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ORIGINAL ARTICLE

The Effect of Different Liners on the Microleakege of Class II Restorations after Thermocyclign and Occlusal Loading

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Abstract

Objective: We evaluated in vitro marginal adaptation of class II resin composite restorations with and without a liner.

Materials and Methods: In total, 48 extracted sound human **mandibular** molars were used. The teeth were prepared following a standardized pattern for a class II cavity. The teeth were then randomly divided into four groups of 12 teeth each: group 1: resin-modified glass ionomer liner (RMGI) + composite resin (CR), group 2: flowable composite liner + CR, group 3: self-adhesive flowable composite liner + CR, and group 4: CR. The specimens were thermocycled and loaded with a mechanical loading device. The methylene blue dye penetration test was used to evaluate microleakage.

Results: When specimens were evaluated for occlusal and gingival microleakage, the resin-modified and flowable composite groups showed significantly less microleakage than the control group with no liner. The self-adhesive flowable composite group showed no significant improvement.

Conclusions: Flowable composite and RMGI liners were useful in decreasing microleakage, but the self-adhesive flowable composite liner showed no significant advantage.

Keywords: Microleakage, liner, occlusal loading, self-adhesive flowable composite, thermocycling

Introduction

The earliest introduced light-curing resin composites were not suitable for the restoration of posterior teeth, because of their inadequate wear resistance, microleakage, and polymerization shrinkage (1-3). Due to developments in adhesive systems and resin composites since then, today, they have begun to be used for restoring the posterior teeth (4). However, in vivo and in vitro studies still report that microleakage at restoration margins is not prevented completely (5,6) .

Polymerization shrinkage and dimensional changes in resin composites are factors in adhesive failures at the resin composite-tooth structure interface (7). Volumetric polymerization shrinkage of composite materials of at least 2.0% has been observed (8). In fact, a direct relationship between polymerization contraction stress and marginal adaptation has been demonstrated (1). As a result, microleakage occurs and its consequences, such as postoperative sensitivity, secondary caries, and pulp irritation, are causes of restoration failure (9,10).

The tooth-restoration interface can be controlled using various methods and materials. Incremental techniques, soft-curing methods, and the use of low-viscosity and low-modulus lining materials are generally preferred (11-13). It is generally accepted that the use of materials with a low modulus of elasticity increase the marginal adaptation (14). Flowable composites and resin-modified glass ionomers are usually used as liners for composite restorations. Lower modulus liners, such as flowable composites and resin-modified glass ionomers, can compensate for dimensional changes during polymerization (15). Also, using a liner can reduce the total amount of composite needed, so that polymerization shrinkage and gap formation can be reduced (16).

Glass ionomers were first introduced in the early 1970s (17). Since then, several changes were made to improve the mechanical properties of glass ionomers and subsequently resin-modified glass ionomers were developed. Glass ionomers were usually used for restorations of primary teeth, luting cements, liners for different restoration, and class V restorations of permanent teeth (18). The advantages of glass ionomers include thermal expansion similar to that of teeth, chemical bonding between the dentin and enamel, advanced biocompatibility, and bacteriostatic effects (19).

Flowable composites have lower physical properties when compared with 'standard' restorative composites (20). However, flowable composite can be used as liners under restorations and can increase marginal adaptation by absorbing contraction

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stresses. Today, self-adhering flowable composites are available. These new composite resin systems reportedly bond to dentin and enamel without the application of an adhesive bonding agent. They combine adhesive and composite technology (21). The self-adhering composite resin "Fusio Liquid Dentin" (Pentron Clinical Technologies, Wallingford, CT, USA) contains the functional monomer 4-methacryloxyethyltrimetellitic acid (4-MET) that has demonstrated chemical bonding potential to hydroxyapatite and tooth tissue (22). It also contains hydroxyl-ethyl methacrylate (HEMA), a monomer commonly used in dental adhesives to enhance wetting and resin penetration in dentin (23). These materials have been recommended for fissure sealants, blocking out undercuts, liners, and small permanent teeth restorations (24).

The first objective of this study was to evaluate in vitro microleakage of class II resin composite restorations with and without liners. The second objective was to compare the effects of different base materials on microleakage.

Materials and Methods

In total, 48 extracted sound (non-carious and unrestored) mandibular human molars were selected. The teeth were cleaned, polished using scalers and pumice, and then stored in distilled water until use.

Table 1: Materials used in the study

Material	Type	Composition
Ionolux Voco, Cuxhaven, Germany	Light-cured resin modified glass ionomer restorative	Polyacrylic acid solution, 2-hydroxyethyl methacrylate, glycerindimethacrylate, urethanedimethacrylate, tartaric acid and initiators
Grandio Flow Voco, Cuxhaven, Germany	Flowable composite resin	Flowable, light-curing nanohybrid composite dimethacylates, silicates, initiators, stabilizers, pigments and additives
Fusio Liquid Dent Pentron, CT, USA	Self adhesive flowable composite	Mixture of UDMA, TEGDMA, HEMA, & 4-MET resins, silane-treated bariumborosilicate glasses, silica with initiators, stabilizers and UV absorber, organic and/or inorganic pigments, opasifiers
Futura Bond NR Voco, Cuxhaven, Germany	Self Etch Adhesive	Acidic adhesive monomer, Bis-GMA, 2-hydroxyethyl methacrylate
X-trafill Voco, Cuxhaven, Germany	Hybrid midi-fill composite	Bis-GMA, UDMA, TEGDMA, Barium, Bor, Aluminium, silisium glass

Cavity Preparation

The teeth were mounted in a plastic model. Conservative class II cavities were prepared with a cylindrical diamond bur (Diatech Diamond Tools, Toronto, Ontario) using a high-speed air/water-cooled turbine. The specimens were prepared following a standardized pattern in which the class II cavity had a length of 3.0 mm, width of 3.0 mm, and depth of 3.0 mm **in** occlusal. After preparation, the specimens were divided randomly into four experimental groups of 12 teeth each.

Restorative Procedures

Group 1

A resin-modified glass ionomer liner (Ionolux AC, Voco GmbH, Cuxhaven, Germany), 1 mm thick, was placed, extending to the full width of the pulpal floor and the axial wall of the teeth and was light-cured for 20 s using an LED curing unit (Elipar FreeLight 2, 3M ESPE, St. Paul, MN, USA). Then, matrix bands (Sectional Matrix Retainer System, 3M ESPE) and wooden wedges (TDV, Santa Catarina, Brazil) were installed. A self-etch adhesive (Futura Bond NR, Voco GmbH) was used according to the manufacturer's instructions. Restorations were performed incrementally with a light-curing posterior composite resin (X-tra fil, Voco GmbH). The matrix band and wedges were removed and then the restorations were finished with #8379 and 863 EF finishing burs (Busch, Germany) on a high-speed hand piece with a light water-spray, and polished with aluminum oxide-coated discs (Sof-Lex, 3M, USA) on a slow-speed hand piece.

Group 2

A self-etch adhesive (Futura Bond NR) was used according to the manufacturer's instructions. Flowable composite (Grandio Flow, Voco GmbH) was placed in the same manner as the resin-modified glass ionomer liner in Group 1. Then, the teeth were restored in the same manner as group 1.

Group 3

A self-adhesive flowable composite (Fusio Liquid Dentin, Pentron, Orange, CA, USA) was placed in the same manner as the resin-modified glass ionomer liner in Group 1. Then, the teeth were restored in the same manner as group 1.

Group 4.

A self-etch adhesive (Futura Bond NR) was used according to the manufacturer's instructions. Specimens were treated only with a light-curing posterior composite resin (X tra fil). Table 1 shows the properties of the restorative materials.

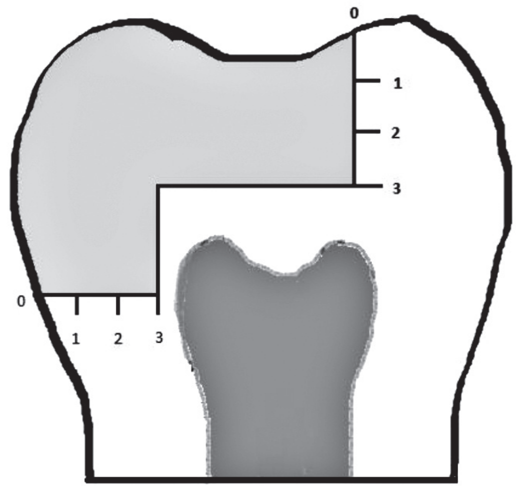
Thermocycling and Occlusal Loading

The restored teeth were stored at 37°C and 100% humidity in an incubator for 24 h. Then, the specimens were thermocycled for 2000 cycles between 5°C and 55°C with a dwell time of 30 s in each bath. Specimens were loaded 10,000 times with 100 N in a mechanical loading device.

Microleakage Testing

The apices of the specimens were sealed with sticky wax and all tooth surfaces were covered with two coats of clear nail polish, with exception of 1.0 mm around the tooth-restoration margins, and were allowed to air dry. All specimens were then immersed in 2% methylene blue dye for 24 h. After removal from the dye, the teeth were rinsed under running water and the nail polish was

Figure: Microleakage Scoring Criteria



0: No dye penetration
1: Dye penetration up to, but not beyond half of the occlusal or gingival wall
2: Dye penetration up to, but not contacting the axial wall
3: Dye penetration along the axial wall

The results were transferred to a statistical software package for data analyses. Analyses included Kruskal-Wallis and Mann-Whitney U-tests.

Table 2 : Microleakage scores of **the** specimens

Groups	Occlusal				Gingival			
	Max.	Min.	Mean	Std.Dev.	Max.	Min.	Mean	Std.Dev.
Group1 Resin modified glass ionomer	2	0	0,72	0,64	3	0	1,09	0,94
Group2 Flowable composite	2	0	0,81	0,6	3	0	1,18	0,87
Group 3 Self adhesive flowable composite	2	0	1,09	0,7	3	0	1,36	0,8
Group 4 No Base	3	0	1,27	0,78	3	1	1,63	0,88

scraped off. The teeth were sectioned along the mesio-distal direction, coincident with the center of the restoration, using a water-cooled diamond saw.

Dye penetration at the occlusal and gingival margins of each section was evaluated independently by two observers using a stereomicroscope (Olympus SZ 60, Japan) at a magnification of ×16 and scored. The scoring criteria outlined in the figure were used to rank the degree of microleakage (25).

Results

The means, maximum scores, minimum scores, and standard deviations of the microleakage scores for all groups are presented in Table 2. Generally, the occlusal margins had lower scores than the gingival margins; however, the difference was not statistically significant. When specimens were evaluated for occlusal and gingival microleakage, the resin-modified glass ionomer (group 1) and flowable composite resin (group 2) groups had significantly less microleakage than the control (group 4) group. The self-adhesive flowable composite resin group (group 3) showed no significant improvement over the control group.

Discussion

Microleakage is considered a major cause of clinical failure in composite restorations (3). The sealing ability of adhesive resins, polymerization shrinkage of composite resins, configuration factors (C-factors), and occlusal forces and temperature changes that occur during eating may affect microleakage in composite restorations (8, 26-29). In this study, occlusal loading and thermocycling were applied to specimens to simulate the **oral** environment.

The sealing of restorations can be evaluated using various techniques. Bacterial leakage, micro CT, scanning electron microscopy, fluid filtration, dye penetration, and electrochemical techniques have been used (29-33). In this study, methylene blue dye penetration was used because dye-penetration techniques are inexpensive and simple. Also, the various microleakage techniques yield essentially similar results (34).

In the current study, higher microleakage was observed in the gingival margins than the occlusal margins, but the difference was not statistically significant. This was likely due to the greater thickness of the enamel at the occlusal margins (more regular substrate and better adhesion than dentin) and better polymerization of the composite resin at the occlusal margins (related to the distance of the material from the light source). Previous studies are consistent with this (34).

The effect of a liner under a composite restoration was also evaluated, because several studies have shown that a thin layer of liner can absorb contraction stresses due to the polymerization of a composite resin, while also increasing marginal adaptation (9,20,35). Polymerization shrinkage of composites can produce gaps at the restoration-tooth interface, contributing to microleakage. Also, using a liner reduces the volume of composite and the C factor of the cavity (36). The results of this study showed the importance of using liners under composite restorations; the groups with resin-modified glass ionomer and flowable composite liners showed significantly less microleakage.

The resin-modified glass ionomer group showed less microleakage than the other liner groups, but the difference was not statistically significant. The resin-modified glass ionomer likely showed better performance because it can bond to dentin chemically (37). Also, the resin-modified glass ionomer cement setting mechanism may be effective, because the setting reaction of resin-modified glass ionomer cement occurs slowly, and it can tolerate shrinkage stress from a composite resin (38).

The content of the flowable composite resin differs (less filler, many smaller resin components) from the other composite types. Thus, flowable composite shrinks more than the other types, and it likely induces more stress at the tooth-restoration interface (39).

In this study, the self-adhesive flowable composite resin did not decrease microleakage, compared with the samples with no base. This result may have been caused by the mechanical properties and chemical structure of the material. Fu et al. compared the bonding performance of self-adhesive flowable composite resins with conventional composite resins applied with one- and two-step dental adhesives. According to the results of that study, conventional composite resin application with one- or two-step dental adhesive application showed higher bonding performance compared to self-adhering flowable composite resins. The fracture modes of the self-adhering flowable composite resin samples showed that 87.5% and 100% of failures were adhesive failures, occurring at the resin dentin interface (40). This finding is consistent with our results. The higher microleakage values of self-adhering flowable composite resin samples were likely due to their lower bond strength than the conventional composite resins. Future studies should address the reason(s) for this finding.

Conclusions

1. The occlusal margins showed lower microleakage scores than the gingival margins; however, the difference was not statistically significant.
2. No technique used in this study prevented microleakage.
3. Flowable composite and RMGI liners may be useful in decreasing microleakage, compared with the no-base group.
4. The self-adhesive flowable composite liner showed no significant improvement versus the control group, which had no base.
5. The results of this study showed the importance of using liners under composite restorations, because the groups with resin-modified glass ionomer and flowable composite liners showed less microleakage.

References

1. Braga RR, Ballester RY, Ferracane JL. Factors involved in the development of polymerization shrinkage stress in resin-composites: a systematic review. Dent Mater. 2005; 21:962-70.
2. Jackson RD, Morgan M. The new posterior resins and a simplified placement technique. J Am Dent Assoc. 2000; 131:375-83.
3. Leevailoj C, Cochran MA, Matis BA, Moore BK, Platt JA. Microleakage of posterior packable resin composites with and without flowable liners. Oper Dent. 2001; 26:302-7.
4. Statement on posterior resin-based composites. ADA Council on Scientific Affairs; ADA Council on Dental Benefit Programs. J Am Dent Assoc. 1998;129:1627-8.
5. Belli S, Inokoshi S, Ozer F, Pereira PN, Ogata M, Tagami J. The effect of additional enamel etching and a flowable composite to the interfacial integrity of Class II adhesive composite restorations. Oper Dent. 2001;26:70-75.
6. Ernst CP, Canbek K, Aksogan K, Willershausen B. Two-year clinical performance of a packable posterior composite with and without a flowable composite liner. Clin Oral Invest. 2003;7:129-134.
7. Feilzer AJ, Dooren LH, de Gee AJ, Davidson CL. Influence of light intensity on polymerization shrinkage and integrity of restoration-cavity interface. Eur J Oral Sci. 1995;103:322-6.
8. Lutz F, Krejci I, Barbakow F. Quality and durability of marginal adaptation in bonded composite restorations. Dent Mater. 1991;7:107-13.
9. Sano H, Shono T, Takatsu T, Hosoda H. Microporous dentin zone beneath resin-impregnated layer. Oper Dent. 1994;19:59-64.
10. Van Meerbeek B, Perdigao J, Lambrechts P, Vanherle G. The clinical performance of adhesives. J Dent. 1998;26:1-20.
11. Gueders AM, Charpentier JF, Albert AI, Geerts SO. Microleakage after thermocycling of 4 etch and rinse and 3 self-etch adhesives with and without a flowable composite lining. Oper Dent. 2006;31:450-5.
12. Knezevic A, Tarle Z, Meniga A, Sutalo J, Pichler G, Ristic M. Degree of conversion and temperature rise during polymerization of composite resin samples with blue diodes. J Oral Rehabil. 2001;28:586-91.
13. Mullejans R, Lang H, Schuler N, Baldawi MO, Raab WH. Increment technique for extended Class V restorations: an experimental study. Oper Dent. 2003;28:352-6.
14. Kemp-Scholte CM, Davidson CL. Complete marginal seal of Class V resin composite restorations effected by increased flexibility. J Dent Res. 1990;69:1240-3.
15. Haak R, Wicht MJ, Noack MJ. Marginal and internal adaptation of extended class I restorations lined with flowable composites. J Dent. 2003;31:231-239.
16. Bowen R. Reduction of microleakage around composite restoration. J Dent Res. 1987;66:246.
17. Wilson AD, Kent BE. A new translucent cement for dentistry. The glass ionomer cement. Br Dent J. 1972;132:133-5.
18. Berg JH. Glass ionomer cements. Pediatr Dent. 2002;24:430-8.
19. Aboushala A, Kugel G, Hurley E. Class II composite resin restorations using glass-ionomer liners: microleakage studies. J Clin Pediatr Dent. 1996;21:67-70.
20. Kasraei S, Azarsina M, Majidi S. In vitro comparison of microleakage of posterior resin composites with and without liner using two-step etch-and-rinse and self-etch dentin adhesive systems. Oper Dent. 2011;36:213-21.
21. Wajdowicz MN, Vandewalle KS, Means MT. Shear bond strength of new self-adhesive flowable composite resins. Gen Dent. 2012 Mar-Apr;60(2):e104-8.)
22. Poitevin A, De Munck J, Van Ende A, Suyama Y, Mine A, Peumans M, Van Meerbeek B. Bonding effectiveness of self-adhesive composites to dentin and enamel. Dent Mater. 2013 Feb;29(2):221-30
23. Bektas OO, Eren D, Akın EG, Akın H. Evaluation of a self-adhering flowable composite in terms of micro-shear bond strength and microleakage. Acta Odontol Scand. 2013 May-Jul;71(3-4):541-6
24. Margvelashvili M, Vichi A, Carrabba M, Goracci C, Ferrari M. Bond strength to unground enamel and sealing ability in pits and fissures of a new self-adhering flowable resin composite. J Clin Pediatr Dent. 2013 Summer;37(4):397-402
25. Bagıs YH, Baltacıoglu IH, Kahyaogulları S. Comparing Microleakage and the Layering Methods of Silorane-based Resin Composite in Wide Class II MOD Cavities. Oper Dent. 2009, 34-5, 578-585.

26. Amaral CM, Hara AT, Pimenta LA, Rodrigues AL, Jr. Microleakage of hydrophilic adhesive systems in Class V composite restorations. Am J Dent. 2001;14:31-3.

27. Costa Pfeifer CS, Braga RR, Cardoso PE. Influence of cavity dimensions, insertion technique and adhesive system on microleakage of Class V restorations. J Am Dent Assoc. 2006;137:197-202.

28. Krejci I, Sparr D, Lutz F. Three-layer light hardening procedure with traditional composites for Black Class II restorations. Quintessence Int. 1987;38:1217-29.

29. Manhart J, Chen HY, Mehl A, Weber K, Hickel R. Marginal quality and microleakage of adhesive class V restorations. J Dent. 2001;29:123-30.

30. Deveaux E, Hildelbert P, Neut C, Boniface B, Romond C. Bacterial microleakage of Cavit, IRM, and TERM. Oral Surg Oral Med Oral Pathol. 1992;74:634-643.

31. Eden E, Topaloglu-Ak A, Cuijpers V, Frencken JE. Micro-CT for measuring marginal leakage of Class II resin composite restorations in primary molars prepared in vivo. Am J Dent. 2008;21:393-397.

32. Pradelle-Plasse N, Wenger F, Picard B, Colon P. Evaluation of microleakage of composite resin restorations by an electrochemical technique: the impedance methodology. Dent Mater. 2004;20:425-434.

33. Prati C, Tao L, Simpson M, Pashley DH. Permeability and microleakage of Class II resin composite restorations. J Dent. 1994;22:49-56.

34. Tredwin CJ, Stokes A, Moles DR. Influence of flowable liner and margin location on microleakage of conventional and packable class II resin composites. Oper Dent. 2005;30:32-38.

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

36. Arora V, Kundabala M, Parolia A, Thomas MS, Pai V. Comparison of the shear bond strength of RMGIC to a resin composite using different adhesive systems: An in vitro study. J Conserv Dent. 2010;13:80-3.

37. Marquezan M, Fagundes TC, Toledano M, Navarro MF, Osorio R. Differential bonds degradation of two resin-modified glass-ionomer cements in primary and permanent teeth. J Dent. 2009;37:857-64.

38. Kim YG, Hirano S. Setting shrinkage and hygroscopic expansion of resin-modified glass-ionomer in experimental cylindrical cavities. Dent Mater J. 1999;18:63-75.

39. Bayne SC, Thompson JY, Swift EJ, Jr., Stamatiades P, Wilkerson M. A characterization of first-generation flowable composites. J Am Dent Assoc. 1998;129:567-9.

40. Fu J, Kakuda S, Pan F, Hoshika S, Ting S, Fukuoka A, Bao Y, Ikeda T, Nakaoki Y, Selimovic D, Sano H, Sidhu SK. Bonding performance of a newly developed step-less all-in-one system on dentin. Dent Mater J. 2013;32(2):203-11.