Compomer as a Pit and Fissure Sealant: Effectiveness and Retention after 24 Months

Regina M. Puppin-Rontani, DDS, MSc, PhD Magda E. Baglioni-Gouvea, DDS, MSc
Mario F. deGoes, DDS, MSc, PhD Franklin Garcia-Godoy, DDS, MS

ABSTRACT

Purpose: The aim of this study was to evaluate the effectiveness and retention of occlusal sealing using FluroShield or Compoglass.
Methods: The sample consisted of 57 children aged 7 to 9 years who had 4 sound, fully erupted, first permanent molars (total=228 teeth). Both materials were applied on contralateral teeth in a split-mouth design in 2 groups: (1) FluroShield—left upper molar and right lower molar; (2) Compoglass—right upper molar and left lower molar. The materials were applied under cotton roll isolation by the same operator according to the manufacturers' instructions. The evaluations were carried out at 6, 12, and 24 months. The data were subjected to the G2 (likelihood ratio chi-square test; P<.05).
Results: At the 6-month evaluation, Compoglass showed 60% total retention, 23% partial retention, and 17% total loss. FluroShield showed 53% total retention, 31% partial retention, and 16% total loss. At the 12-month recall, Compoglass and FluroShield, respectively, showed 39% and 43% total retention, 38% and 33% partial retention, and 24% and 25% total loss. At the 24-month evaluation, there was a reduction of 56% of the initial sample numbers (32/57), with 22% and 20% having total retention, 52% and 48% partial retention, and 26% and 32% total loss, respectively, for Compoglass and FluroShield. There was no significant statistical difference between the retention of both materials studied. There was no new caries formation during the evaluation period.
Conclusion: It could be concluded that both materials effectively prevented caries in occlusal surfaces during the follow-up period, although both showed a low retention rates. (J Dent Child 2006;73:31-36)

KEYWORDS: OCCLUSAL SEALANT, COMPOMER, OCCLUSAL CARIES, PIT AND FISSURE SEALANT

The high caries susceptibility of the occlusal surface is inherent in its morphology. The pits and fissures, which form mechanical retention niches for bacteria, food, and other debris, allow the initiation of enamel demineralization.[1]

Dr. Puppin-Rontani is pediatric dentistry professor, Department of Pediatric Dentistry, Dr. Baglioni-Gouvea is a predoctoral student in pathology and biology and a lecturer in pediatric dentistry, and Dr. deGoes is dental materials professor, Department of Restorative Materials, all at Piracicaba Dental School, University of Campinas, São Paulo, Brazil; Dr. Garcia-Godoy is professor and associate dean for research, and Director, Bioscience Research Center, College of Dental Medicine, Nova Southeastern University, Fort Lauderdale, Fla. Correspond with Dr. Garcia-Godoy at godoy@nova.edu

The traditional preventive methods, such as diet control and fluoride therapy effectively prevent dental caries on smooth tooth surfaces, but they have not been satisfactory methods to control caries lesions in pits and fissures.[2,3] In 1975, Graves and Burt[4] reported that even populations living in communities with fluoridated water have significant problems with occlusal caries. In later studies, it was reported that, although the total caries experience has decreased, the proportion of caries lesions occurring in occlusal surfaces has increased compared to smooth surface lesions in children.[5-8]

The attempts to obliterate pits and fissures to prevent occlusal caries has been observed since 1895, when Perry[9] reported a technique for sealing fissures with zinc phosphate

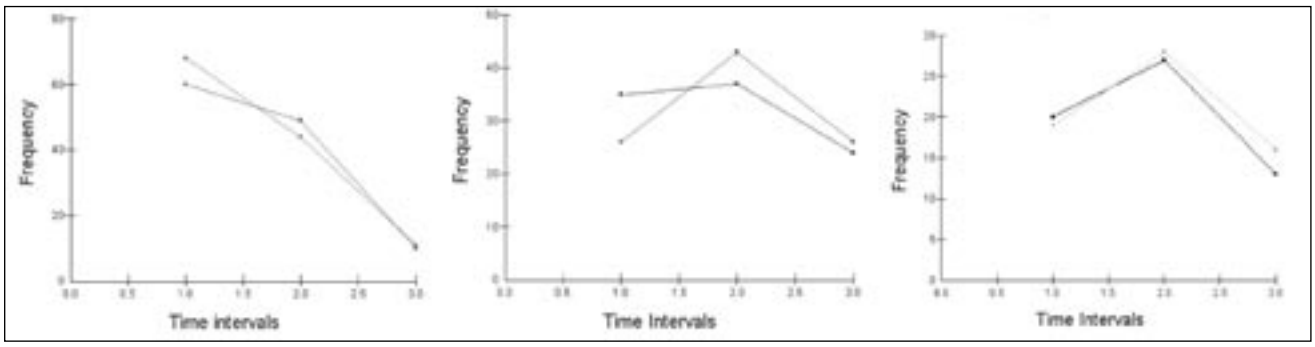

Figure 1. Survival curves (log–rank test) for Compoglass (blue line) and FluroShield (green line), concerning total retention (A), partial retention (B), and total loss (C).

cement. The modern method of sealing occlusal surfaces, however, was introduced in the late 1960s. It involves the application of a thin layer of resin directly on the fissures after pretreatment with acid.

Many studies have proven sealants to be safe and highly effective in preventing tooth decay.[1,4,10,11] Resin-based sealants show satisfactory physical properties and clinical longevity. These materials are made of an organic matrix with variable proportions of Bis-GMA resin and UDMA and may contain inorganic filler such as glass, porcelain, or quartz—differing in amount and quality of this filler in the overall material composition.[11]

A property of some fluoride-containing restorative dental materials that has attracted substantial interest is the ability to release fluoride at the tooth/sealant interface.[12] Most dental restorative materials increase the surface energy of the enamel and tend to retain bacterial plaque on the surfaces and margins of restorations. Fluoride present on the tooth surface decreases the surface energy, inhibits enamel demineralization during acid attacks, and enhances the remineralization during periods of neutrality. Furthermore, fluoride ions also inhibit bacterial growth and can have a lytic effect on some cariogenic strains of bacteria.[13] Loyola-Rodríguez and García-Godoy[14] showed in their study that fluoride released by sealants is able to produce an inhibitory effect against *Streptococcus mutans*.[1]

Several materials have been developed to be used as pit and fissure sealants. In the middle of the 1970s, glass ionomer cement (GIC) was introduced as an alternative to resin-based sealants. Their advantage is the hydrophilic nature of these cements, making application easier where moisture control can be a major problem and in developing countries.[15] Resin-based sealants have exhibited better retention than glass ionomer sealants. One advantage proposed by GICs is that they seem to exert a cariostatic effect, even after they are not present macroscopically. The fluoride released from glass ionomer can be taken up by the enamel.[16]

Polyacid-modified, resin-based composites, called compomers, have been used as pit and fissure sealants, combining some of the best properties of composites and glass ionomers. When compared to conventional GIC, this restorative material has shown: (1) better adhesion to enamel and dentin; (2) lower water solubility; and (3) low dehydration susceptibility or split formation. The fluoride release of these restorative materials, however, is smaller and less effective than conventional glass ionomer and resin-modified glass ionomer.[12]

The ability of fissure sealants to prevent fissure caries is also related to sealant retention, and the successful application of fissure sealants is dependent upon good clinical technique.

Because occlusal sealing is the most effective method for caries prevention on pit and fissure surfaces, the aim of this study was to verify the retention and effectiveness of caries prevention in occlusal surfaces after the use of 2 fluoride-containing materials: (1) FluroShield, a resin-based sealant; and (2) Compoglass, a polyacid-modified, resin-based composite.

METHODS

SUBJECTS

A convenience sample of 57 children aged 7 to 9 years was selected from a public elementary school. The study was carried out in Piracicaba, São Paulo, Brazil—an area with fluoridated water supply. Each child showed high caries activity

Table 1. Procedures Used for Materials Application

Material	Surface cleaning	Isolation	Acid etching	Bonding agent	Material application	Occlusal check
Compoglass A3 shade	Tooth-brushing/ washing	Cotton rolls; washing/drying	No	Syntac single component; Light curing 20 s; second layer/light curing 20 s	Adaptation with a suitable instrument; light curing 40 s	Articulation paper
FluroShield Opaque	Tooth-brushing/ washing	Washing/drying	35% phosphoric acid–30 s	No	Probe	Articulation paper

(presence of decayed primary teeth or white spots) and had sound and completely erupted first permanent molars, totaling 228 teeth. Written informed consent was obtained from the parents of all children participating in the study. All consent forms and experimental procedures were previously approved by the Ethics Committee of the School of Dentistry of Piracicaba, University of Campinas, São Paulo, Brazil.

Table 2. Compoglass and FluroShield Retention after 6-, 12-, and 24-month Recall

Material	Total Retention	Partial Loss	Total Loss	Total
		Retention after 6 months		
Compoglass	68 (60%)	26 (23%)	20 (17%)	114
FluroShield	60 (53%)	35 (31%)	19 (16%)	114
		Retention after 12 months		
Compoglass	44 (38%)	43 (38%)	27 (24%)	114
FluroShield	49 (43%)	37 (32%)	28 (25%)	114
		Retention after 24 months		
Compoglass	11 (22%)	26 (52%)	13 (26%)	50
FluroShield	10 (20%)	16 (32%)	24 (48%)	50

CLINICAL EXAMINATIONS

Using a dental mirror and artificial light to determine the DMFT index, the same examiner conducted the clinical examinations. Selection criteria included the presence of 4 sound and fully erupted permanent first molars. The children needing restorative dental care were referred to the Pediatric Dental Clinic of the School of Dentistry of Piracicaba for free treatment. All children received oral hygiene instructions and extra restorative treatment. The city of Piracicaba is a fluoridated water region since 1984 where only fluoride toothpastes are available.

SEALING

The 228 teeth were divided into 2 groups, according to each material used, in a split-mouth design as follows:

1. Group I—the left upper first molar (No. 14) and the right lower first molar (No. 30) were sealed using a resin-based sealant, FluroShield (Dentsply International, York, Pa); and
2. Group II—the right upper first molar (No. 3) and the left lower first molar (No. 19) were sealed using a compomer, Compoglass (Vivadent Ets, Fl-9494 Schaan/Liechtenstein).

The teeth were cleaned using a child-sized toothbrush and water prior to sealant application. Both materials were applied under relative isolation (cotton rolls and portable saliva ejector) by one operator (MEBG) with a dental student assisting. The main clinical procedures used in the material application are described in Table 1. The same operator applied both materials. The sealants were applied in the standard manner, according to the manufacturers' instructions, using an explorer tip, cotton pliers, and mouth mirror (Table 1).

EVALUATION

The retention of the materials was assessed after 6, 12, and 24 months by the same examiner. Sealant retention was clinically evaluated as total retention, partial retention, or total loss using the tactile-visual method (mirror and explorer). The incidence of caries was also reported. At the 12- and 24-month evaluations, the sealants were not replaced even after partial or total loss of the sealant. The examiner was properly trained and calibrated in DFMT data collection.

STATISTICAL ANALYSIS

The data from the 6-, 12-, and 24-month evaluations were compared statistically using the log-rank test. At 24 months, the data were analyzed statistically using the chi-square test for independent samples, comparing teeth type and sealant material within retention category. The level of significance was set at $P<.05$.

RESULTS

The 6-, 12-, and 24-month results are shown in Table 2. The retention rates for each material and the mandibular and maxillary teeth are displayed in Table 3. At the 24-month follow-up, 56% of the sealed teeth (228/128) were unavailable. This was because either the children had moved or Class I restorations were inserted on sealed teeth by unknown dental professionals, which did not allow for evaluation.

At 24 months, there were no significant differences in

Table 3. Relationship Among the Retention Rates for Compoglass and FluroShield to Maxillary and Mandibular Teeth at 24 Months.

Teeth	Total retention*	Partial loss	Total loss	Total
	Compoglass retention			
3	8 (73%)	10 (38%)	7 (54%)	25
19	3 (27%)	16 (62%)	6 (46%)	25
Total	11	26	13	50
	FluroShield retention			
14	2 (20%)	9 (56%)	14 (58%)	25
30	8 (80%)	7 (44%)	10 (42%)	25
Total	10	16	24	50

*Chi Square for independent samples (chi square=5.838; P=0.0157)

retention between FluroShield and Compoglass. Compoglass demonstrated 22% total retention of all teeth sealed and evaluated after 24 months. Among those teeth, 73% were upper teeth and 27% lower teeth. For FluroShield, a similar percentage of total retention was found (20%) for all teeth examined after 24 months. The lower teeth, however, showed a higher total retention rate (80%). There was a significant difference between lower and upper teeth for both materials ($P<.05$) concerning total retention ($P=.0157$) at 24 months.

DISCUSSION

Sealed pits and fissures have reduced the incidence of dental caries in occlusal surfaces.[17-19] This was confirmed in the present study.

Resin-based pit and fissure sealants demonstrated successful retention, such as total or partial retention. Some other materials, such as GIC, resin-modified GIC, and flowable resin-based composites, are used as sealants.[17,19,20] All these materials have adhesive properties and do not need open cavities to apply them. The fluoride-releasing property may contribute to surface remineralization.[21-29]

The total retention rate for FluroShield, the resin-based sealant used in this study, was similar to that found for Compoglass, a polyacid-modified, resin-based composite. Although the total retention rates could be considered low, an increase in dental caries was not observed during the study period (24 months).

In this study, the total retention rate for FluroShield was relatively similar to that found by Smales and Wong[20] using Delton (Dentsply International, York, Pa) (32%) for 24 months. On average, the performance of FluroShield and Compoglass was similar after 24 months. These findings are consistent with other reports[30] showing a decrease in retention over time.

Several factors can be related to the retention of a material on the dental surface. The material characteristics and adhesive properties are the most important factors. Considering that both materials used in this study were resin-based (which have hydrophobic monomers), the quality of etched enamel surfaces could influence the retention rate and may contribute to the low rates for total retention observed. This study was conducted in a public health setting, and it was not possible to use a rubber dam to eliminate or reduce moisture contamination. The materials were applied using relative isolation (cotton rolls and saliva ejector).

Grande et al[31] observed in vitro that Delton and FluroShield—both hydrophobic sealants—when applied under humid conditions were completely lost in all cases. The use of relative isolation might not prevent contamination of the etched surface. This may have been the reason for the retention failures in this study.

The total material loss on the occlusal surface was observed in 26% and 48% of the Compoglass and FluroShield sealed teeth, respectively, after 24 months. This could be considered a low retention rate for both materials. The retention performance for both materials demonstrated a linear coefficient. FluroShield, however, showed a higher tendency for total loss compared to Compoglass. It should be noted that, even in the clinical absence of the material on the occlusal surface, an increase in occlusal caries incidence was not observed. Using a compomer, Pereira et al[32] observed that 73% of the sealed teeth had no sealant present on the occlusal surface after 48 months and the caries incidence was 16%, representing an annual increase of 4%. The present study showed that, even when the materials were partially lost, no caries was observed.

The partial retention rates of the materials used in this study increased with time. During this study, the higher percentage of partial retention of the material was observed with Compoglass, except in the 6-month evaluation, where FluroShield showed a higher percentage of partial retention. Using a polyacid-modified, resin-based composite (Vari-Glass LD Caulk, Milford, Conn), Pereira et al[32] reported that, 48 months after application, the material was present in two thirds and one third of the pit extension in 8% and 14% of the teeth examined, respectively.

Considering the total retention of the materials, FluroShield demonstrated better results in the lower teeth (80%). The pattern of total retention for FluroShield was similar to that found by Rock et al,[23] verifying much higher full retention on lower molars than on upper molars at each recall. It may be possible that the tooth-color appearance of some of the materials tested may have made clinical detection of the sealant more difficult and led to an underestimation of the sealant retention.

In addition, due to the isolation technique chosen in this study, the upper arch presented a greater moisture control problem compared to the lower arch. This fact may have influenced the material retention. It is also possible, however, that the proximity of the palatal pit to the gingival margin and crevicular fluid may have moistened the etched surface and influenced the retention of the FluroShield sealants on the upper molars.

In a study by Straffon et al[33] analyzing the effect of isolation on efficacy of a sealant (Delton) for 36 months, 61% of the total number of retreated sealants were on mandibular teeth. In that study, one group of teeth was isolated with a rubber dam and the other with cotton rolls. No tooth under treatment with a sealant became carious.

Despite the low retention shown at the end of this study, caries increment was not observed. This is interesting, because the data reported in the literature suggest that deficient sealants are not effective in caries prevention. Any considerable "partial loss" sealant is as equally susceptible to caries as an unsealed control tooth. Chestnutt et al[34] reported that 23% of deficient sealants were scored as carious after 4 years, compared with a 21% caries rate on surfaces originally scored as sound but not sealed. The sealant may have stayed in enamel microporosites, even after it had been considered clinically lost. In these situations, the resin tags embedded in the etched enamel will still offer bacterial invasion protection to the pits and fissures.

Another issue to be considered in the efficacy of sealing to prevent occlusal caries is the material's antibacterial activity. FluroShield showed antibacterial activity on *S mutans* and *Streptococcus sobrinus*, perhaps due to fluoride release. Loyola-Rodríguez and García-Godoy[14] showed that Helioseal (Vivadent Ets, Fl-9494 Schaan/Liechtenstein) and Teethmate-F (Kuraray Dental, Düsseldorf, Germany) had antibacterial effects in vitro. They observed that Teethmate-F was the only active material in the study and showed more than 4 times more fluoride release than FluroShield.

Karanika-Kouma et al,[35] however, showed that adhesive bonding systems and polyacid-modified, resin-based composites exhibited various degrees of antibacterial activity. They also suggested that these properties may reduce the consequences of microleakage. This property of polyacid-modified, resin-based composites was attributed to their chemical composition (resin-based composite and glass ionomer). It should also be considered that, if the fluoride release is a factor in a material's antibacterial effect, this category of material has a significantly lower fluoride release when compared with glass ionomers.[35,36] Future investigations should establish the minimum amount of fluoride release to provide an anticariogenic effect.

In this study, it was not possible to conclude that the remaining sealant and the antibacterial activity of fluoride were factors influencing the observed caries protection.

Despite the success obtained in preventing caries in this study, the authors did not consider the other factors that interfere in the etiology of the decay. Therefore, longer-term clinical studies should be performed.

CONCLUSIONS

Based on this study's results, it can be concluded that:

1. When evaluated 24 months after being applied, total sealant retention was significantly different between FluroShield and Compoglass concerning upper and lower teeth. FluroShield and Compoglass showed significantly higher total retention rates when applied in lower teeth and in upper teeth, respectively.
2. During the follow-up period, both materials effectively prevented caries in occlusal surfaces, although both showed low retention rates.

REFERENCES

1. Galil KA, Gwinnett AJ. Exchange for Histology of fissures in human unerupted teeth. J Dent Res 1975;54:960-964.
2. Hyatt TP. Prophylactic odontotomy: The ideal procedure in dentistry for children. Dent Cosmos 1936;78:353-370.
3. Rizzo A. Occlusal sealants. In: Newbrun E, ed. *Cariology*. 3rd ed. Chicago, Ill. Quintessence Publishing; 1989:315-330.
4. Graves RC, Burt BA. The pattern of the carious attack in children as a consideration use of fissure sealants. J Prev Dent 1975;2:28-32.
5. Horowitz HS. Review of topical applications: Fluorides and fissure sealants. J Can Dent Assoc 1980;1:38-41.
6. Burt BA. The future of the caries decline. J Public Health Dent 1985;45:261-269.
7. Mitchell L, Murray JJ. Fissure sealants: A critique of their cost-effectiveness. Community Dent Oral Epidemiol 1989;17:19-23.
8. Moreira BH, Pereira AC, Oliveira SP. Evaluation of the prevalence of dental caries in schoolchildren from an urban area of Southeastern Brazil. Rev Saude Publica 1996;30:280-284.
9. Perry SG. Dent Cosmos 1884;26:76.
10. Cueto E, Buonocore MG. Sealing of pits and fissures with an adhesive resin. Its use in caries prevention. J Am Dent Assoc 1967;73:121-126.
11. Symons AL, Chu CY, Meyers IA. The effect of fissure morphology and pretreatment of the enamel surface on penetration and adhesion of fissure sealants. J Oral Rehabil 1996;23:791-798.
12. Zimmerman BF, Rawls HR, Querens AE. Prevention of in vitro secondary caries with an experimental fluoride-exchanging restorative resin. J Dent Res 1984;63:689-692.
13. Featherstone JDB, O'Reilly MM, Shariati M, Brugler S. Enhancement of remineralization in vitro and in vivo. In: Leach SA, ed. *Factors Relating to Demineralization and Remineralization of the Teeth*. Oxford, England: IRL Press Ltd; 1994:23-34.
14. Loyola-Rodriguez JP, Garcia-Godoy F. Antibacterial activity of fluoride release sealants on mutans streptococci. J Clin Pediatr Dent 1996;20:109-111.
15. McLean JW, Wilson AD. Glass ionomer cements. Br Dent J 2004;196:514-515.
16. Forss H, Seppä L. Prevention of enamel demineralization adjacent to glass ionomer filling materials. Scand J Dent Res 1990;98:173-178.
17. Raadal M, Utkilen AB, Nielsen OL. Fissure sealing with a light-cured resin-reinforced glass ionomer cement (Vitrebond) compared with a resin sealant. Int J Paediatr Dent 1996;6:235-239.
18. de Luca-Fraga LR, Pimenta LA. Clinical evaluation of glass ionomer/resin-based hybrid materials used as pit and fissure sealants. Quintessence Int 2001;32: 463-468.
19. Poulsen S, Beiruti N, Sadat N. A comparison of retention and the effect on caries of fissure sealing with a glass ionomer and a resin-based sealant. Comm Dent Oral Epidemiol 2001;29:298-301.
20. Smales RJ, Wong KC. 2-year clinical performance of a resin-modified glass ionomer sealant. Am J Dent 1999;12:59-61.
21. Hicks MJ, Flaitz CM. Occlusal caries formation in vitro: comparison of resin-modified glass ionomer with fluoride-releasing sealant. J Clin Pediatr Dent 2000;24:309-314.

22. Kawai K, Takaoka T. Inhibition of bacterial and glucan adherence to various light-cured fluoride-releasing restorative materials. J Dent 2001;29:119-122.
23. Rock WP, Foulkes E, Perry H, Smith AJ. A comparative study of fluoride-releasing composite resin and glass ionomer materials used as fissure sealants. J Dent 1996;24:275-280.
24. Vercruysse CW, De Maeyer EA, Verbeeck RM. Fluoride release of polyacid-modified composite resins with and without bonding agents. Dent Mater 2001;17:354-358.
25. Muller U, Kielbassa AM, Schulte-Monting J, Hellwig E. Fluoride release from light-curing restorative materials. Am J Dent 2000;13:301-304.
26. Mass E, Eli I, Lev-Dor-Samovici B, Weiss EI. Continuous effect of pit and fissure sealing on S mutans presence in situ. Pediatr Dent 1999;21:164-168.
27. Garcia-Godoy F, Abarzua I, De Goes MF, Chan DC. Fluoride release from fissure sealants. J Clin Pediatr Dent 1997;22:41-49.
28. Peng D, Smales RJ, Yip HK, Shu M. In vitro release from aesthetic restorative materials following recharging with APF gel. Aust Dent J 2000;45:198-203.
29. Vermeersch G, Leloup G, Vreven J. Fluoride release from glass ionomer cements, compomers, and resin composites. J Oral Rehabil 2001;28:26-32.
30. Weintraub JÁ. The effectiveness of pit and fissure sealing. J Public Health Dent 1989;49:317-330.
31. Grande Rh, Ballester R, Singer JdaM, Santos JF. Microleakage of a universal adhesive used as a fissure sealant. Am J Dent 1998;11:109-113.
32. Pereira AC, Pardi V, Mialhe FL, Meneghim MC, Basting RT, Werner CW. Clinical evaluation of a polyacid-modified resin used as a fissure sealant: 48-month results. Am J Dent 2000;13:294-296.
33. Straffon LH, Dennison JB, More FG. Three-year evaluation of sealant: Effect of isolation on efficacy. J Am Dent Assoc 1985;110:714-717.
34. Chestnutt IG, Schafer F, Jacobson AP, Stephen KW. The prevalence and effectiveness of fissure sealants in Scottish adolescents. Br Dent J 1994;177:125-129.
35. Karanika-Kouma A, Dionysopoulos P, Koliniotou-Koubia E, Kolokotronis A. Antibacterial properties of dentin bonding systems, polyacid-modified composite resins and composite resins. J Oral Rehabil 2001;28:157-160.
36. Millar BJ, Abiden F, Nicholson JW. In vitro caries inhibition by polyacid-modified composite resins ("compomers"). J Dent 1998;26:133-136.