Retention of three fissure sealants and a dentin bonding system used as fissure sealant in caries prevention: 12-month follow-up results

Pilar Baca [1], Manuel Bravo [1], Adela P Baca [2], Ana Jiménez [2], María Paloma González-Rodríguez [3]

(1) Professor in Preventive and Community Dentistry
(2) Dentistry
(3) Assistant Professor in Operative Dentistry. School of Dentistry, University of Granada, Granada, Spain

Correspondence:
Prof. Pilar Baca
Facultad de Odontología. Campus de Cartuja s/n.
Universidad de Granada.
E-18071 Granada.
E-mail: pbaca@ugr.es

Received: 27-05-2006
Accepted: 17-05-2007

Indexed in:
-Index Medicus / MEDLINE / PubMed
-EMBASE, Excerpta Medica
-SCOPUS
-Indice Médico Español
-IBECS

Baca P, Bravo M, Baca AP, Jiménez A, González-Rodríguez MP. Retention of three fissure sealants and a dentin bonding system used as fissure sealant in caries prevention: 12-month follow-up results. Med Oral Patol Oral Cir Bucal 2007;12:E459-63.
© Medicina Oral S. L. C.I.F. B 96689336 - ISSN 1698-6946

ABSTRACT

Background. Bonding agents could be used as fissure sealants. This study compares the retention three fissure sealants (Delton®, Delton Plus® and Concise®) and a filled dentin bonding system (Optibond Solo®).

Methods. Fifty-six children aged 7-8 years received fissure sealants either in the four permanent first molars, in the four deciduous second molars, or in all eight of these teeth. Every child received a different sealing material in each quadrant on a random basis. Clinical evaluation at 12 months was performed by a single blind examiner, and the retention was classified as either a success (total retention) or a failure (partial retention or not present).

Results: There were no statistically significant differences among the four materials in permanent maxillary molars or deciduous molars. In permanent mandibular molars, Optibond Solo® showed a lower percentage of retention (40.9%), significantly different (p=0.002) to that of Delton® (89.5%), Delton Plus® (87.5%) and Concise® (76.5%).

Conclusion: One bottle dentin bonding system used as a sealant does not improve the retention of conventional fissure sealants.

Clinical Implication: Because of the scarcity of studies on the use of dental adhesives as sealants, further studies are warranted for the final support of that conclusion.

Key words: *Pit and fissure sealants, dentin-bonding agent.*

INTRODUCTION

The correct diagnosis of incipient caries lesions on occlusal surfaces is not simple. When the presence of caries is uncertain, it is possible to perform an invasive technique that should be followed by restoration with an adhesive dentin and a resin, completing it by sealing the rest of the system of fissures (1). A simplified technique to apply pit and fissure sealant with an invasive technique without using restorative material has been evaluated at 24 months with good results (2). Another simplified approach is to use dentin adhesive to seal the rest of the fissures. One-bottle or self-priming adhesive systems have been shown to bond extremely well to either dry or moist enamel (3). A recent study demonstrated that sealant survival is protected by using one-bottle bonding agents between sealant and saliva-contaminated or non-contaminated enamel (4). Therefore, it may be possible to simplify the technique of preventive resin restorations by using the adhesive agent as fissure sealant.

There have been few studies comparing the retention of fissure sealants with that of adhesives used as fissure sealants. Grande et al. (5) compared the retention of a multi-use bonding agent (OptiBond®) with that of a conventional sealant (Delton®) used as pit and fissure sealant and reported a better clinical performance with OptiBond®. An earlier in vitro study comparing microleakage between a conventional sealant, a bonding agent, and an ionomer

material suggested that the bonding agent could be used by itself as a pit and fissure sealant (6). The present study was designed to compare the percentage of retention at 12 months between two unfilled sealants (Delton® and Concise®), one fluoride and filled sealant (Delton Plus®), and a self-priming adhesive system (OptiBond Solo®), when applied on occlusal surfaces of permanent first molars and deciduous second molars in children aged 7-8 years.

MATERIALS AND METHODS

The study was carried out in five primary schools in Granada (Andalusia), Southern Spain. At the time of the study, the Andalusian Public Health Service did not provide free restorations for caries in children, and only a small number of school-children were treated with fissure sealant. The level of fluoride in drinking water was 0.07 ppm.

Children in the second year of these schools, aged 7-8 years, participated in a preventive program organized by the University of Granada School of Dentistry that included fissure sealing, one application of fluoride gel, and dietary and oral hygiene instruction. The children underwent no sustained oral health program or regular re-examinations. The present study included the children in the program who received fissure sealants in either the four permanent first molars, four deciduous second molars, or all eight of these teeth. Written informed consent was obtained from the parents or guardians of all children in the study, and the study design was approved by the ethics committee of the School of Dentistry, University of Granada.

At baseline, the participants were examined by two trained and calibrated clinicians (PB and MB). Carious lesions were detected using a flat mirror and an exploration probe, following WHO criteria (7). The clinicians then selected healthy teeth and sites that required sealing. After the baseline examination, a report on restorative treatment needs was delivered to all children.

Sealing material was applied following the manufacturer's instructions at the dental clinic of the School of Dentistry, by dental students assisted by a second student. The technique included: the slow-speed, dry-brush cleaning of the surface; moisture control using cotton roll; half-minute acid-etching (H3PO4 37% gel); washing with air-water spray for 20 sec; air-drying; application of sealant or bonding agent; 40 sec of light polymerization, and a 20-sec re-etch in cases of saliva contamination. After each application, the sealant was tested for lack of air bubbles, marginal adaptation, retention, and complete polymerization (PB or MB). If a sealant was deficient, exhibited surface porosity, or could be displaced with an explorer, the tooth was immediately re-treated, although this information was not recorded. When the sealant was evaluated as satisfactory, the occlusion was then verified and possible premature contacts were eliminated. The sealants and dentin adhesive were applied on healthy permanent first molars and deciduous second molars with adequate eruption. The application was made on mesi-occlusal sites of maxillary permanent molars and on occlusal sites of mandibular permanent molars and maxillary or mandibular deciduous molars. Although the buccal pits of mandibular molars and occlusal-lingual grooves of maxillary molars were also treated in some teeth, these areas are not included in this report. All four materials were used in every child in the study, with a different material randomly applied to each quadrant.

The sealants and bonding agent used in the study were: Delton®, unfilled light-polymerized opaque fissure sealant (Dentsply Caulk, Milford, DE); Delton Plus®, filled light-polymerized opaque fissure sealant with fluoride (Dentsply Caulk, Milford, DE); Concise sealant®, unfilled light-curing white sealant (3M Dental, St Paul MN); and OptiBond Solo®, one-bottle filled adhesive (Kerr, Orange, CA).

The school-children were re-examined at 12 months after the sealant application. Evaluations were made by a clinician (AJ) who had previously been trained by clinician PB in using WHO caries criteria and recognizing sealant retention, using a No. 5 explorer and flat mirror. The training program included a repeat examination by clinician AJ in 15 of the children, with a one-week interval between examinations. The kappa coefficient was greater than 0.60 for all four types of sealant. Colored glasses were worn by the clinician to minimize sealant color differences, guaranteeing a blind examination. Sealants were classified as present, partially present or lost, following the criteria proposed by García-Godoy (8), although only two situations were considered for the outcome analysis: success (present) and failure (partially present or lost). Uncovered fissures were examined for the presence of caries. Sealants applied outside this program were not taken into account.

The statistical analysis was performed with the SPSS-Windows v.11.0 package (SPSS Inc, Chicago IL), using the methods listed in Table 1.

RESULTS

At the beginning of the study, 67 children fulfilled the inclusion criteria. At 12 months, 11 children (16.41%) had been lost to the follow-up because of changing school, illness, or absenteeism. Among the 56 children in the follow-up study, the mean age was 7.32 years (standard deviation (sd)=0.47), the decayed and filled deciduous (dft) Teeth index was 1.16 (sd= 2.06) and the Decayed and Filled permanent first Molar (DFM) index was 0.16 (sd=0.46). Twelve of these children received sealants in the four permanent first molars, 19 in the four deciduous second molars, and 25 in all eight teeth. The permanent first molars and deciduous second molars were analyzed independently.

Table 1 displays the percentages of success (total retention) for the four materials at 12 months. In permanent first molars, the success rate was similar between the three fissure sealants but it was significantly higher for Delton® and Delton Plus® than for OptiBond Solo®. For OptiBond Solo®, the success rate significantly differed (p=0.004) between arches (maxilla, 93.3% vs mandible, 40.9%). In deciduous second molars, there were no statistically significant differences in success rate among the four materials under study (p=0.137).

Table 1. Number of teeth and percentage of success (total retention) using fissure sealants or dentin bonding system [a].

Tooth	Delton®	Delton Plus®	Concise®	OptiBond Solo®	Comparison (Cochran test)
Permanent first molar (n=37 children)	37 (89.2%)	37 (86.5%)	37 (78.4%)	37 (62.2%)	Q=10.268 (3 gl), p=0.016[b]
Maxillary (n=74 teeth)	18 (88.9%)	21 (85.7%)	20 (80.0%)	15 (93.3%)	χ^2=1.42, p=0.701[c]
Mandibular (n=74 teeth)	19 (89.5%)	16 (87.5%)	17 (76.5%)	22 (40.9%)	χ^2=15.37, p=0.002[d]
2nd Deciduous molar (n=44 children)	44 (97.7%)	44 (84.1%)	44 (88.6%)	44 (86.4%)	Q=5.533 (3 gl), p=0.137
Maxillary (n=88 teeth)	22 (95.5%)	23 (78.3%)	24 (87.5%)	19 (94.7%)	χ^2=4.21, p=0.240
Mandibular (n=88 teeth)	22 (100.0%)	21 (90.5%)	20 (90.0%)	25 (80.0%)	χ^2=5.12, p=0.163

a: Comparisons between Maxilla and Mandible (within each sealant) by χ^2_c test (or bilateral Fisher exact test). The difference was only significant for Optibond in permanent first molars (χ^2_c=8.31, p=0.004).

b: Global comparison: Cochran test, Comparison by pairs (McNemar test), Optibond ≠ Delton and Delton F, where "≠" means p<0.05.

c: Chi-square test.

d: Analysis of the significance indicated that Optibond Solo was statistically different from the other collapsed three categories (p<0.001, bilateral Fisher's exact test). The collapsed first three categories were not statistically different (p=0.519, chi-square test).

At 12 months, no caries or fillings were observed on any occlusal surface in permanent first molars. However, three decayed and two filled surfaces were observed in deciduous second molars: two fillings and one caries lesion in surface fissures sealed with Optibond Solo®, and two caries in surface fissures sealed with Concise®.

DISCUSSION

In this comparative study of fissure sealants, all four materials were applied in every child in order to overcome the sensitivity of fissure sealing to inter-operator variability (9). Moreover, the resin was applied and evaluated by different operators, the selection of material for each quadrant was randomized, and the evaluation process was blind, further minimizing the possibility of bias in this study.

Two very widely used and studied unfilled fissure sealants (Delton® and Concise®), a fluoride and filled sealant (Delton Plus®) and a long-available filled dentin adhesive system (Optibond Solo®) were selected for the study. Optibond Solo® has demonstrated a good bonding to both dry and wet enamel (3) and an adequate clinical performance (10). The retention of a sealing material is of interest because the efficacy of the seal is related to the retention to the enamel surface (11). Most sealing failures occur within the first year of their application, and the overall sealant loss rate is estimated to be 5-10% per year (12).

In general, our retention outcomes are somewhat worse, probably because the operators in our study were students (13).

The success rate was very similar between all four materials in the deciduous second molars and between the three sealants in the permanent molars. The best retention percentages in both deciduous (97.7%) and permanent (89.2) dentition were obtained using Delton®, a non-fluoride unfilled sealant (Table 1) known to have a greater penetration coefficient than Concise®, the other unfilled sealant under study (14).

Delton® and Delton Plus® differ in two ways: Delton Plus® releases fluoride and Delton® contains 38% filler. On the other hand, there has been no scientific demonstration of a difference in retention rate between fluoride and conventional sealants (15). Regarding the filler, Delton® is less viscous than Delton Plus®, although there are no differences in leakage scores (16). Sealant penetration is a major factor in retention: sealants with low viscosity penetrate better and form a resin-impregnated layer with enamel (17). There is no evidence that the performance of a filled sealant is better than that of an unfilled sealant; indeed a tendency to a worse retention by the former has been reported (18). The recently published interim results of a clinical trial showed similar retention using Delton® or Delton Plus® (19), although the follow-up period was only 5-8 months.

There were no differences between the four materials under study in deciduous molars, but OptiBond Solo® showed a worse success rate in permanent first molars, which was lowest in the mandible (40.9%). We had expected good outcomes for the dentin adhesive system because of the characteristics of this material. The marginal leakage and bond to enamel of Optibond Solo®, a hydrophilic one-bottle filled dentin adhesive, is not affected by humid conditions (20,21). Indeed, an increase in bond strength to enamel was reported when bonds were performed under wet conditions (22).

We cannot assume that the behavior of Optibond Solo® is worse than that of normal sealants, because it obtained similar retention ranges in the upper arch and second deciduous molars. On the other hand, the considerable difference found cannot be attributed to diagnostic error, given that adequate diagnostic reliability had been demonstrated in the examiner calibration tests. It may be due to a greater sensitivity to possible saliva contamination compared with the sealants. This effect may have been multiplied because the application was performed by students in a region posterior to the second deciduous molar, where there is greater contamination, especially in the lower arch. The retention of fissure sealants was shown to be greater in the central groove of maxillary molars than on the occlusal surface of mandibular molars (23). Another reasonable hypothesis seems to be that the markedly longer grooves of permanent mandibular molars may limit the retention of Optibond Solo®.

The use of a dentin bonding agent as a sealant is not novel. Grande et al. (5) reported a better clinical performance for OptiBond® (dual cure) used as sealant compared with Delton® after a 30-month follow-up. They used a two-step adhesive system: a primer of low viscosity and high penetration power; and a bonding agent containing filler particles that bonds to the primer. This method allows a great penetration of the material into the fissure. We used a one-bottle adhesive system that combines the primer and bonding agent in a single solution, with 25% filler that increases the viscosity. Filled materials have some advantages over unfilled materials, including less polymerization shrinkage, greater microhardness values and better abrasion resistance (24,25). However, as remarked above, they also have a higher viscosity. To our knowledge, there are no studies comparing the viscosity of OptiBond Solo® with that of fissure sealants. However, it can be argued that unfilled resin would penetrate deeper into the fissure system and may, therefore, be better retained. Recently, Autio-Gold (26) observed slightly lower retention rates in teeth sealed with a medium-filled material when compared with an unfilled sealant (Delton®).

In resin preventive restorations, it would be very simple to apply the adhesive to the entire fissure system. The behavior of a dentin bonding agent when used as sealant or under sealant material is of interest because of a possible simplification of the technique and because the protection of fissures that have already suffered a caries lesion should be a priority.

CONCLUSION

Given the worse retention on the occlusal surface of permanent molars in the lower arch and that the operators were students, the only reasonable conclusion of the present study is that Optibond Solo® can achieve similar retention to fissure sealants at 12 months but appears to be more sensitive to the application technique. Preliminary clinical studies are required before a product can be recommended for use in a different technique to the one it was initially designed for. Because of the scarcity of studies on the use of dental adhesives as sealants, further studies are warranted that include other adhesive systems, children of different ages, surfaces that are more prone to contamination, and longer follow-up periods.

REFERENCES

1. Pitt NB. The diagnosis of dental caries. 1. Diagnostic methods for assessing buccal, lingual and occlusal surfaces. Dent Update 1996;18:393-6.
2. Do Rego MA, De Araújo MA. A 2-year clinical evaluation of fluoride-containing pit and fissure sealant placed with an invasive technique. Quintessence Int 1996;27:99-103.
3. Swift EJ. Dentin/enamel adhesives: review of the literature. Pediatr Dent 2002;24:456-61.
4. Feigal RJ, Musherure P, Gillespie B, Levy-Polack M, Quelhas I, Hebling J. Improved sealant retention with bonding agents: a clinical study of two-bottle and single-bottle systems. J Dent Res 2000;79:1850-6.
5. Grande RHM, Pedroso De Lima AC, Rodrigues Filho LE, Ferreira Witzel M. Clinical evaluation of an adhesive used as a fissure sealant. Am J Dent 2000;13:167-70.
6. Grande RHM, Yagüe Ballester R, Da Motta Singer J, Ferreira Santos JF. Microleakage of a universal adhesive used a fissure sealant. Am J Dent 1998;11:109-13.
7. WHO. Oral Health Surveys. Basic methods. Geneva: WHO; 1988.
8. García-Godoy F. Retention of a light-cured fissure sealant (Helioseal) in a tropical environment after 12 months. Clin Prev Dent 1986;8:11-3.
9. Rock WP, Bradnock G. Effect of operator variability and patient age on the retention of fissure sealant resin: 3 year results. Community Dent Oral Epidemiol 1981;9:207-9.
10. Swift EJ Jr, Perdigao J, Wilder AD Jr, Heymann HO, Sturdevant JR, Bayne SC. Clinical evaluation of two one-bottle dentin adhesives at three years. J Am Dent Assoc 2001;123:1117-23.
11. Simonsen RJ. New materials on the horizon. JADA 1991;122:25-31.
12. Ismael AI, Gagnon PA. A longitudinal evaluation of fissure sealant applied in dental practices. J Dent Res 1995;74:1583-90.
13. Mitchell L, Murris JJ. The durability of fissure sealant placed in children attending a dental hospital. Br Dent J 1987;163:353-6.
14. Retief DH, Mallory WP. Evaluation of two pit and fissure sealants: an in vitro study. Pediatr Dent 1981;3:12-6.
15. Morphis TL, Toumba KJ, Lygidakis NA. Fluoride pit and fissure sealants: a review. Int J Paediatr Dent 2000;10:90-8.
16. Barnes DM, Kihn P, Von Fraunhofer JA, Elsabach S. Flow Characteristics and sealing ability of fissure sealant. Oper Dent 2000;25:306-10.
17. Irinoda Y, Matsumura Y, Kito H, Nakano T, Toyama T, Nakagaki H, et al. Effect of sealant viscosity on the penetration of resin into etched human enamel. Oper Dent 2000;25:274-82.
18. Simonsen RJ. Pit and fissure sealant: review of the literature. Pediatr Dent 2002;24:393-414.
19. Heifetz SB, Yaari A, Proskin H. Retention of a Fluoride-releasing Sealant Compared with its Non-fluoride Analogue: Interim Results of a Clinical Trial After 5 to 8 Months of study (abstract). The 32nd Annual Meeting and Exhibition of the AADR (March 12-15, 2003) San Antonio, TX (web page). Avalaible at: http://iadr.confex.com/iadr/2003SanAnton/techprogram/ (accessed March 5, 2006).
20. Santini A, Plasschaert AJ, Mitchell S. Marginal leakage of filled dentin adhesives used with wet and dry bonding techniques. Am J Dent 2000;13:93-7.

21. Asmussen E, Peutzfeldt A. The influence of relative humidity on the effect of dentin bonding systems. J Adhes Dent 2001;3:123-7.
22. Walls AW, Lee J, McCabe JF. The bonding of composite resin to moist enamel. Br Dent J 2001;191:148-50.
23. Bravo M, Osorio E, García-Anllo I, Llodra JC, Baca P. The influence of dft index on sealant success: a 48-month survival analysis. J Dent Res 1996;75:768-74.
24. Strang R, Cummings A, Stephen KW. Laboratory studies of visible-light cured fissure sealants: Setting times and depth of polymerization. J Oral Rehabilit 1996;13:305-10.
25. Strang R, Cummings A, Stephen KW, McMenemy P. Further abrasion resistance and bond strength studies of fissure sealants. J Oral Rehabilit 1996;13:257-62.
26. Autio-Gold JT. Clinical evaluation of a medium-filled floatable restorative material as a pit and fissure sealant. Oper Dent 2002;27:325-9.