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Effect of flowable composite resin and resin modified glass ionomer cement (RMGIC) on the microleakage of class II composite restorations: A systematic review

[1]Dr. Sanket Sawant, PG Student, Dept of Conservative, Dentistry and Endodontics, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune.

[2]Dr. Pradeep Shetty, Professor, Dept of Conservative Dentistry and Endodontics, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune.

[3]Dr. Shalini Aggarwal, Professor, Dept of Conservative Dentistry and Endodontics, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune.

[4]Dr. Eshani Shah, PG Student, Dept of Conservative Dentistry and Endodontics, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune.

Corresponding Author: Dr. Sanket Sawant, PG Student, Dept of Conservative Dentistry and Endodontics, Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune.

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Abstract

Effect of flowable composite resin and resin modified glass ionomer cement (RMGIC) on the microleakage of class II composite restorations: A systematic review

Background: Class II composite restorations most of the times have gingival margins apical to the cemento-enamel junction (CEJ). The most important causes of failure are microleakage at the cement dentinal margins. The aim of this review is to evaluate effect of flowable composite resin liner and resin modified glass ionomer cement (RMGIC) liner on the microleakage of class II composite restorations.

Aim: To systematically gather and evaluate the microleakage in class II composite restorations when flowable composites and resin modified glass ionomer cements are used as liners.

Data Sources: A systematic search was conducted using MEDLINE PubMed, Ebcso Host, Scopus, Google Scholar and manual search using DPU College library resources were searched up to and including 31st September 2018 in order to identify appropriate studies. All cross references were also screened.

Study Eligibility Criteria: The inclusion criteria were articles in English or those having detailed summary in English. Studies published between 2000 to 2018. Articles

providing information about microleakage in class II composite restorations. In vitro and comparative studies were selected. Review, case reports, abstracts, letters to editors, were excluded. In vivo studies were also excluded.

Result: Total 407 articles were identified through the database search and 9 articles were identified through other sources. Total records obtained were 416. These articles were then screened for titles. After thorough reading of titles 299 articles were excluded as they did not match the motive of study. Remaining 122 articles were further assessed for any duplicates and 89 articles were removed. These 33 articles were screened for abstracts and 22 articles were excluded after screening abstracts as these articles did not meet the eligibility criteria of study. Microleakage in class II cavities was not evaluated. Thorough reading of the full text of remaining 11 selected articles was assessed for eligibility. Amongst these 2 articles were then excluded from the study, due to eligibility criteria, full text was not accessible. Further 9 articles were included in the study.

Conclusion: There was statistically significant reduction in microleakage when a liner was applied under packable composites in comparison to the groups without any liner. However no significant difference was seen between flowable composite and resin modified glass ionomer cement (RMGIC).

Keywords: Microleakage, Flowable Composite Liner, Resin Modified Glass Ionomer Cement Liner, Class II Restorations.

Introduction

Rationale: Direct Class II composite restorations are often placed at a suitable standard if the cervical margin is in sound enamel; when the adhesive restorations are located below the CEJ (cemento-enamel junction) and cervical lesions have no enamel the quality of the marginal integrity is questionable.[1] Below the CEJ the bond with dentin is weaker: the polymerization shrinkage can result in gap formation between composite resin and also the cavity walls. Marginal gap formation contributes to micro leakage permitting the passage of oral fluids and bacteria from the mouth and become a source of postoperative sensitivity, pulpal inflammation and recurrent caries.[2-4] To scale back these effects are suggested, as a far better choice to the traditional resin technique, the class II open-sandwich restorations: glass-ionomer cement (GIC) or resin-modified glass-ionomer cement (RMGIC) is placed between the dentin cervical margins and occlusal composite restoration.[5,6] GICs and RMGICs are shown to be less able to seal margins, can dissolve over time in the oral environment.[7-9]

Recently flowable resin composites (FRC), with lower filler content and much lower viscosity, are recommended as liners at CEJ margins of the proximal box of class II composite restorations to improving marginal integrity and to resulting less micro leakage and post-operative sensitivity:[4,10] A layer of flowable materials at the gingival floor (in cementum margins) of Class II composite restorations get better the marginal seal of a restoration and is a perfect choice to be used during a open-sandwich technique.[11-13]

Some studies report that flowable composite liners do not reduce microleakage in Class II cavities,[14,15,16-18] while other studies indicate that flowable composites as liners in Class II cavities could reduce microleakage.[12,19,20] These conflicting results might be attributed to the physical and mechanical characteristics of different flowable composites having different effects on marginal sealing. On one hand, the high fluidity of flowable composites would increase the

wetting of resin, leading to better coverage of surface irregularities.

The type of adhesive system used in the bonding of restorative material is another factor contributing to marginal microleakage.[18] To obtain adequate bonding, the smear layer, which is formed during cavity preparation, must be treated or removed by adhesives.[21] However, the effects of different adhesive systems vary widely both on the smear layer and in bonding quality.[17,22,23] Biologically and technically, bonding mechanisms are different in etch-and-rinse and self-etch systems.[24]

Thus considering the available literature, the main aim of this systematic review is to examine the effect of flowable composite resin liner and resin modified glass ionomer cement (RMGIC) liner on the microleakage of class II composite restorations.

Methods

Inclusion Criteria:

- Articles in English language.
- Studies published in 1st Jan 2000 to 31st Sept 2018.
- In vitro studies done in human extracted teeth.
- Studies comparing effect flowable composite resin liner and resin modified glass ionomer cement (RMGIC) liner on the microleakage of class II composite restorations.

Exclusion Criteria

- Review, Abstract, Letter to editorials and in vivo studies are excluded.
- Any studies done before 1st Jan 2000

The PICO guidelines that were selected are: P as Participants were included and this comprised of freshly extracted human teeth with class II cavities. C as the comparison where comparison was between flowable composite resin and resin modified glass ionomer cement (RMGIC). O as the outcome where microleakage was assessed. The PICO is mentioned below:

P - (Product) - Extracted teeth with class II cavities

C - (Comparison) - Flowable composite resin liner with resin modified glass ionomer cement (RMGIC) liner

O - (Outcome) - Microleakage

Information Sources: Four internet sources of evidence were used in the search of appropriate papers satisfying the study purpose: the National Library of Medicine (MEDLINE PubMed), EBSCOhost, SCOPUS and Google Scholar. All cross reference lists of the selected studies were screened for additional papers that could meet the eligibility criteria of the study. The data bases were searched including January 2000 to September 2018 using the search strategy.

Search: The following databases were searched on PubMed (The limits used were all full text articles in English dated from 1st January 2000 to September 31st 2018), EBSCOhost, SCOPUS and Google Scholar. For the electronic search strategy, the following terms were used as keywords in several combinations.

Table 1: Table Showing Keywords Used In This Systematic Review

Primary Keywords	Secondary Keywords
Microleakage	
Flowable Composite Liner	
Resin Modified Glass Ionomer Cement Liner	RMGIC Liner
Class II Restorations	Class II Composite Restorations

Table 2: Table representing number of articles established using search strategy

Sr. No.	Search strategy	Number of articles	Number of selected articles	After Duplicate Removal
Search Strategy 1	Microleakage AND Flowable Composite AND Resin Modified Glass Ionomer Cement AND Class II Restorations	12	10	-
Search Strategy 2	Microleakage AND Flowable composite AND Class II Restorations	33	25	19
Search Strategy 3	Microleakage AND Glass Ionomer Cement AND Class II Restorations	21	5	1
Search Strategy 4	Microleakage AND Class II Restorations	158	31	8
Search Strategy 5	Flowable Composite AND Resin Modified Glass Ionomer Cement AND Class II Restorations	10	05	0
Search Strategy 6	Flowable Composite AND Resin Modified Glass Ionomer Cement	20	05	0
Search Strategy 7	Resin Modified Glass Ionomer Cement OR RMGIC AND Class II Restorations	89	06	0
Search Strategy 8	Flowable Composite AND Class II Restorations	64	26	1
Search Strategy 9	Other Sources	09	09	04
Total		416	122	33

Study Selection Process

In vitro and comparative studies were selected. However, only articles where class II cavities restored using restorative resin, lined by flowable composite and resin modified glass ionomer liner, which were assessed for microleakage using dye penetration method ,visualised under microscope were included. By applying different search strategies from the above mentioned key words and the combinations various electronic databases were searched. Total 416 articles were identified through the database searching and 9 articles were identified through other sources. After thorough screening of 416 titles , 299 articles were excluded. Further these records were assessed for any duplicates and search articles were removed. Further 33 articles were screened for abstracts. 22 articles were then excluded after review of abstracts. 11 articles were then screened for full texts. Finally, 9 articles were quantified and were then included in the study.

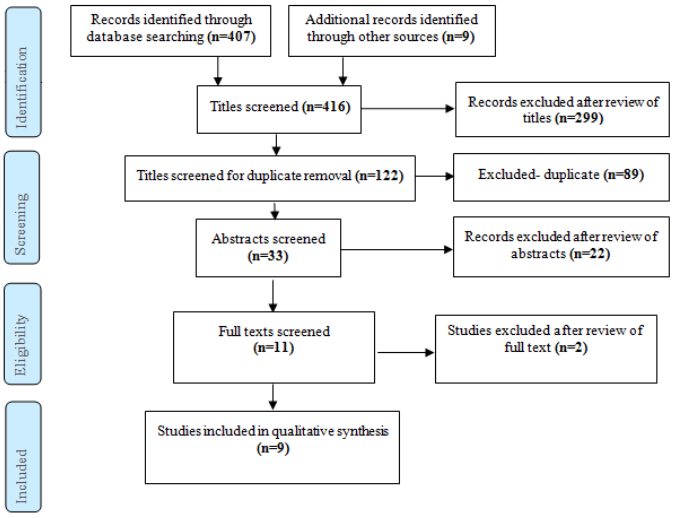
Data Collection Process: Data collection process was done according to the consultation approved from our expert. First a Pilot Microsoft Excel Sheet was filled accordingly and then the expert was consulted for further progress. According to the data and the records selected, the remaining Excel sheet was filled only with the data that was related to this study and retained.

Data Items: The headings under which the data was tabulated are Study ID where the number of selected studies were mentioned number wise. Various articles were included and so was the Name of the Author as an important factor. Year of publication to mention and specify the fixed time interval that was selected. Location where the study was done was specified according to various studies. Study Design was mentioned as to specify the type of study design, for example whether the study was in vivo, in vitro or in situ, comparative, control or blinding. Sample Size was mentioned to specify the number of participants included in the study. This comprised of freshly extracted human teeth on which class II cavities were made. Methodology included was standard in all the selected articles. Type of restorative resin used was specified according to various studies. Methodology for evaluation of microleakage was dye penetration method when visualised under microscope. Time duration for which specimens were placed in the dye was noted and specified according to the various studies undertaken. Mean values and standard deviation of microleakage was evaluated for comparison. Statistical significance to come to a mean conclusion. Results were mentioned according to the study protocol and in the authors original words. Remarks were expressed by the author of this systematic review.

Results

Total 407 articles were identified through the database search and 9 articles were identified through other

sources. Total records obtained were 416. These articles were then screened for titles. After thorough reading of titles 299 articles were excluded as they did not match the motive of study. Remaining 122 articles were further assessed for any duplicates and 89 articles were removed. These 33 articles were screened for abstracts and 22 articles were excluded after screening abstracts as these articles did not meet the eligibility criteria of study. Microleakage in class II cavities was not evaluated. Thorough reading of the full text of remaining 11 selected articles were assessed for eligibility. Amongst these 2 articles were then excluded from the study, due to eligibility criteria, full text was not accessible. Lastly, 9 articles were included in the study.



Discussion

Summary of Evidence: The advent of the esthetic era as well as the advances in adhesive technology saw the rise of resin composite materials. But the problem of polymerization shrinkage is still there. This lead to gap formation and microleakage. So many techniques and materials have been tried to overcome this problem. This systematic review has been undertaken to verify the hypothesis that the placement of resin-modified glass ionomer cement liner (RMGIC) or flowable composite as liner, beneath the packable composite, could reduce the microleakage in class II composite restorations. However, it is difficult to draw conclusions from the articles selected as they cannot be compared directly due to the diversity of eligibility criterias, assessment methods and outcomes.

Nine studies met the inclusion criteria established for the present investigation.

Kasraei S et al in 2011 evaluated microleakage at the occlusal and gingival margins of Class II packable composite restorations using resin-modified glass ionomer and flowable composite as liners, using the two-step etch-and rinse and self-etch dentin-bonding systems. This in vitro study was applied on 48 intact human premolars. Class II preparations were made with the gingival margins placed 1.0 mm apical to the CEJ. The teeth were randomly assigned to 6 groups of 16 boxes and restored using the below mentioned techniques:

Group 1: Single Bond(3M ESPE) + Filtek P60 (3M ESPE);

Group 2: Clearfil SE Bond (Kuraray) + Filtek P60;

Group 3: Single Bond + Filtek Flow (3M ESPE) + Filtek P60;

Group 4: Clearfil SE Bond + Filtek Flow + Filtek P60;

Group 5: Single Bond + Fuji II LC (GC) + Filtek P60;

Group 6: Clearfil SE Bond + Fuji II LC + Filtek P60.

The restorations were thermocycled for 1000 cycles at 5ºC and 55ºC, soaked in 2% methylene blue for 48 hours, then sectioned and viewed under a stereomicroscope for leakage at the gingival margin. Results showed that resin modified glass ionomer cement (RMGIC) causes significantly less microleakage than flowable composite when used as liners.

There was no difference between restorations with flowable resin composite liners and those without the liner; in addition, no significant difference was observed between the two kinds of adhesive systems.

Simi B, Suprabha BS., in 2011 compared the microleakage in class II nanocomposite restorations without liner, with resin-modified glass ionomer liner and flowable composite liner. 36 sound premolars extracted for orthodontic reasons were taken and assigned into 3 groups of 12 teeth each. Class II cavities of specific dimensions were prepared with margins placed in the enamel.

Group 1 : Cavities lined with resin modified glass ionomer cement (GC Fuji II LC-Improved)

Group 2 : Cavities lined with flowable composite resin (Filtex Z350 Flowable Restorative)

Group 3 : No liner.

Nanocomposite was used to restore all the teeth (Z 350 Universal Restorative). The teeth were placed in 0.5% methylene blue dye, sectioned and observed under stereomicroscope. Result showed there was less microleakage in group lined with resin-modified glass ionomer liner as compared to flowable composite liner group but not statistically significant. Group with no liner showed maximum leakage compared to resin modified glass ionomer liner and flowable composite liner group.

Majety KK, Pujar M., in 2011 evaluated the cervical marginal microleakage of class II packable composite resin restorations using flowable composite and resin modified glass ionomer as intermediate layers and whether the difference in the thickness of these intermediate layers would influence the microleakage. Standardized class II box only cavities (4 mm bucco lingual width 2 mm mesio distal depth with the gingival margin 1 mm above the cemento-enamel junction (CEJ) were restored as follows:

Group A : Restoration with packable composite alone;

Group B, Subgroup 1 : 1 mm flowable composite liner + packable composite;

Group B, Subgroup 2 : 2 mm flowable composite liner + packable composite;

Group C, Subgroup 1 : 1 mm resin modified glass ionomer cement (RMGIC) liner + packable composite;

Group C, Subgroup 2 : 2 mm RMGIC liner + packable composite

The specimens were thermocycled, stained with methylene blue, sectioned to evaluate the dye penetration under stereomicroscope. Results showed there was no statistically significant difference between the groups. The difference in the thickness of the intermediate layers did not influence the microleakage.However, use of 1 mm of flowable composite intermediate layer improved the sealing ability of packable composites than the differential thickness of resin modified glass ionomer.

Rajesh A. et al in 2012 evaluated the effect when resin-modified glass ionomer cement (RMGIC) and flowable composite were placed, as liner, beneath the packable composite, on the gingival surface of the tooth, on microleakage in class II composite restoration. Sixty recently extracted noncarious human mandibular molars were selected. The teeth were randomly divided into 3 groups (20 specimens each):

Group I : Filtek P60 with RMGIC liner

Group II : Filtek P60 with Filtek Z350 liner

Group III : Filtek P60 without liner

The teeth of each group were further divided into two subgroups (same number of cavities).

Subgroup A: gingival seat 1 mm occlusal to cementoenamel junction on mesial side

Subgroup B: gingival seat 1 mm apical to cementoenamel junction on distal side.

It was found that in class II composite restorations, more microleakage at the dentinal surface than on enamel. The use of a flowable composite and RMGIC, as liners, beneath the packable composite, in class II composite

restorations, significantly reduces the microleakage when margins are in dentin. The reverse is true for the margins in enamel.

Moazzami SM. et al in 2014 evaluated the effect of four different sandwich techniques on gingival microleakage of Class II direct composite resin restorations. Fifty sound human premolars were selected and randomly divided into five groups (n=10). Class II box only cavities were prepared in one of the proximal surfaces of each tooth with a gingival margin located approximately 0.5 mm below the cemento- enamel junction.

Group A : Cavity restored restored incrementally with composite resin (Tetric Ceram)

Group B : Cavity restored with compomer (Compoglass F)

Group C : Cavity restored with flowable composite resin (Tetric Flow)

Group D : Cavity restored with self-cure composite resin (Degufill SC)

Group E : Cavity restored with resin modified glass ionomer (Fuji II LC).

After thermal-load cycling, the specimens were immersed in 0.5% basic fuschin for 24 hours. Dye penetration (10^{-1} mm) was detected using a sectioning technique. Results showed the least amount of microleakage was in the incremental group (1.28 ± 0.98). The sandwich technique using resin modified glass ionomer (7.99 ± 9.57) or compomer (4.36 ± 1.78) resulted in significantly more leakage than did the sandwich technique using flowable (1.50 ± 1.97) or self-cure composite (2.26 ± 1.52).

Sawani S. et al in 2014 obsereved microleakage in Class II restorations using open vs closed centripetal buildup techniques with various liner materials. Ideal mesi-occlusal (MO) and distoocclusal (DO) Class II tooth preparations were made on 53 molars and samples were divided into 6 groups and on 1 control group for restorations.

Group 1 : Open-Sandwich technique with flowable composite at the gingival floor

Group 2 : OST with resin-modified glass ionomer cement at the gingival floor

Group 3 : Closed-Sandwich technique with flowable composite resin at the pulpal floor and axial wall

Group 4 : CST with RMGIC at the pulpal floor and axial wall

Group 5 : OST with flowable composite resin at the pulpal floor, axial wall, and gingival seat

Group 6 : OST with RMGIC at the pulpal floor, axial wall, and gingival seat

Group 7 : Control — no liner.

After restorations and thermocycling, apices were sealed and samples were dipped in 0.5% basic fuchsin dye. Sectionings were subjected to stereomicroscopic evaluation. Cervical scores of control were more than the exprimental groups ($P < 0.05$). Less microleakage was seen in CST than OST in all experimental groups ($P < 0.05$). Insignificant differences were observed among occlusal scores of different groups ($P > 0.05$).

Gowda VB. et al in 2015, carried out a study to compare the microleakage in class II composite restorations without a liner and with RMGIC and flowable composite liner. Forty ideal mesio-occlusal cavities were prepared on permanent mandibular molars. Later, divided into 4 groups of 10 teeth. The cavity preparations were etched, rinsed, blot dried, and light cured and Adper Single Bond 2 is applied.

Group 1 : Cavtity restored with Filtek P60 packable composite in 2mm oblique increments

Group 2 : Cavity restored with 1mm Filtek Z350 flowable liner is applied and light cured for 20 se

Group 3 : Cavity restored same as group 2, but the liner was cocured with packable composite

Group 4 : 1mm RMGIC, Fuji Lining LC is applied and cured for 20 sec.

Teeth were restored as in case of Group 1. The teeth were coated with nail varnish leaving 1 mmaround the restoration, then subjected to thermocycling, basic fuchsin dye penetration, sectioned mesiodistally. Finally observed under a stereomicroscope. In results, the mean leakage scores of the individual study groups were Group 1 (33.40), Group 2 (7.85), Group 3 (16.40), and Group 4 (24.35). Group showed maximum microleakage. Flowable composite liner with less microleakage.

Aggarwal V. et al in 2014, conducted an in-vitro study to comparatively evaluate the effect of flowable composite resin liner and resin modified glass ionomer liner on gingival marginal adaptation of class II cavities restored using three bonding agents (Single Bond 3M ESPE, One Coat Self Etching Bond Coltene Whaledent; Adper Easy Bond Self-Etch Adhesive 3M ESPE) and respective composite resins, under cyclic loading. The marginal adaptation was evaluated in terms of 'continuous margin' (CM) at the gingival margin. Ninety class II cavities with margins extending 1mm below the cement enamel junction were prepared in extracted mandibular third molars. The samples were divided into three groups: no liner placement; 0.5–1 mm thick flowable resin liner placement (Filtek Z350 XT flowable resin) on gingival floor and; light cure glass ionomer (Ketac N100) liner. The groups were further subdivided into three sub-groups on the basis of the bonding agents used. Cavities were restored with composite resins (Z350 for Single Bond and Adper Easy Bond; and SynergyD6Universal, for One Coat Self Etching Bond) in 2 mm increment sand the samples were mechanically loaded (60 N, 1,50,000 cycles). Marginal adaptation was evaluated using a low vacuum scanning electronmicroscope. Placement of flowable composite liner improved the CM values of Single Bond (78 ± 11%) and One Coat Self Etching Bond (77 ± 9%) when compared with no liner group, but the values of CM of Adper Easy Bond were not so good (61 ± 12%). Placement of glass ionomer fairly improved the values of CM in all the sub-groups (78 ± 9%, 72 ± 10% and 77 ± 10% for Single Bond, One Coat Self Etching Bond & Adper Easy Bond respectively) compared with no liner group.

Shirinzad M et al in 2016, conducted a study to determine the microleakage in gingival margins of Class II composite restorations through using three various types of liners. In this in-vitro study, two mesial and distal Class II cavities with 1mm gingival margins were made under CEJ on 24 healthy human premolar teeth. The teeth were randomly divided into four groups:

Group 1 : Rely X Unicem liner,

Group 2 : PAN F2 liner,

Group 3 : RMGI liner,

Group 4 : No liner

Then, teeth were restored using SE bond and Z-250 composite. The teeth were immersed in 2% fushin solution. Before that thermocycling was done for 24 hours. Then, the teeth were sectioned mesiodistally for to analyzing the microleakage under stereomicroscope. In results, microleakage of cavities in experimental groups were significantly different ($p < 0.05$). Groups 1 and 3 had significantly lower microleakages compared to group 2 ($p < 0.05$). However, these two groups had no significant difference with each other ($p=0.590$). Thus it is concluded that Pacement of liner in posterior composite restorations reduced microleakage significantly compared to the control group. RXU and RMGI cements had similar effects on reducing microleakage and had significantly lower microleakage than PAN F2 cement.

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