dye penetration.

In this study, p60 restorative material shows more microleakage when compared to all other groups. Packable composite resins were difficult to adapt to cavity preparation due to their stiffness.

The specimens which are lined with RMGIC showed more microleakage. It could be due to the (1) Different rates of polymerization shrinkage during light curing in Fuji II LC Resin component which will lead to gap formation at tooth restoration interphase. (2) Fuji II LC Resin framework may be less capable of elastic deformation and more rigid leading to disruption of the bond at the tooth restoration interphase during initial curing. (3) More chances of porosities because RMGIC is a two-component system. (4) RMGIC may show some changes at the tooth restoration interface in the form of failure because it is sensitive to dehydration leading to severe loss of water. (5) Presence of smear layer must have prevented hybridization in this area.[5]

In the present study, when compared to RMGI liner group with a flowable composite liner, specimens showed statistically less microleakage and this could be due to (1) It will provide an intimate union with the microstructural defects of the cavity preparation because of a good adaptation of flowable composite to the prepared tooth structure. (2) flowable composite with a low surface tension and/or low modulus of elasticity and increased flexibility that would have ameliorated the stresses of polymerization shrinkage and preserved the integrity of bond to tooth structure.[1] In this study, although statistically insignificant, activa bioactive shows least microleakage among all the other groups.

The results of the present study demonstrated that under all the experimental conditions, all the groups showed some amount of microleakage. None of the liners and both curing techniques completely stopped microleakage. However, active bioactive liner under packable composite restoration showed the least microleakage values.

CONCLUSION

It can be concluded that ACTIVA BioACTIVE liner was superior to Filtek flow and RMGIC in preventing microleakage above the CEJ. In clinical situations, it is advisable to line the cavity with Activa Bioactive liner in class II cavities to reduce the incidence of microleakage. co-cure technique has better marginal sealing when compared to pre-cure technique.

Limitations of this study:

- The restorative materials when tested in vitro fail to simulate the dynamic intraoral thermal changes induced by routine eating and drinking.
- The completely altered dentinal surface and the absence of outward flow of the dentinal fluid due to extraction lead to a poor correlation between in vivo and in vitro conditions.

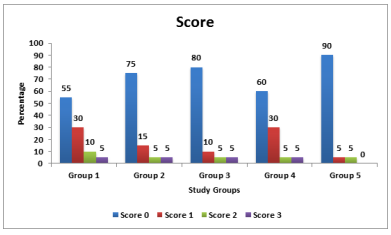

Fig 2: Graph shows comparision of five groups with respect to microleakage score

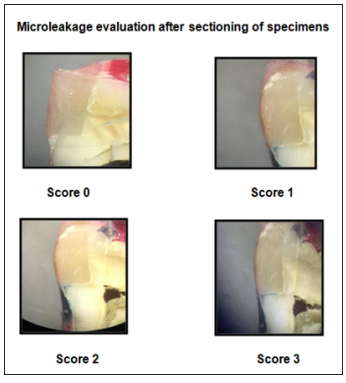

Fig 2 : microleakage evaluation after sectioning of specimens

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