# Clinical evaluation of three different materials used as pit and fissure sealant: 24-months results

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*To evaluate the retention and caries experience effects of three different materials used as fissure sealants after 24 months of clinical application: a resin-modified glass ionomer cement (A), a flowable resin composite (B) and a compomer (C). One hundred and seventeen (117) teeth were sealed with material A, 119 teeth with material B and 120 teeth with material C. Children were randomly assigned. Each one received only one of the materials studied. Plaque index, dmft score and socioeconomic level were scored at baseline. The clinical exams were conducted 6, 12 and 24 months after application of the sealant. Statistical analysis (Kruskal-Wallis) revealed that there were statistically significant differences between the retention rates of groups A and B and between groups B and C after 2 years, with material B showing better results. After 2 years, 3.1% of the teeth of group A, 4.3% of group B and 6.7% of group C were Carious+Filled. There was no evidence of association between caries presence after 2 years and plaque index, dmft score and socioeconomic level. These results suggest that flowable resin composite had a satisfactory retention after this period of evaluation and all three materials were effective on occlusal caries prevention.*
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## INTRODUCTION

During the last few decades, numerous studies have shown a decrease in caries incidence,[1,2] due mainly to fluoride present in dentifrices and fluoridation of water supply. However, these fluoride therapies benefit primarily smooth surfaces,[3] while occlusal surfaces continue to be responsible for about 56% to 70% of caries in children 5 to 17 years of age.[4-5]

Today, modern principles of dentistry emphasize preventive procedures as a way to control caries disease. Under the preventive methods available, fissure sealants have been used to prevent occlusal caries.

Different materials can be used as fissure sealant. Unfilled resin-based materials are effective in preventing carious lesions, since they can have high retention rates.[6-8] Although glass ionomer cement (GIC) is less dependent on moisture control during application,[7] it presents low retention rates.[9-14] However, an advantage of its use is fluoride release. Modified materials such as resin modified glass ionomer cement and compomer have been tested as fissure sealants,[12-16] demonstrating retention rates that are better than GIC, but inferior to unfilled resin-based materials. Flowable resin composite is indicated as a potential fissure sealant, since the materials have a lower quantity of inorganic fillers and/or reological modifiers than conventional composites.

Based on these considerations, the aims of this 24-month study were to evaluate the retention and caries experience effects of three different materials when used as fissure sealants, and to establish associations between three clinical characteristics and the presence of carious lesions.

## MATERIAL AND METHODS

### Sample selection and sealant placement

The project was submitted and approved by the Ethics Committee of the Dentistry College – University of Campinas (#041/2002).

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**Table 1.** Number of children with fissure sealants of each material by dmft score.

| | Materials | | |
|---|---|---|---|
| dmft | Vitremer | Revolution | Dyract flow |
| 1 e 2 | 9 | 9 | 10 |
| > 3 | 27 | 30 | 28 |

**Table 2.** Numbers and percentages (in parenthesis) of treated teeth observed at each evaluation period.

| | Evaluation periods | | | |
|---|---|---|---|---|
| Materials | Baseline | 6 months | 12 months | 24 months |
| Vitremer | 117 (100) | 114 (97.4) | 106 (90.6) | 97 (82.9) |
| Revolution | 119 (100) | 108 (90.8) | 108 (90.8) | 93 (78.2) |
| Dyract Flow | 120 (100) | 113 (94.2) | 111 (92.5) | 89 (74.2) |

The sample was composed of 113 children (356 teeth), ages 7 to 8 years, who studied in two public schools in Piracicaba - São Paulo, Brazil. They presented at least one permanent first molar with no previous filling, sealant or clinical evidence of caries (white spot lesion and cavity). Clinical procedures started after the adults responsible for the children signed an informed consent. The socioeconomic level of the children was determined using a questionnaire that included number of house appliances and education level of the family head (ABA-ABIPEME criteria)[17] to associate this factor with caries present at the 24-month sealant evaluation period.

The children were divided into groups of different dmft scores (dmft=1 e 2 and dmft>3) before being allocated to three experimental groups at random. In this way, it was possible to obtain homogeneity of the sample for this caries risk predictor (Table 1).

The clinical procedures were done using portable dentistry equipment (Proquest Delivery System, model 4010; Compressor Technologies Ltd, Englewood, USA). Children received just one material as a fissure sealant that was applied in permanent first molars. Plaque was scored using the Simplified Oral Hygiene Index[18] after the application of fuchsine. The following materials were used: a resin modified glass ionomer – Vitremer (A) (3M ESPE, St Paul, MN, USA), a flowable resin composite - Revolution (B) (Kerr Corporation, Orange, CA, USA) and a compomer - Dyract Flow (C) (Dentsply Caulk, Dentsply International Inc., Milford, DE, USA).

After pumice prophylaxis, the occlusal surfaces were rinsed with air/water spray. The teeth were isolated with cotton rolls to avoid saliva contamination, conditioned for 15 to 20 seconds with 37% phosphoric acid gel and then rinsed with water. After this, the cotton rolls were carefully substituted to avoid saliva contamination.

Vitremer material (A) was mixed in a powder/liquid proportion of 1:2 to obtain a lower viscosity so that the mixture flowed into the fissures.[12] This material was inserted using a dental explorer after the application and light-cured for 20s of the Primer (3M ESPE) and at the end was applied Finishing Gloss. Revolution (B) was inserted in fissures after the application and light-cured of the filled bonding system OptiBond Solo (Kerr Corporation). Dyract Flow material (C) was inserted in fissures after the application and light-cured of the filled bonding system Prime & Bond NT (Dentsply). Occlusal contacts were verified and adjustments were made when necessary. One-hundred-seventeen teeth were sealed with material A, 119 teeth with material B and 120 teeth with material C.

**Clinical evaluation**

Clinical evaluations were done 6, 12 and 24 months after sealant application at the school where the children were studying. In the exam register there were drawings of molar occlusal surfaces, in which it was indicated the fissures that lost the sealant. Portable dentistry equipment and artificial lighting were used. After drying for 5 seconds, the teeth were examined by one calibrated dentist, who used an explorer and a dental mirror. The numbers and percentages of treated teeth that were examined are shown in Table 2.

The following criteria were adopted to evaluate the retention of the sealant:[12]

- Total Retention (TR) – score 0: total retention of sealant on the occlusal surface;
- Partial Retention Type 1 (PR1) – score 1: presence of sealant in 2/3 of the pit extension, with small fractures and losses of material.
- Partial Retention Type 2 (PR2) – score 2: presence of sealant in 1/3 of the pit extension with fractures and losses of material.
- Total Loss (TL) – score 3: absence of sealant on the occlusal surface.

The following criteria were used to evaluate occlusal caries in the sealed teeth (adapted from Thylstrup and Fejerskov[19] and Ketley and Holt[20]:

No visible caries.

Presence of an active white spot lesion (translucent enamel alterations[19] on occlusal surfaces of the teeth that received sealants.

Presence of a microcavity (diameter ≤ 1.5 mm across fissure and large cavities.

Filled teeth.

**Table 3.** Percentages for retention rates of fissure sealants after 6, 12, 24 months.

| | Retention levels | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Materials** | **TR** | | | **PR1** | | | **PR2** | | | **TL** | | |
| | 6 | 12 | 24 | 6 | 12 | 24 | 6 | 12 | 24 | 6 | 12 | 24 |
| Vitremer | 97.4 | 77.4 | 47.4 | 0.9 | 12.3 | 20.6 | 1.8 | 4.7 | 16.5 | 0.0 | 5.7 | 15.5 |
| Revolution | 96.3 | 84.4 | 76.3 | 3.7 | 11.9 | 15.1 | 0.0 | 1.8 | 2.2 | 0.0 | 0.9 | 6.5 |
| Dyract Flow | 89.4 | 75.7 | 58.4 | 5.3 | 15.3 | 21.3 | 5.3 | 7.2 | 6.7 | 0.0 | 1.8 | 13.5 |

Kruskal-Wallis test: 6-month evaluation ($p>0.05$); 12-month evaluation ($p>0.05$); 24-month evaluation ($p<0.05$).
TR – Total Retention, R1 – Partial Retention 1, R2 – Partial Retention 2, TL – Total loss.

**Table 4.** Comparison of ranked means for retention of the three sealants materials after 6, 12 and 24 months (Friedman Test).

| | Rank Means | | |
|---|---|---|---|
| **Materials** | **6 months** | **12 months** | **24 months** |
| Vitremer | 1.64[b] | 1.90[b] | 2.45[a] |
| Revolution | 1.83[a] | 2.01[a] | 2.15[a] |
| Dyract Flow | 1.72[b] | 1.94[b] | 2.34[a] |

Values with the same superscript letter are not significantly different ($p>0.05$).

**Table 5.** Numbers and percentages of carious + filled and sound sealed teeth after 12 and 24 months for the three sealant materials.

| **Materials** | **Carious + Filling N (%)** | | **Sound N (%)** | |
|---|---|---|---|---|
| | **12 months** | **24 months** | **12 months** | **24 months** |
| Vitremer | 1 (0.9) | 3 (3.1) | 105 (99.0) | 94 (96.9) |
| Revolution | 3 (2.8) | 4 (4.3) | 105 (97.2) | 89 (95.7) |
| Dyract flow | 3 (2.7) | 6 (6.7) | 108 (97.3) | 83 (93.2) |

Fisher Exact test: $p=0.71$ at 12 months; $p=0.49$ at 24 months.

**Table 6.** Number of sound and carious sealed teeth at 24 months associated with dmft score, plaque index and socioeconomic level.

| **Carious teeth** | **dmft score** | | **Plaque index** | | | | **Socioeconomic level** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1-2** | **>3** | **0** | **1** | **2** | **B** | **C** | **D** | **E** |
| Yes | 5 | 8 | 2 | 11 | 0 | 1 | 7 | 5 | 0 |
| No | 63 | 203 | 48 | 179 | 39 | 34 | 105 | 123 | 4 |
| **p** | **0.38*** | | **0.34**** | | | | **0.72**** | | |

Chi-square test*
Fisher Exact test**

## Statistical analysis

The Kruskal-Wallis test was used to evaluate differences in the retention rates (TR, PR1, PR2 and TL) among the three sealants each evaluation period. The Friedman test was employed to verify differences in retention rates for each material over the study period. The probability level for this and subsequent test was set at $\alpha=0.05$ for statistical significance. The Fisher Exact test was used to compare caries experience (carious and filled teeth - C+F) at each evaluation period among three sealants. The Chi-square test or Fisher Exact test was used to evaluate associations between plaque index, dmft score and socioeconomic level at the initial exam, with caries present at the 24-month sealant evaluation period. The Kappa test was used to verify intra-examiner (D1) reproducibility for the clinical assessments of sealant retention and caries diagnosis.

## RESULTS

Intra-examiner reproducibility was 0.72 and 0.81 for the clinical assessments of sealant retention and caries evaluation, respectively. The percentages for sealant retention after 6, 12 and 24 months are shown in Table 3. After 6 and 12 months the differences in retention rates (TR, PR1, PR2 and TL) were not significant. However, statistically significant differences after 24 months were verified among the three materials ($p<0.05$). Revolution showed the best retention rates in comparison to Vitremer and Dyract Flow.

Table 4 shows the ranked means for the Friedman test. The difference in retention rates (TR, PR1, PR2 and TL) was significant for Vitremer and Dyract Flow with poorer retention after 24 months ($p<0.05$). However, there was no difference in retention rates for Revolution after 12 and 24 months.

There were no fissure caries at the 6-month evaluation. Table 5 shows the number and percentage of carious and filled teeth at 12 and 24 months. There were 7 teeth with white spot lesions after 12 months. There were 7 teeth with white lesions, 2 with a microcavity and 4 with restorations after 24 months. No significant differences in caries increments were found among the sealant materials after 12 and 24 months ($p=0.05$).

As shown in Table 6, there were no associations either between the dmft score, the plaque index or the socioeconomic level, with caries present in the sealed teeth at 24 months ($p>0.05$).

## DISCUSSION

The morphology of occlusal surfaces makes the mechanical removal of dental plaque difficult. For this reason, full-retained fissure sealant is the best preventive method for these surfaces, since it acts as a physical barrier that prevents the exchange of metabolic products between fissure microorganisms and the oral environment. Different materials, such as flowable resin composite, unfilled resin, GIC and modified materials[7,10-11,13-16,21-23] have been evaluated as fissure sealants.

The results of the present study show that after 6 and 12 months there were no statistically significant differences among the materials regarding retention rates (total, partial 1, partial 2 and total loss). However, after 24 months, Revolution showed the best retention results ($p<0.05$). These retention rates are similar to those verified by a great number of studies using resin-based materials as fissure sealants.[6-7,15,24-25]

The retention rates for Vitremer and Dyract Flow were not significantly different in this study ($p>0.05$). They are modified materials, Vitremer is a resin-modified GIC and Dyract Flow is a compomer or a polyacid-modified resin composite. There are not a great number of studies that have used these materials as fissures sealants.

After 12 months, Winkler *et al*.,[15] observed a total retention rate of 51% for a resin-modified GIC, while Pereira *et al*.,[12] observed 31% for a resin-modified GIC (Vitremer) and de Luca-Fraga and Pimenta[22] found a total retention rate of 85.7% for Vitremer. The present study found a total retention rate of 77.4% for the same material and time of evaluation. After 24 months, the total retention rate decreased to 47.4%, while to the study of Pereira *et al*.,[23] the total retention of Vitremer was 14.1%.

For compomers, in the present study a total retention rate of 58.4% for Dyract Flow was observed after 24 months. de Luca-Fraga and Pimenta[22] observed a total retention rate of 95.9% for Dyract after 12 months as compared to 75.7% in this study.

Ripa[6] stated that "the highest rate of sealant loss occurred during the 1st year following treatment" because of failures during sealant application. In this study a statistical difference in the retention rates was observed between the 12 and 24 months for Vitremer and Dyract Flow, which did not occur when the retention rates for 6 and 12 months were compared (Table 4). The retention rates for Revolution were not significantly different among the three evaluation periods. Resin composites are more wear resistant than resin-modified GIC and compomers,[26-28] be one reason for the different retention rates of the materials.

After 12 months, 7 white spot lesions were observed in teeth that had totally or partially lost the sealants. However, after 24 months, 7 teeth showed white spot lesions, 2 showed microcavities and 4 teeth were restored (Table 5). There were no statistically significant differences among the groups for caries presence after 12 and 24 months ($p>0.05$). Occlusal surfaces of erupting permanent first molars show favorable conditions for plaque accumulation, so with an increased susceptibility for developing carious lesions.[29] Nevertheless, after complete tooth eruption, the presence of sealant material to obliterate the fissures is not so important.[11] In this way, the teeth in the present study were not at a critical period for caries development. This might partly explain, together with the high retention rate for Revolution and the confirmed fluoride releasing abilities of resin-modified GIC and compomers[30-32] the low caries incidence found after 24 months. The results for caries from the present study are similar to those of de Luca-Fraga and Pimenta,[22] who found two caries in the experimental group (Dyract and Vitremer) after 12 months and are better than the results of Pereira *et al*.[23] (9.9% of caries to Vitremer group) after 24 months. Forss *et al*.[24] verified 4.6% of carious lesions in the groups sealed with resin-based light cured and GIC after two years. Winkler *et al*.[15] verified that there were no significant differences in caries development between sealed teeth with resin-modified GIC and light-cured resin sealant after 12 months, similarly to the present study.

Determining the caries risk of children is extremely important for indicating fissure sealants. Therefore, the caries history (dmf index), plaque index and socio-economic level are factors that should be evaluated, since they can be indicators for development of future carious lesions. No association was verified between these three indicators for caries risk in the sealed teeth and caries present after 24 months (Table 6). The lack of association was probably due to the low caries prevalence that has been observed in Piracicaba. A decrease of about 50.0% in the DMFT index in Piracicaba was observed from 1991 (DMFT=3.4) to 2001 (DMFT=1.7).[33] Probably, the widespread use of fluoride dentifrices and the consumption of fluoridated water (0.7ppm) in this city, as well as the application of fissure sealants, decreased the risk of carious lesions, even in children considered to beat high risk for developing caries. It is possible that the period of evaluation was not long enough to verify an association between the caries risk indicators and caries present in the sealed teeth.

## CONCLUSION

Therefore, it can be concluded in the present study that the flowable resin composite (Revolution) showed better retention rates than a resin-modified GIC (Vitremer) and a compomer (Dyract flow). However, all showed a similar low incidence of carious lesions after 24-month clinical evaluation.

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