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Marginal Leakage of Class II Packable Resin Composite Lined with Flowable Composite and Resin Modified Glass Ionomer Cement: An In Vitro Study

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ABSTRACT

Background: Packable composites are commonly used as posterior restorative materials. However, disadvantages like polymerization shrinkage limit their use. The aim of this study was to investigate the marginal leakage at the gingival seat of the proximal box of Class II cavities restored with posterior packable composite(Solitaire-2) using different liner materials The liners used were flowable resin composite(Flowline) and resin modified glass ionomer cement (Fuji II LC GC) using open sandwich technique. Assessment was done at the gingival seat of the proximal box located above the cemento-enamel junction (CEJ) in enamel.

Materials and Methods: Thirty recently extracted human upper premolars were prepared with standardized Class- II cavities as follows; **Occlusal Outline Form:** 2mm in bucco-lingual width and 1.5 mm in depth measured from occlusal fissure to pulpal floor. **Proximal Boxes:** The depth of the proximal box from the proximal cavo-surface margin to the axial wall was 3 mm, so as the bucco-lingual width (2mm). The proximal box margin located 1 mm coronal to the CEJ (in enamel). The teeth were assigned into 3 groups (n=10): **Group-I** (control): acid etching (Gluma etch 20 gel)) + bonding agent (Gluma comfort bond) + posterior packable composite (solitaire-2), **Group-II** (RMGIC): acid etching + resin modified glass ionomer cement (Fuji II LC GC) + posterior packable composite; **Group-III** (Flowable): acid etching + bonding agent + flowable composite (Flowline) + posterior packable composite. The teeth were immersed in distilled water at 37ºC for 24 h., then thermocycled (1000X, 5°-55°C, 30 sec. dwell time) and immersed in 0.5% Rhodamine B solution for 24 h., after that the teeth were sectioned longitudinally in mesiodistal direction and dye penetration in millimeters was measured in each cavity by using fluorescent microscope. Data obtained was analyzed using ANOVA and LSD tests at 0.05 significance level.

Conclusion: The use of flowable composite (Flowline) and resin modified glass ionomer (Fuji II LC GC) in the open sandwich technique was shown to decrease the marginal leakage of posterior packable composite (Solitaire-2).

Keywords: Flowable composite, marginal leakage, RMGIC and packable composite.

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INTRODUCTION

Composite restorations have become a popular alternative to amalgam restorations in posterior teeth. Increased patient demand for better aesthetics, possibility of mercury toxicity from amalgam and improvements in composite materials has significantly contributed to the popularity of these materials. However posterior composite restorations have many clinical problems including: severe leakage, secondary caries, loss of anatomic form and high rate of wear. To overcome these short comings, Packable composites have been introduced to the dental market.[1] The increased viscosity of these materials permits greater packability with less slumping characteristics and lower polymerization shrinkage as compared to conventional universal composites. Packable composites are indicated for stress bearing posterior restorations. [1-4] Packable composites use amalgam techniques for placement and produce acceptable interproximal contacts and because of the high depth of cure and low polymerization shrinkage of packable composites, a bulk–filling technique may be possible. [1] Clinicians are concerned with poor adaptation of the material to tooth structure when placing posterior restorations. A material's ability to seal cavity preparations can be influenced by its composition, plastic deformation flow, coefficient of thermal expansion, modulus of elasticity and the mechanical stresses caused by cavity preparation and shape[2]. Composite resins have an initial polymerization shrinkage ranging from 1.67- 5.68%. This shrinkage leads to the pulling of the resin material from the walls of the preparations and results in a gap between the restoration and the tooth structure and causes marginal leakage. [3] Another factor affecting marginal leakage directly is the difference between the co-efficients of thermal expansion of the resin and the tooth structure. Temperature change also causes varying volumetric changes in the resin and tooth structure leading to marginal leakage. [4] Moreover, concerns related to the ability of these stiffer materials to adequately adapt to internal areas and cavosurface margins have been raised. To offset this problem, materials with low viscosity and better adaptability to the cavity are used under packable composites. [1] The purpose of this in vitro study was to evaluate the marginal leakage of posterior packable resin composite restorations with and without liner using open sandwich technique at the proximal box of class II preparation located above the cemento-enamel junction (in enamel).

MATERIALS AND METHOD

Thirty caries-free recently extracted human upper premolars were selected for this study. The teeth were cleaned and stored in normal saline until sample preparation. [5, 6]

Cavity Preparation:

In each tooth, standardized Class II cavities were prepared as follows:

Occlusal Outline Form: 3 mm in buccolingual width and 1.5 mm in depth measured from occlusal fissure to pulpal floor.

Proximal Boxes:

The depth of the proximal box from the proximal cavo-surface margin to the axial wall was 2 mm, so was the bucco-lingual width (3mm). The gingival margin was located 1 mm coronal to the CEJ (in enamel).[5] The cavity preparations were prepared by using high-speed hand piece with water spray and #245 bur (SS White). The teeth were divided into three groups of 8 cavities each.

Restorative Procedure:

Etching Enamel and dentin was etched with Gluma etch 20 gel (37% phosphoric acid, see Table-1) for 15 sec., etching gel was applied to all of the prepared cavity walls approximately 0.5 mm beyond unprepared tooth surface using dispensing tips for application. Then the gel was removed with water spray for 10 sec. [7]

Bonding:

Immediately after blotting out the excess water, two coats with fully saturated brush tip of Gluma comfort bond Adhesive (see Table-1) were applied onto the etched tooth surface for 15 sec, with gentle agitation, then gently air dried for 5 sec. and light cured for 10 sec., according to manufacturer's instruction.[5]

Sample grouping

Table 1: Details of Composite materials.

Material	Type	Company	Batch no.
Gluma etch 20 gel	Total etch	Heraeus Kulzer, Hanau, Germany	Lot no.225030
Gluma comfort bond	Bonding agent	Heraeus Kulzer, Hanau, Germany	Lot no.010066
Flow line	Flowable composite	Heraeus Kulzer, Hanau, Germany	Lot no.010103
Solitaire-2	Packable composite	Heraeus Kulzer, Hanau, Germany	Lot no.010256
Dentin conditioner	conditioner	GC corporationTokyo	Lot no.0311271
Fuji II LC	Resin modified glass ionomer cement	GC corporationTokyo	Lot no.0503301
Rhodamine B	Flourscent dye 0.5%	S.D fine-chem limited , mumbai	Lot no.LO3/0103/1911/71
Nail varnish	Varnish	Elle-18	
SOF-LEX	Composite polishing kit	3M USA	

Table 2: Descriptive analysis: Mean, Standard deviation of marginal leakage values of the groups.

groups	N	Means	SD	Min.	Max.
Group I (control)	10	0.78	0.124	0.6	1
Group II (RMGIC)	10	0.63	0.106	0.5	0.8
Group III (FLOWABLE)	10	0.55	0.119	0.4	0.7

Table 3: One Way –ANOVA test for all groups.

	Sum of squares	D. f	Mean squares	F	P-Value	Sig.
Between groups	0.231	2	0.115			
With in groups	0.287	21	0.014			
Total	0.518	23		8.43	0.002	S

S: significant

Table 3: LSD test compare between the groups in marginal leakage values (mm).

Groups	P – value	Level of significant
I vs. II	0.018	S
I vs. III	0.001	S
II vs. III	0.150	NS

NS: non significant, S: significant

Group- I (control): The cavities were filled with packable posterior composite (Solitaire-2, see Table-1) only without lining according to manufacturer instructions. [1]

Group-II (RMGIC): Resin modified glass ionomer cement (Fuji II LC GC, see Table-1) was placed in 0.5 mm thick layer in axial wall and gingival margin using open sandwich technique and light cured for 20 sec. [7]

Group-III (Flowable):-Flowable composite (Flowline, see Table-1) was applied in 0.5 mm increment depth in axial wall and gingival margin using open sandwich technique and light cured for 20 sec. [2]

Filling: The matrix band was adjusted in the matrix retainer Ivory no. 8, then the retainer and the band were seated around the tooth.[5] The cavities were filled with packable composite as a restorative material in bulk technique by using the plastic instrument and light cured for 20 sec. to restore the cavities. All materials were polymerized using a halogen light curing unit (Dentsply, United Electronic Co.). Finishing procedure was performed with a fine diamond bur (Diatech Dental AG, Heerbrugg, Switzerland), then polished with a graded series of Sof-Lex discs (3M ESPE, St. Paul, MN, USA). Care was taken to avoid polishing the cervical margin. [7]

Testing procedure: All teeth were stored in distilled water at 37ºC for 24 hours using incubator time of 30 sec. The teeth were previously sealed with a composite resin at the root apices, and two coats of nail varnish were applied on the tooth within 1mm of the restoration margins. [5] The teeth were then immersed in a 0.5 % Rhodamine B solution for 24 hours at room temperature. Subsequently they rinsed with tap water and dried at room temperature [7]. All specimens were sectioned longitudinally in mesiodistal using a water-cooled; slow-speed diamond saw ISO 524 (Top Dent, Swiss Made). The lengths of the dye penetration in millimeters were examined with a Fluorescent microscope (40X magnifications, Hamilton, BioVision 320). [5]

Statistical analysis was performed with SPSS software package (version 19.0). Analysis of Variance test (ANOVA) and least significant difference (LSD) were performed to test for any significant difference between the groups in marginal leakage values. The mean difference is significant at the 0.05 level.

RESULTS

The mean and standard deviation of marginal leakage values are presented in (Table- 2). The data showed that there is statistically significant difference (p0.05) between group-II and III in marginal leakage reduction

DISCUSSION

Packable composites most commonly used as posterior restorative materials, however, disadvantages like polymerization shrinkage, high co-efficient of thermal expansion and increased wear, limited their use. Further research led to improvements in wear resistance and strength but the problem of polymerization shrinkage remained. Polymerization shrinkage resulted due to the contraction of the resin during curing and is in the range of 1.67-5.68%. This polymerization shrinkage results in the formation of a marginal gap which can ultimately lead to increased marginal leakage, [8] so various techniques and modifications in the material were proposed to overcome and minimize polymerization shrinkage and marginal leakage. These included changes in filler content, use of expanding resin matrices and modifications in curing techniques like soft curing, ramped curing and delayed curing.[9] They observed that when the material isin more rigid state, most of the polymerization cannot be observed and is transmitted to the adhesive interface. Here, the contraction stress can become responsible for opening marginal gap. It has been proposed that an “elastic” layer at the restoration base be incorporated to act as a stress absorber, not only of the functional loads but also of the internal tensions induced by composite polymerization. [8, 10] In our study, the concept of using various liners as stress absorbing cushions to minimize polymerization shrinkage was proposed; two types of materials (resin modified glass ionomer cement and flowable composites) were experimented as stress absorbing liners. The use of GIC as lining material in conventional sandwich restoration reduces considerably the bulk resin composite used, thus the amount of polymerization shrinkage of the composite resin is decreased and the marginal adaptation may be improved. A further advantage of the sandwich technique is the fluoride-release property of GICs, which is considered to have some inhibitory effect on caries formation and progression around the restoration. The sandwich restorations using RMGIC showed significantly less dye penetration than control group (packable composite without lining), this result in agreement with the results of Chuang et al.[6] and Donly et al.[11] . RMGIC obtained by adding a resin, usually the water-soluble polymerizable 2-hydroxyethyl methacrylate (HEMA), to the liquid and its bonding process to tooth structure takes place by micromechanical retention, like in resin composites. The setting reaction of RMGIC follows two distinct mechanisms: resin polymerization and acid-base reaction. The better sealing produced by RMGIC is a result of the formation of resin tags into the dentinal tubules allied to the ion exchange process present in the interface between dentin and RMGIC, this assumption stands to be the reason for the superior performance of the RMGIC. In addition, the presence of HEMA in the RMGIC is responsible for the increased bond strengths to resin composite and prevent dye penetration through the interface of these materials, as demonstrated by the results of the present study. The shrinkage stresses of resin composites during polymerization create forces that compete with the adhesive bond, and this may disrupt the bond to cavity walls, which is one of the main causes of marginal failure and, subsequent, marginal leakage. The main rationale behind the use of flowable composites is the formation of an elastic layer that may compensate for the polymerization shrinkage stresses. [5] The thirdgroup in this study showed that using of flowable composite as liner under packable composite significantly reduced marginal leakage more than RMGIC, this result due to low filler loading of flowable composite (47% by volume) that enhanced flow and reduced elastic modulus. These two characteristics reduce marginal leakage by increasing adaptation and forming an elastic stress-absorbing layer [8] These results in agreement with studies by, Leevailoj et al.[1] , Peutzfeldt and Asmussen [8] and Stefanski and van Dijken [12] . The reduction in marginal leakage values by using two types of liners, measured when the margin of class II cavity located at enamel surface. Enamel has homogeneous structure, hydrophobic character and strong adhesion achieved with its inorganic tissue. [13] In the future, further clinical studies and researches needed to compare between these two liners at margin located in dentin surface.

CONCLUSIONS

Under the conditions of this an in vitro study: None of groups tested were able to totally prevented marginal leakage at enamel margin. · Marginal leakage of packable composite significantly decreases by using of RMGIC and flowable composite as liners. Among these two liners RMGIC showed less amount of marginal leakage than the flowable composite. Still further studies are required to determine the marginal leakage.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Leevailoj C, Cochran MA, Matis BA, Moore BK, Platt JA. Microleakage of posterior packable resin composites with and without flowable liners. Oper Dent. 2001; 26 (3): 302-7.

2. Neme AL, Maxson BB, Pink FE, Aksu MN. Microleakage of Class II packable resin composites lined with flowables: an in vitro study. Oper Dent. 2002; 27 (6): 600-5.

3. Tung FF, Hsieh WW, Estafan D. In vitro microleakage study of a condensable and flowable composite resin. General Dent. 2000; 48 (6): 711-5.

4. Tung FF, Estafan D, Scheren W. Microleakage of a condensable resin composite: an in vitro investigation. Quintessence Int. 2000; 31: 430-34.

5. Sensi LG, Marson FC, monteiro S J. Flowable Composites as Filled Adhesives, A Microleakage Study. J Cont Dent Prac. 2004; 5(4): 1-5.

6. Chuang SF, Jin YT, Lin TS, Chang CH, GarciaGodoy F. Effects of lining material on microleakage and internal voids of class II resin-based composite restorations. American J Dent. 2003; 16 (2): 84-90.

7. Bona A, Pinzetta C, Rosa V. Effect of acid etching of glass ionomer cement surface on the

microleakage of sandwich restorations. J appl oral sci. 2007; 15(3): 230-4.

8. Peutzfeldt A, Asmussen E. Composite restorations: Influence of flowable and self curing resin composite linings on microleakage in vitro. Oper Dent. 2002; 27: 569-575.

9. Goracci G., Mori G. and de' Martinis L.C. Curing light intensity and marginal leakage of resin composite restorations. Quintessence Int. 1996; 27: 355-362.

10. Beznos C. Microleakage at the cervical margin of composite Class II cavities with different restorative techniques. Oper Dent. 2001; 26: 60-69.

11. Donly ZR, Segura A, Donly KJ. In Vitro Microleakage of Two Glass Ionomer Cements. IADR/ AADR/ CADR 85th General Session and Exhibition (March 21-24, 2007); Seq#71 (Internet site:http://iadr.confex.com/iadr/2007orleans/tech pro gram/abstract_88957.htm. Date of access: 01/11/2011).

12. Stefanski S, van Dijken JWV. Clinical performance of a nanofilled resin composite with and without an intermediary layer of flowable composite: a 2-year evaluation. Clin Oral Invest. 2012; 16(1):147–153. (IVSL)

13. Loguercio AD, Bauer JR, Reis A. Microleakage in class II composite resin restorations: total bonding and open sandwich technique. J Adhes Dent. 2002; 4(2): 137-44.