



Microleakage analysis of dental caries lesions sealed with flow resin and compared to microhybrid resin restorations in dentin

Avaliação da microinfiltração de lesões de cárie dentinárias seladas com resina flow e restauradas com resina microhíbrida


Amanda de Albuquerque VASCONCELOS¹

 ORCID iD 0000-0001-8230-2907


Juliana Tietbohl de Almeida REIS¹

 ORCID iD 0000-0002-3218-7901


Bianca Fiorentin MOURA¹

 ORCID iD 0000-0002-3387-8034


Daniela Cavalcante GIRÃO¹

 ORCID iD 0000-0002-7151-1030

José Carlos Pettorossi IMPARATO²

 ORCID iD 0000-0002-1990-2851

Sérgio Luiz PINHEIRO³

 ORCID iD 0000-0001-7157-4923

ABSTRACT

Objective

To evaluate the sealing of cavities of dentinal occlusal caries lesions, reproduced *in vitro*, with flow resin compared to cavity restorations presenting healthy dentin using microhybrid composite resin.

Methods

The sample consisted of 27 healthy deciduous molars where cavities of approximately 2 mm in the fossa region were performed and occlusal cleft of each tooth were sealed, impermeabilization was performed and the sample was randomly divided into 2 groups: group I underwent cariogenic challenge and occlusal sealing with resin flow. The teeth of group II were restored with microhybrid composite resin. The teeth were immersed in 5% methylene blue for 8 hours at 37° C and washed until all the dye was removed from the surface. The teeth were sectioned in the mesio-distal direction. The penetration of the dye was evaluated: 0- no penetration; 1- dye penetration up to 1/3 of the restoration; 2- dye penetration up to 2/3 of the restoration depth; 3 - penetration of dye into the pulp wall. The results were analyzed by the Biostat 4.0 program. Descriptive analysis and the mode among the examiners submitted to the Mann-Whitney test.

Results

There was no significant difference in microleakage between restoration performed in healthy dentin with microhybrid composite resin or maintenance of infected dentin in primary teeth sealed with resin flow ($p = 0.6035$).

Conclusion

It was concluded that the marginal infiltration of primary molars sealed with microhybrid composite resin and resin flow was not influenced by the removal -or not -of the carious tissue or the material used.

Indexing terms: Dental caries. Dental leakage. Methylene blue. Pediatric dentistry. Tooth deciduous.

RESUMO

Objetivo

Avaliar o selamento de cavidades de lesões de cárie oclusais em dentina, reproduzidas *in vitro*, com resina flow comparando com restaurações em cavidades com dentina hígida utilizando resina composta microhíbrida.

Métodos

Foram selecionados 27 molares decíduos hígidos, realizadas cavidades de aproximadamente 2 mm na região de fossa e fissura da face oclusal de cada dente, impermeabilização e divisão em 2 grupos aleatoriamente: grupo I foram submetidos ao desafio cariogênico e selamento oclusal com resina flow. Os dentes do grupo II foram restaurados com resina composta microhíbrida. Os dentes foram imersos em azul de metileno a 5% durante 8 horas a 37 ° C e lavados até que todo o corante fosse removido da superfície. Os dentes foram seccionados no sentido mesio-distal. A penetração do corante foi avaliada: 0- nenhuma penetração; 1- a penetração de corante até 1/3 da restauração; 2- a penetração de corante até 2/3 da restauração profundidade; 3- penetração de corante para a parede pulpar. Os resultados foram analisados pelo programa Biostat 4.0. Foi feita análise descritiva e a moda entre os examinadores submetidas ao teste de Mann-Whitney.

¹ Faculdade São Leopoldo Mandic, Curso de Odontologia. Rua José Rocha Junqueira, 13. Swift, 13045-755, Campinas, SP, Brasil. Correspondência para / Correspondence to: AA VASCONCELOS. E-mail: <amanda_vasconcelos@hotmail.com>.

² Universidade de São Paulo, Faculdade de Odontologia. São Paulo, SP, Brasil.

³ Pontifícia Universidade Católica de Campinas, Faculdade de Odontologia. Campinas, SP, Brasil.

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Resultados

Não houve diferença significativa na microinfiltração entre restauração realizada em dentina hígida com resina composta microhíbrida ou a manutenção da dentina infectada em dentes decíduos selados com resina flow ($p=0.6035$).

Conclusão

A remoção ou não do tecido cariado, assim como o material utilizado, não influenciou na infiltração marginal de molares decíduos selados com resina composta microhíbrida e resina flow.

Termos de indexação: Cárie dentária. Dente decíduo. Infiltração dentária. Azul de metileno. Odontopediatria.

INTRODUCTION

With the advancement of preventive and minimally invasive dentistry, the treatment of caries lesions in children and adolescents has been viewed with great concern concerning invasive approaches. Thus, preventive measures which minimize the onset and progression of caries disease on occlusal surfaces are essential [1]. Conventional restorative treatment advocates complete removal of carious tissue. However with the occurrence of Minimal Intervention (MI), the conventional treatment of caries lesion was replaced by dental structure preservation treatments and incipient lesions on the enamel and dentin started to be treated as caries control procedures [2].

Due to the fact that some studies suggest that it is not essential to remove infected tissue in order to arrest the cariogenic process [3-5] studies propose the use of sealants for the control of lesions in dentin [6-14] and in the literature. The results of these studies suggest dentinal caries lesions arrestment. The studies carried out that propose the use of pit and fissure sealants in the control of dentinal caries lesions in primary molars have concluded that such procedures are a conservative alternative to restorative treatment, leading to the caries lesions arrestment in the early stages [11-14].

The efficacy of grooves and fissures sealing when compared to traditional restorations was analyzed through a randomized clinical trial in the treatment of non-cavitated dentin caries lesions in deciduous molars when compared to the conventional restoration with composite resin. In a sample experimental 30 children were studied using the split mouth design. The treatment efficacy was evaluated after one year, through clinical and radiographic examinations; after one year of follow-up the sample was reduced to 26, where 88.46% presented total retention, 11.54% partial retention and 0% complete loss. The radiographic analysis showed no difference between the groups.

Resin sealant and conventional restoration proved to be equally effective for fissure sealing. Invasive procedures can be replaced by a non-invasive approach

[15]. The efficacy of sealing for control of non-cavitated caries lesions when compared to teeth that have not received treatment was also analyzed, where the sealant of cavities and fissures proved to be effective in the caries lesions arrestment in a follow-up of 36 months [16]. Systematic reviews of total removal compared to ultraconservative removal of carious tissue have shown no difference concerning pulpal damage or disease or in the progression of caries lesion and longevity of the restorations, regardless of total removal or non-removal of the caries tissue [17,18].

In a study analyzing the effect of two sealants on the treatment of non-cavitated occlusal lesions in dentin of permanent molars, fourteen teeth sealed with resin sealant (Gres - Fluoroshield®) and 14 teeth with ionomeric sealant (Gciv - RIVA®) were analyzed. A qualitative and quantitative radiographic follow-up of 12 months was performed. The qualitative analysis showed lesion arrestment and regression and it was demonstrated that 64.3% of the cases in Gciv and 85.7% in Gres were found to be successful.

The quantitative evaluation, carried out by means of a comparison between the coefficients of demographic density, showed an increase of the density coefficients in Gres and in the Gciv a stability of the coefficients. Thus, it can be concluded that, under the conditions of this study, the use of pit and fissure sealants was effective in the treatment of carious lesions [19].

In a systematic review of superficial and moderately deep pit and fissure lesions, several treatment options were analyzed: 1) non-invasive treatments (application of fluoride, anti-bacterial treatments and oral hygiene orientation), avoiding any removal of dental tissue; 2- microinvasive treatment (sealing of the lesion with resinous and ionomeric sealants); 3 - minimally invasive treatments (restorative treatment with removal of carious tissue preserving the hard tissues); 4 - control, injuries without active treatment (this group is not a treatment option, but it was included for comparison purposes). The research included 14 studies representing 1440 patients with 3,551 treated lesions, where it was found that lesions with

microinvasive and minimally invasive treatment required less invasive retreatment than the control lesions.

The treatment which presented the best performance was the minimally invasive, followed by the microinvasive and the non-invasive, where the non-invasive treatment is still uncertain for the management of these. Microinvasive treatment was effective, but the disadvantage of microinvasive treatment was the need for retractions [20].

The use of resinous sealants for caries lesions sealing may present material retention failure. The high failure rate of sealant retention is often not associated with inadequate insulation. It can be caused by occlusal wear, shear forces, marginal failure and high risk of caries [21].

A study comparing the properties of the sealants of pits and fissures and flow resin in order to define clinical indications concluded that the flow resin has better mechanical properties than the sealant of pits and fissures [22,23].

Low resins present good aesthetic properties and due to the low viscosity are more easily inserted and adaptable to the cavity in comparison with other types of resin [24]. Due to their lower loading content compared to conventional composite resin, they present a higher polymerization contraction, thermal expansion coefficient and lower mechanical properties [23].

A clinical study was proposed to evaluate the retention and progression of caries lesion in small cavities up to 1.5 mm wide, using three types of materials: fluid resin composite, fluid composite, composite resin. The result obtained showed that there was no difference in the development of caries lesions in the 3 groups. The authors suggest that the fluid resin and fluid composite can be used for this type of restoration, as long as the restoration is followed-up due to the greater risk of failure for fluid materials [24].

A perfect seal of the tooth-restoration interface is important in order to avoid penetration of bacteria that can cause secondary caries [25]. The absence of enamel at the preparation margin aggravates the marginal failure [26].

In strictly occlusal and small-extension cavities the entire extent of the cavo-superficial angle presents enamel thus favoring marginal sealing, and due to its small extent it is believed that this type of cavity is less subject to chewing forces.

The present work shows scientific- base evidences in order to prove the minimal intervention efficacy and in the better performance of the flow resin when used in the sealing of decayed teeth, compared to the conventional

sealants of pits and fissures.

The objective of this study was to evaluate the microleakage of occlusal caries lesions in the outer half of dentin with flow resin, comparing restorative treatment sealing with microhybrid composite resin in healthy dentin.

METHODS

The present research was approved by the Ethics and Research Committee (ERC) of the Faculty of Dentistry São Leopoldo Mandic with approval number: 484,111. To carry out the study, 27 healthy deciduous molars were obtained from the donation of the Human Tooth Bank of the São Leopoldo Mandic Dental School. Inclusion criteria were: primary molars with a minimum of 1/3 root, absence of carious lesion - healthy, absence of internal and / or external perforation in the furca region.

A cavity with cylindrical diamond tips 1090 (KG Sorensen Indústria e Comercio LTDA, São Paulo, Brazil) was made on the occlusal surface of each tooth, depth reaching the dentine, 2 mm wide, 2 mm long and 2 mm deep. Measurements were checked with a periodontal probe.

Samples were sealed with epoxy resin (Araldite, São Paulo, Brazil) and enamel (Colorama, São Paulo, Brazil) except for 2 mm around the cavity margins in the laminar flow (Veco, Campinas, SP, Brazil).

The teeth were randomly divided into 2 groups: a) Experimental Group (EG): 13 teeth, caries lesion sealing with flow resin; b) Control Group (CG): 14 teeth, restorative treatment with microhybrid composite resin.

After impermeabilization the EG teeth were autoclaved at 120° for 1 hour and subjected to cariogenic challenge for 14 days: the samples were maintained in medium containing BHI (Brain Heart Infusion), 0.5% of yeast extract, 0.5 % glucose, 1 % sucrose and *Streptococcus mutans* standard strain ATCC 25175 standardized on the 0.5 scale of MacFarland. The medium was maintained in anaerobic environment at 37° C and replaced every 48 hours. The pH measurement was performed at each medium exchange [27].

After the preparation of the carious lesion in dentin, laboratorially in the experimental group, the sealing process of the caries lesion with flow resin in the EG and restoration with microhybrid composite resin in the GC were performed by a single operator, properly trained and accompanied by a flow laminar assistant. The EG teeth were subjected to the following steps: conditioning the occlusal surface with 37% phosphoric acid (condac 37,

FGM, Joinville, SC, Brazil) for 15 seconds, washing the acid with water jet at the same time, applying adhesive (Adper Single Bond 2, 3M ESPE, Saint Paul, USA) as directed by the manufacturer, photopolymerization of the adhesive system for 20 seconds. The sealing of the caries lesions with flow resin (Natural flow - New DFL, RJ, Brazil) was carried out by means of vibratory movements with exploratory probe, with the purpose of increasing the material flow, minimizing the inclusion of air bubbles. The material was polymerized for 20 seconds. The marginal integrity and sealing retention were analyzed with the aid of an exploratory probe.

The CG teeth were submitted to the following steps: conditioning of the occlusal surface with 37% phosphoric acid (condac 37, FGM, Joinville, SC, Brazil) for 15 seconds, removal of the acidic conditioning with water jet for 15 seconds, application of dentin adhesive (Adper Single Bond 2, 3M ESPE, Saint Paul, USA) as manufacturer-oriented and photopolymerization of the adhesive system for 20 seconds. The restoration was made with composite resin (Z-250, 3M ESPE, Saint Paul, USA) in A1 color, being inserted obliquely (to reduce the polymerization contraction) in small increments of approximately 2 mm. The polymerization time of each increment was 20 seconds. Photopolymerization in both groups was performed with a high power wireless led light curing device (Radii-cal, SDI, Australia). After restorative procedures, the teeth were immersed in 5% methylene blue for 8 hours at 37 ° C and washed until all dye was removed from the surface [28]. The teeth were sectioned through the center of the restorations in the mesio-distal direction using a carborundum disc (KG Sorensen, Cotia, SP, Brazil) with the aid of a mandrel and straight piece, where each dental unit gave rise to two pieces for evaluation, EG 26 pieces and CG 28. The dye penetration was evaluated by three independent pre-calibrated examiners by means of digital camera images.

The penetration of the dye was measured with the following degrees [28]:

0 = no penetration

1 = the penetration of dye to 1/3 of the depth restoration

2 = the dye penetration up to 2/3 of the depth restoration

3 = penetration of dye into the pulp wall

Inter and intra-examiner results were analyzed by the Kappa test for reproducibility evaluation.

The results of the evaluations were analyzed by the Biostat 4.0 program. Descriptive analysis and mode

were performed among the examiners submitted to the Mann-Whitney test.

RESULTS

Descriptive analysis of the data of each group was carried out and the mode between the evaluators is represented in Table 1. No significant statistical difference between the evaluators was found.

The behavior of the restorations according to the levels of infiltration presented by the groups can be visualized in Figure 1. In the majority of cases, the evaluators scored the sample in 0 (no penetration), where the Experimental Group presented a higher rate, 20 samples 76 (92%) and Control Group 19 (67.85%).

Score 1 (penetration of dye to 1/3 of the depth restoration) presented a higher percentage in the CG with 21.42% and in the EG 7.69%. Score 2 (dye penetration up to 2/3) was only presented in the GE with 7.69% of the cases. Scoring 3 (penetration of dye into the pulp wall) occurred only in the control group with a rate of (10.71%). The statistical analysis showed that there was no significant difference in microleakage between restoration performed in healthy dentin with microhybrid composite resin nor the maintenance of infected dentin in primary teeth sealed with resin flow ($p = 0.6035$).

Table 1. Medians, arithmetic means, interquartile deviations, standard deviations between sample groups.

	Group 1	Group II
MD (DI)	0.00 (0.00) ^a	0.00 (1.00) ^a
MA (DP)	0.38 (0.75) ^a	0.53 (0.96) ^a

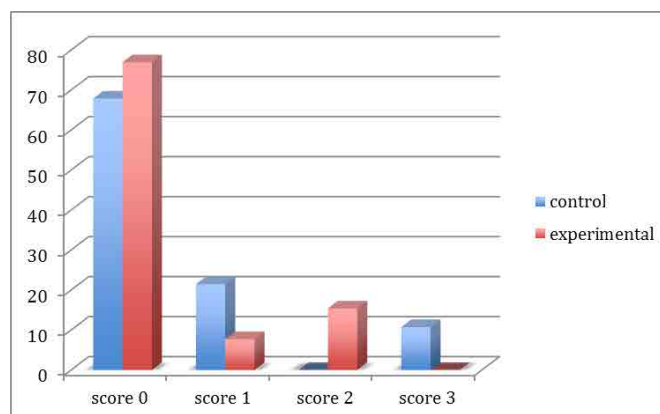


Figure 1. Behavior of the restorations (%) according to the infiltration scores.

DISCUSSION

The results of the present study showed no difference in the infiltration of the restorations when teeth with caries lesions in dentin sealed by flow resin were compared with dentin cavities restored with composite resin without the presence of carious tissue.

The non-removal of the infected dentin has already been studied by several researchers while sealing the caries lesion with different materials such as resin [3], glass ionomer [29], phosphate sealants and fissures [11-16]. In all the studies, the caries lesion was arrested in 100% of the sealed teeth. Except in a study that presented 64.3% success rate in sealed lesions with glass ionomer sealant and 85.7% in lesions sealed with resin sealant [19]. In the present study the non-removal of the carious tissue did not present differences when compared to teeth restored with healthy dentin in relation to the infiltration of the methylene blue dye. The caries lesion progression is controlled by the restriction of nutrients to bacterial metabolism [11], the results of this research have shown that the flow resin was able to promote an effective seal when tested through the penetration of the dye. The present research used flow resin, since this material has not yet been studied regarding the sealing of caries lesions and which presents possible superiority in the performance of the physical and mechanical properties of the resin flow when compared to the sealant of pits and fissures, as proposed in other studies [22]. Concerning micro-infiltration of the methylene blue dye it was observed that

the flow resin showed no difference when compared to conventional composite resin. It is important to note that caries sealing in deciduous molars is encouraged in lesions on occlusion of small proportions up to the external half of dentin, with opening up to 3mm [14]. Flow resins have good aesthetic properties and present low viscosity, facilitating their use in these types of cavity [24].

CONCLUSION

It was concluded that the removal or not of carious tissue in lesions in dentin, as well as the material used, did not influence the marginal infiltration of primary molars sealed with flow resin or restored with microhybrid composite resin.

Collaborators

AA VASCONCELOS, elaboration of the research project, collection of samples, laboratory phase 1 (preparation of caries lesions) writing of the text. JTA REIS, elaboration of the research project, phase 2 laboratory (preparation of the restorations and sealing). BF MOURA, elaboration of the research project, Phase 1 laboratory (preparation of caries lesions). DC GIRÃO, elaboration of the research project, Phase 2 laboratory (making the restorations and sealing). JCP IMPARATO, development of the project idea and revision of the final manuscript. SL PINHEIRO, statistical analysis, interpretation of results.

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