Article published online: 2021-11-01

ORIGINAL ARTICLE

Effect of a resin-based and a glass-ionomer sealant on the treatment of noncavitated occlusal caries lesions in teenagers

Ana Daniela Silva da Silveira, Nathália Carolina Fernandes Fagundes, Cesar Angelo Lascala[1], Antônio José da Silva Nogueira, Marcia Martins Marques[2], Maria Aparecida Alves de Cerqueira Luz[2]

Department of Public Health, School of Dentistry, Federal University of Pará, Belém, PA, [1]Department of Stomatology, School of Dentistry, University of São Paulo, [2]Department of Operative Dentistry, School of Dentistry, University of São Paulo, São Paulo, SP, Brazil

Address for correspondence:
Prof. Maria Aparecida Alves de Cerqueira Luz,
School of Dentistry, University of São Paulo, São Paulo, SP, Brazil.
E-mail: maacluz@usp.br

ABSTRACT

Objectives: The aim of the study was to use clinical outcomes and digital radiographs to compare the effects of two types of sealant materials on the treatment of noncavitated occlusal caries lesions regarding their progression or arrest in teenage permanent molars. **Methods:** The sample consisted of 28 teeth from 20 patients aged 11–15 years with random distribution to receive either a resin-based sealant (Fluroshield®, Dentsply, Philadelphia, PA, USA; Gres group) or a glass-ionomer sealant (RIVA Protect®, SDI, São Paulo, Brazil; Ggis group). Caries progression was monitored by clinical evaluation and radiographic examination. Clinical outcomes were analyzed using the Mann–Whitney and Fisher's exact test, and radiographic data were analyzed by Student's *t*-test for paired data ($P \leq 0.05$). **Results:** There were no significant differences between the clinical outcomes of both groups regarding the sealant retention, thermal sensitivity, and development of new caries lesions adjacent to the sealed surface. There was an increase in the radiographic density coefficient (carious dentin density/sound dentin density) at the end of the study for the Gres group ($P = 0.003$), but the coefficient for the Ggis group was similar for both time points ($P = 0.49$). **Conclusions:** Radiographic features showed an increase in the mineralization of the caries lesions when the teeth were sealed with a resin-based sealant; however, both techniques may be considered an adequate clinical approach for controlling the progression of the lesions.

Key words
Dental caries, pit and fissure sealants, radiographic image enhancement, social/community dentistry

INTRODUCTION

The concept of minimally invasive dentistry has directly affected the treatment of caries lesions. The preservation of tooth structure has become the focus of this philosophy.[1] Noninvasive treatment, which does not include the use of burrs, has emerged on the agenda of scientific research. These treatments are well accepted by patients.[2-4] Nevertheless, in cases of noncavitated occlusal caries lesions, the restorative treatment is often requested once the dentin under the enamel injury may undergo a remineralization process if the lesion becomes isolated of buccal biofilm.[5-8] To overcome this problem, the use of fissure and pit sealants instead of restoration as a therapeutic measure for noncavitated occlusal caries lesions was first proposed by Handelman *et al.* in 1976.[9] For this purpose, the sealant materials must present retention and adhesion along with fluoride-release similar to most desirable characteristics. Glass-ionomer cements (GICs) present adhesion and fluoride release but low resistance to masticator forces. On the other hand, resin composites present adhesion and retention but do not always present fluoride release.

Access this article online	
Quick Response Code:	Website: www.ejgd.org
	DOI: 10.4103/2278-9626.198613

How to cite this article: da Silveira AD, Fagundes NC, Lascala CA, da Silva Nogueira AJ, Marques MM, de Cerqueira Luz MA. Effect of a resin-based and a glass-ionomer sealant on the treatment of noncavitated occlusal caries lesions in teenagers. Eur J Gen Dent 2017;6:48-53.

In a previous study, we have shown that sealing noncavitated caries lesions with GIC was able to control caries progression.[5] In addition, in a clinical trial, our group showed that GIC was also able to control the incidence of secondary caries when this material was used as a sealant in atraumatic restorative treatment, even with the extensive loss of this material.[10] Other authors have shown that occlusal pits and fissures sealed with resin sealants provide efficient clinical performance in arresting noncavitated occlusal caries lesions.[6,8,11] Thus, although there are studies showing the effectiveness of both materials,[5-8] there is a lack of literature on the clinical outcome of noncavitated caries lesions comparing the effect of a GIC and a resin-based sealant which releases fluoride. Thus, this controlled randomized clinical trial aimed to analyze the 12-month outcome of noncavitated occlusal dental caries sealed with two types of sealant (GIC or a fluoride-releasing resin sealant) on a clinical and radiographic basis. The radiograph density changes along with sealant retention, thermal sensitivity, and the development of new caries lesions adjacent to the sealing material were studied to detect the progression or the arrest of the lesions.

METHODS

This randomized controlled clinical trial was registered and approved by the National System of Research Ethics Committee (protocol CAAE nº 0102.0.073.073–10; patients enrolled in the trial signed an informed consent form).

The sample of this randomized and controlled clinical trial consisted of 28 teeth from 20 patients between 11 and 15 years old. The study was conducted with public schools students of a community where the public water supply has no fluoridation. The power analysis to confirm the sample size was calculated based on data obtained from a previous study.[6] The statistical power was considered to be 80% with an α error of 5%.

Inclusion/exclusion criteria

Patients in good general health presenting one or more than one permanent molar with noncavitated occlusal caries lesion were included. On bitewing radiographic examination, the caries lesions must display visible radiolucency between the dentine-enamel junction until reaching half of the dentin thickness. Patients with any systemic disease were excluded. Teeth that exhibited the "match band" effect on radiographic examination, early white spot lesions, cavitated lesions on smooth surfaces, restorations, any type of sensitivity, and/or occlusal sealants were also excluded.

After visual and radiographic examination, the molars selected for the study were randomly divided into two groups using the randomization tool of statistical software (Bioestat 5.3® Software, Tefé, AM, Brazil) which arbitrarily allocates each patient in an experimental group. Thus, the experimental groups consisted of Gres (n = 14): Teeth treated with a fluoride-releasing resin-based sealant (Fluroshield®, Dentsply, Philadelphia, PA, USA) and Ggis (n = 14): Teeth treated with a glass-ionomer resin-modified sealant (RIVA protect®, SDI, São Paulo, SP, Brazil).

Clinical procedures

To standardize the tooth position for the radiographic registration throughout the study, a resin bite-registering occlusal guide was obtained for each tooth. Using this device, the bitewing radiographs were taken at the same orientation and distance at all experimental times (4, 8, and 12 months follow-up). Kodak E-Speed films (Eastman Kodak Co, Rochester, NY, USA) were used, and radiographs were taken using the same X-ray source (Spectro II, Dabi Atlante, Ribeirão Preto, SP, Brazil) at 50 kV e 10 mA that is regularly calibrated according to the current standards (e.g., exposure time: 0.5 s). To avoid bias related to radiographic processing, all films were processed at the same time in an automatic machine Peri-Pro III (Air Techniques, New York, NY, USA). The first radiograph was taken for the registration of the baseline caries lesion conditions. Next, after rubber dam application, each tooth was subjected to pumice and water prophylaxis with a Robinson brush. Afterward, the sealants were prepared according to the manufacturer's instructions.

In the Gres group, a conventional resin-based sealant (Fluroshield®, Dentsply) was applied to the occlusal surface of the tooth after etching conditioning using a 37% phosphoric acid (Magic Acid gel®, Vigodent, Rio de Janeiro, RJ, Brazil), followed by abundant water washing and air drying. The application of the sealant in the occlusal surface was performed with a microbrush that slightly touched the tooth surface. Photoactivation was performed during 20 s (Radii, SDI limited, Victoria, Australia) with a distance of 2 mm from the tip to the dental surface.

In the Ggis group, the sealant RIVA Protect® (SDI) was applied to the occlusal surface of the tooth after etching conditioning with 26% polyacrylic acid conditioner (RIVA conditioner®, SDI, São Paulo, SP, Brazil), followed by abundant water washing and air drying. The encapsulated material was prepared in an amalgam machine (Astronmix®, Dabi Atlante/Ribeirão Preto, SP, Brazil) for 10 s and then applied with a dispensing gun and light cured for 20 s. Next, the material received the RIVA Coat® (SDI, São Paulo, SP, Brazil).

In both groups, the occlusal adjustment was performed with carbon paper to eliminate potential premature occlusal contacts. A single trained and experienced

operator executed all sealing procedures in the present study. Each patient received a toothbrush and fluoridated toothpaste (Even Kids® 1100 ppm fluoride; R F Group, Paulista, PE, Brazil).

The follow-up of the cases was performed to control undesired effects of treatment on caries progression at 4, 8, and 12 months. Clinical evaluation and standardized bitewing radiographs were obtained at each visit. The clinical evaluation was based on visual examination and thermal tests observing the retention of the sealant and/or cavitation of the original lesion. The radiographic exams were performed as described above.

Clinical outcomes were assessed by clinical and radiographic analysis at the end-points for patients who completed a 12-month follow-up, as well as for patients whose follow-ups were interrupted due to the observation of clinical signs of lesion progression, such as tooth sensitivity, cavitation, or increases in the visible radiolucent area observed in the radiographs.

Quantitative analysis of radiographs was performed as a blind study by measuring the radiographic density values and comparing the X-ray images taken immediately after treatment with those taken after the total 12-month study period. The radiographic density values represent the quantification of the gray scale images. Using a specific software program, it is possible to detect 256 shades of gray on a scale ranging from 0, corresponding to radiolucent (black) areas, to 255, corresponding to fully radiopaque (white) areas.[9,12] Thus, the radiographs were digitalized at 600 dpi with a transparency scanner (ScanJet G40450 C/T scanner, Hewlett-Packard, Palo Alto, CA, USA). The initial and final radiograph images for each case were saved in JPG format with maximum resolution and analyzed with DIGORA® 2.7 for Windows® (Soredex Medical Systems, Helsinki, Finland). The images were magnified ×5 from the original size.

The quantitative radiograph analyses were based on the determination of the mean of variation of the radiography density coefficient by comparing the baseline dentin tissue in the radiographs images with those of the same lesions observed at the end of the 12-month study. This coefficient was obtained by dividing the density value of carious dentin (cd) by that of sound dentin in the same tooth (internal control) [Figure 1]. This coefficient was obtained to overcome technical factors, such as differences in color and contrast on the images, with the goal of eliminating bias. An increase in the density coefficient was considered suggestive of remineralization. In contrast, a decrease in this coefficient was considered suggestive of the evolution of the caries lesion.

Sample homogeneity between groups in terms of the decayed, missing, and filled teeth (DMF-T) index, tooth group in the arch, location of the tooth in the dental arch, presence of caries lesions in neighboring and antagonist teeth was obtained using the Chi-square test. Clinical events were analyzed to compare both groups regarding the sealant retention, thermal sensitivity, and new adjacent caries lesions after 12 months using the Mann–Whitney test or Fisher's exact test according to each case. Quantitative comparisons between groups comparing initial and final radiographic densities coefficients were performed using Student's *t*-test for paired data.

The experiment flowchart is displayed in Figure 2.

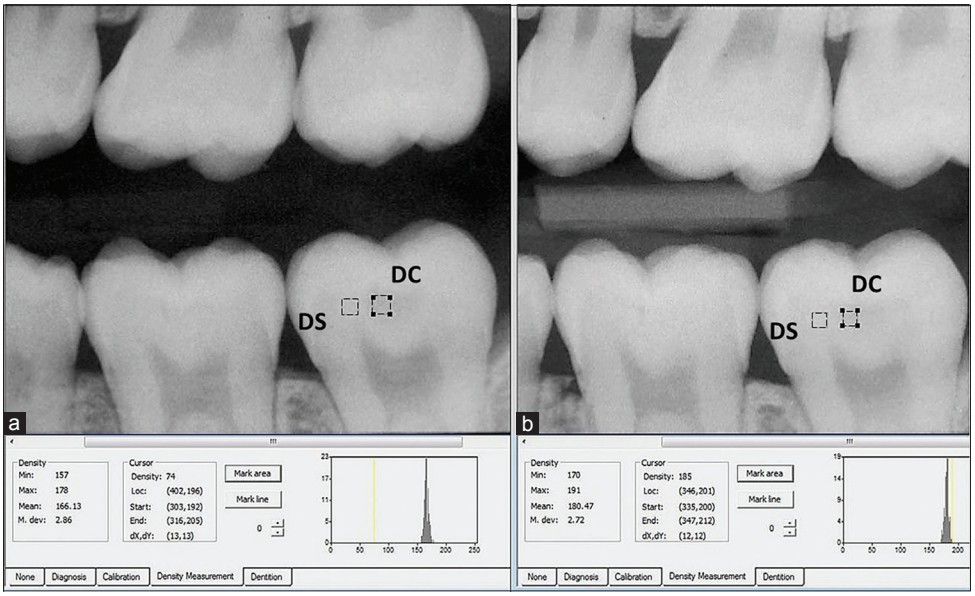

Figure 1: Method for obtaining the radiography density for healthy dentin (DS) and carious dentin. Marked areas show the healthy dentin and caries lesion at baseline (a) and the end of the study (b) (12 months). (3.8X)

RESULTS

The distributions of the sample according to the intervention group showed a lack of association between the intervention group and the baseline conditions (DMF-T index; tooth notation, tooth position, adjacent caries lesion, and thermal sensitivity) and demonstrated the homogeneity of the sample [Table 1].

During the 12 months of follow-up, both groups presented almost no failure of retention, where some cases of thermal sensitivity and some cases of the development of new caries lesions adjacent to the sealed teeth showing no significant differences between groups compared to the baseline conditions [Table 2]. No statistically significant differences between groups were revealed with respect to the effect of the DMF-T index, in retention of sealants (P = 0.56) and in thermal sensibility (P = 0.16) after a 12-month follow-up.

Radiographic analyses showed an increase in the density coefficients index at the end of the study for the Gres group (P = 0.003). However, the radiograph density coefficients for the Ggis group were similar at both time points (P = 0.49) [Table 3].

DISCUSSION

The preservation of healthy dental tissue is mainly based on procedures to prevent dental caries. However, when the teeth already exhibit caries lesions, then other clinical approaches should be applied. Among these approaches, the sealing of noncavitated dental caries has been used to arrest the lesions. GIC as well as resin sealant are used for this purpose. There are studies showing the effectiveness of both materials; however, there is a lack in the literature on the clinical outcome of noncavitated caries lesions comparing the effect of a GIC and a fluoride-releasing resin sealant comparing their clinical and radiographic performance. Thus, this controlled randomized clinical trial aimed to analyze, by means of clinical and radiographic investigation, the performance of these sealant materials. Although all clinical parameters assessed in the present study had shown a similar behavior for both sealants, the radiographic analysis suggested an important increase in the remineralization of the caries lesions after 12 months only in teeth sealed with the resin-based material.

A specific resin sealant, which contains fluoride according to the manufacturers, and a GIC sealant were the materials of choice in the present study. According to the literature, in addition to their fluoride-releasing abilities, both materials also exhibit retention and adhesion to enamel; all of these properties make these sealants therapeutic materials that are likely capable of preventing the progression of caries lesions and the development of adjacent new lesions.[5-7,11,13] Indeed, the clinical outcome of cases sealed with both materials showed at least an arresting of the caries lesions once the radiographic density coefficients were either increased (Gres) or maintained (Ggis).

The success of the sealing was observed in both groups that showed improvement toward remineralization of the lesions (Gres) or at least their arrest (Ggis).

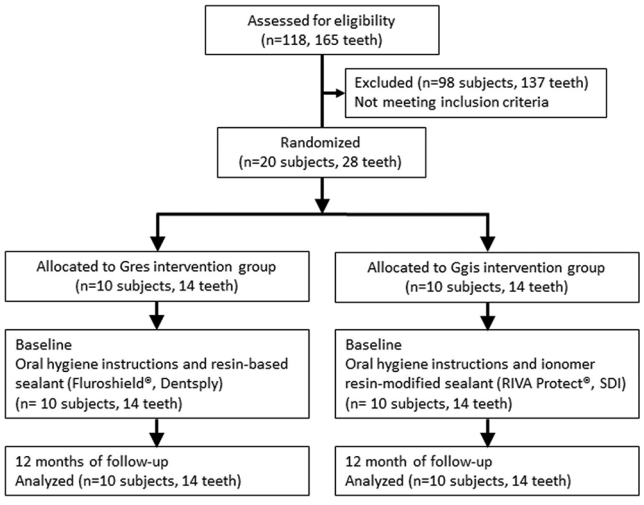

Figure 2: Flowchart of the trial

Table 1: Baseline conditions (Chi-square test)

Variable	Gres, *n* (%)	Ggis, *n* (%)	*P*
DMF-T			
≤3	9 (64.3)	7 (50.0)	0.703
>3	5 (35.7)	7 (50.0)	
Tooth notation			
1° molar	9 (64.3)	9 (64.3)	1.00
2° molar	5 (35.7)	5 (35.7)	
Tooth position			
Maxillary	9 (64.3)	7 (50.0)	0.703
Mandibular	5 (35.7)	7 (50.0)	
Adjacent caries lesions			
Yes	8 (57.1)	7 (50.0)	1.00
No	6 (42.9)	7 (50.0)	
Thermal sensitivity			
Yes	1 (7.14)	1 (7.14)	1.00
No	13 (92.86)	13 (92.86)	
Total	14 (100)	14 (100)	

DMF-T – Decayed, missing, and filled teeth

Table 2: Clinical outcomes after 12-month evaluation

Groups	Mean retention period (months)	Thermal sensitivity	Adjacent new caries lesions
Ggis	10.29	4	4
Gres	10.57	2	2
P	0.716*	0.324†	0.357†

*Mann-Whitney test; †Exact of Fisher test

Table 3: Mean X-ray density coefficients values (±standard deviation) for baseline and a 12-month follow-up and the results of paired Student's *t*-test

Groups	Baseline values	12-month follow-up values	Paired differences	95% CI		*P*
				Lower	Upper	
Gres (*n*=14)	96.45 (±2.05)	97.29 (±1.71)	−0.83 (±0.89)	−1.35	−0.32	0.003
Ggis (*n*=14)	96.37 (±2.14)	96.68 (±2.55)	−0.31 (±1.63)	−1.25	0.63	0.49

Paired difference values were obtained by subtracting the initial values from the final values; thus, negative values indicate an increase in the coefficient after the 12-month follow-up. CI – Confidence interval

Indeed, the radiographic density coefficient increased significantly from the initial to the final examination of teeth sealed with resin (Gres), and this coefficient was maintained at the same levels with glass-ionomer sealant (Ggis). These results strongly suggest an improvement in the remineralization of the dentin caries lesions, most likely due to the retention of the sealant added to the fluoride release.[14] Other aspects are of relevance in the determination of the successful outcome in the present study. The baseline conditions of this study revealed a limited history of caries of this population, for example, a factor that could strongly affect the results, in addition to technical difficulties in applying GIC.

Bitewing radiographic exams are the most commonly used method to detect caries lesions, mainly in proximal surfaces.[15] Although early occlusal lesions may be difficult to detect using this type of examination, in the present study, this examination was used to select the teeth with more extensive lesions reaching half of the dentin thickness. In addition, this auxiliary exam has easy accessibility and low cost, being highly relevant to public health.[16] The period of time for control visits and radiograph evaluation was adopted to give the patients support for any adverse event.

It is important to consider that this was a clinical study; thus, individual factors are highly decisive in determining the success of the treatment. For example, in this case, the baseline conditions, i.e., DMF-T index, did not affect the performance of both materials. Undoubtedly, the socioeconomic profile, motivation, dietary habits, and oral hygiene of the patient can influence the success of any treatment. To attempt to control such variables, the study included patients of the same region (communities of the same city) who received the same guidelines for oral hygiene from the same dentist. Moreover, they performed their oral hygiene using the same toothbrush technique and brands of toothbrushes and toothpaste. Nevertheless, the independent variables are recognized to be numerous and not subject to absolute control. This is an inherent feature of clinical trials.[17]

CONCLUSIONS

These results suggest that under the conditions of this clinical study, the use of pit and fissure sealants is an effective noninvasive approach for the treatment of noncavitated dentinal occlusal caries, particularly when using resin-based material and for patients with low prior caries activity and access to regular dental visits. In addition to monitoring sealant performance, the dental visits have the potential to motivate patients toward self-care and strengthening their role in their own health.

Acknowledgments

The authors would like to thank the National Council for the Improvement of Higher Education (CAPES, Brazil) for their financial support and Helder Henrique Costa Pinheiro, MDS, Professor of School of Dentistry in the Federal University of Pará for the contribution to statistical revision.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Bader JD, Shugars DA. The evidence supporting alternative management strategies for early occlusal caries and suspected occlusal dentinal caries. J Evid Based Dent Pract 2006;6:91-100.
2. Doméjean-Orliaguet S, Tubert-Jeannin S, Riordan PJ, Espelid I, Tveit AB. French dentists' restorative treatment decisions. Oral Health Prev Dent 2004;2:125-31.
3. Traebert J, Wesolowski CI, de Lacerda JT, Marcenes W. Thresholds of restorative decision in dental caries treatment among dentists from small Brazilian cities. Oral Health Prev Dent 2007;5:131-5.
4. Featherstone JD. Dental caries: A dynamic disease process. Aust Dent J 2008;53:286-91.
5. da Silveira AD, Borges BC, de Almeida Varela H, de Lima KC, Pinheiro IV. Progression of non-cavitated lesions in dentin through a nonsurgical approach: A preliminary 12-month clinical observation. Eur J Dent 2012;6:34-42.
6. Borges BC, de Souza Borges J, Braz R, Montes MA, de Assunção Pinheiro IV. Arrest of non-cavitated dentinal occlusal caries by sealing pits and fissures: A 36-month, randomised controlled clinical trial. Int Dent J 2012;62:251-5.
7. Bakhshandeh A, Qvist V, Ekstrand KR. Sealing occlusal caries lesions in adults referred for restorative treatment: 2-3 years of follow-up. Clin Oral Investig 2012;16:521-9.
8. Griffin SO, Oong E, Kohn W, Vidakovic B, Gooch BF; CDC Dental Sealant Systematic Review Work Group, Bader J, *et al.* The effectiveness of sealants in managing caries lesions. J Dent Res 2008;87:169-74.

9. Handelman SL, Leverett DH, Espeland M, Curzon J. Retention of sealants over carious and sound tooth surfaces. Community Dent Oral Epidemiol 1987;15:1-5.
10. Rios EL, Diniz IM, Ruiz O, Marques MM. Atraumatic restorative treatment-Glass ionomer sealants survival after a postgraduate training program in Ecuador: 2-year follow-up. Braz Arch Biol Technol 2015;58:49-53.
11. Yengopal V, Mickenautsch S, Bezerra AC, Leal SC. Caries-preventive effect of glass ionomer and resin-based fissure sealants on permanent teeth: A meta analysis. J Oral Sci 2009;51:373-82.
12. Parks ET, Williamson GF. Digital radiography: An overview. J Contemp Dent Pract 2002;3:23-39.
13. Baseggio W, Naufel FS, Davidoff DC, Nahsan FP, Flury S, Rodrigues JA. Caries-preventive efficacy and retention of a resin-modified glass ionomer cement and a resin-based fissure sealant: A 3-year split-mouth randomised clinical trial. Oral Health Prev Dent 2010;8:261-8.
14. Yamamoto K, Arai K, Fukazawa K, Fukui K, Nagamatsu K, Kato K, *et al.* Effect of plaque fluoride released from a glass-ionomer cement on enamel remineralization *in situ*. Caries Res 2005;39:157-60.
15. Pontual AA, de Melo DP, de Almeida SM, Bóscolo FN, Haiter Neto F. Comparison of digital systems and conventional dental film for the detection of approximal enamel caries. Dentomaxillofac Radiol 2010;39:431-6.
16. Rathore S, Tyndall D, Wright J, Everett E. *Ex vivo* comparison of Galileos cone beam CT and intraoral radiographs in detecting occlusal caries. Dentomaxillofac Radiol 2012;41:489-93.
17. Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 statement: Updated guidelines for reporting parallel group randomized trials. Open Med 2010;1:e60-8.