Clinical Evaluation of Sealants and Preventive Resin Restorations in a Group of Environmentally Homogeneous Children

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ABSTRACT

Purpose: Pit and fissure sealants reduce occlusal caries when proper patient selection and application techniques are followed. To increase retention rate of sealants over time, good adaptation and deep sealant penetration are important. Studies remain inconclusive, however, as to determining if the bur preparation of pits and fissures would increase the adaptation and penetration thus improving sealant retention. The aim of this study was to assess if tooth preparation prior to sealant application improves sealant retention.
Methods: In this prospective cohort study, 43 children and adolescents from 4 Hutterites colonies were, for 3 years, bussed to the University of Manitoba pediatric dental clinic, Winnipeg, Manitoba, Canada, for comprehensive dental care including sealant placement using standard procedures. These came from a community with homogeneous social economical status, dietary habits, fluoride intake, and lifestyles. The decision of tooth preparation prior to sealant application was made ad hoc. Of 122 treated permanent posterior teeth, 54 had been treated as preventive resin restorations (PRRs, type A or B) and 68 were nonprepared sealants.
Results: After 1 year, teeth prepared (type B PRRs) and restored with flowable composite resins had significantly (P<.01) lower retention rates (27% vs 63%) than did teeth with nonprepared sealants or type A PRRs. Teeth prepared (type B PRRs) were also significantly (P<.001) more likely to have caries on follow-up examination (50% vs 11%) than were teeth with nonprepared sealants or type A PRRs.
Conclusions: These results suggest that preventive resin type B restorations restored with flowable composites are not helpful in terms of retention or caries reduction. (J Dent Child 2006;73:15-19)

KEYWORDS: HUTTERITE CHILDREN, PIT AND FISSURE SEALANTS, PREPARED RESIN RESTORATIONS (TYPE A AND B), SEALANT RETENTION

Occlusal caries accounts for more than two thirds of the total caries experienced by children.[1] The morphological configuration of occlusal pits and fissures (narrow, deep gaps) facilitates retention of bacteria, nutrients, and debris.[2] Narrow, deep pits and fissures are difficult to brush, and application of fluorides (ie, varnishes) has also been shown to have a limited effect on occlusal surfaces when compared to the effectiveness of fissure sealants.[3] Therefore, forming a barrier between the tooth surface and oral environment by placing pit and fissure sealants has proved to be an effective method in reducing the rate of occlusal caries on permanent posterior teeth.[4]

Although sealants have shown excellent efficacy,[5,6] many practitioners express doubts concerning their long-term effec-

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tiveness and durability.[7,8] To increase the retention rate of sealants over time, good adaptation and deep sealant penetration are important.[9] Bur preparation of pits and fissures increases adaptation and penetration, thus reducing the restorative material's microleakage.[8] It has also been suggested that preparing the fissures helps eliminate organic material and improve enamel conditioning.[10] Notably, Simonsen[11] and Hicks[12] have introduced preventive resin restorations (PRR) as:

1. type A—minimal fissure preparation (done with ¼ or ½ round bur);
2. type B—caries removal, with 1 or 2 round bur; and
3. type C—when, for caries removal, use of larger round bur (>2) is required.

Collectively, widening of the fissures with rotary instrumentation has been recommended to: (1) clean the fissure entrance; (2) allow inspection of incipient caries[13]; (3) increase the bonding surface[9]; and (4) reduce sealant microleakage.[8] In spite of these recommendations, studies have shown that PRR and nonprepared sealants exhibit a similar success rate.[14-16] Other evidence is encouraging, but it is not conclusive to support a definitive decision regarding making fissure preparation a routine practice prior to sealant application.[17]

One of the confounding factors in comparing PRR and nonprepared sealants may be diversity in the pool of patients studied. To reduce cultural, economical, and environmental diversities, it could be advantageous to assess retention rates of PRR and nonprepared sealants in children from a genetically similar background who live in a homogeneous environment (ie, same diet, same oral hygiene habits, etc). For this reason, the authors assessed the effectiveness of PRR and nonprepared pit and fissure sealant techniques in children from a homogeneous religious (Hutterite) community.

METHODS

STUDY DESIGN

This study used a prospective cohort of 43 Hutterite children. Sealants were placed between August 1998 and April 2001. Follow-up examinations were conducted in August 2001. Subjects came from 4 Hutterite colonies with local natural water fluoride levels ranging from 0.2 to 0.3 ppm.

PATIENT SELECTION

Between August 1998 and April 2001, 43 children aged 6 to 18 years were bussed from 4 Hutterite colonies to the pediatric dental clinic of the Faculty of Dentistry, University of Manitoba, Winnipeg, Manitoba, Canada. Children from these communities come from a homogeneous environment. Collectively, bussing of these children was part of the Faculty's outreach programs to provide dental services to children from rural areas.[18] Senior dental students provided comprehensive dental care to these children, including sealant and PRR placements on permanent posterior teeth.

SEALANT OR FLOWABLE APPLICATION

Sealants were applied to the children's permanent posterior teeth as a part of comprehensive dental care at the Faculty of Dentistry, University of Manitoba. Notably, the teaching doctrine at the Faculty of Dentistry did not favor the tooth preparation method (type A PRRs) or the placement of sealant or flowable resin material. Student clinicians, in consultation with the supervising dentist, decided on an ad hoc basis whether or not to use a nonprepared sealant technique or to prepare a tooth with a ½ or ¼ round turbine bur (type A PRRs). This decision was noted in the daily treatment record in the patient's dental chart. At the same time, if tooth preparation revealed the presence of minor enamel caries that could be removed with a 1 or 2 round bur, the type B form of PRR was performed. Notably, the sealant application's procedures included appropriate isolation of the tooth, preferably using rubber dam. The tooth surface was then cleaned using fluoride-free pumice slurry and rinsed. Teeth were:

1. etched with 34% phosphoric acid gel (Dentsply) for 20 seconds;
2. rinsed for 30 seconds; and
3. dried with uncontaminated compressed air for 15 seconds.

Afterward, dried BIS-GMA sealant was applied and light cured in the nonprepared sealant group. For types A and B PRRs, however, the tooth surface was left slightly moist after rinsing and primer/adhesive (Prime & Bond, Dentsply, Woodbridge, Ontario, Canada) was than applied for 15 seconds. Primer was dried with a gentle stream of air and light cured, after which Revolution flowable composite (Kerr, Los Angeles, Calif) was applied to restore types A and B PRRs.

SEALANT RE-EVALUATION

A follow-up evaluation and examination of previously sealed or restored teeth was conducted at various time periods at least 6 months after sealant applications. As the examinations were performed during the school year and at different time periods the data was collected and pooled as a categorical and noncontinuous variable. During re-evaluation and to avoid examiner bias, investigators were not aware if the tooth was prepared during the filling procedure. A mirror and explorer were used to categorize the material retention as intact, partially retained, or completely missing, and caries status as sound, caries, filled, or missing.

STATISTICAL CONSIDERATIONS

Data entry was performed using Epi Info 6 (USD Inc, Stone Mountain, Ga). SPSS 13.0 (PSS Inc, Chicago, Ill) was used to produce frequency distributions and to look for associations between variables. Statistical analysis was performed at the tooth level using chi-square and the Fisher exact test with statistical significance set at $P<.05$.

ETHICAL CONSIDERATION

The Health Research Ethics Board of the University of Manitoba approved this study.

RESULTS

DEMOGRAPHICS/ORAL HEALTH PRACTICES

A total of 43 children, 27 (63%) male and 16 (37%) female, were available for follow-up examination. Subject ages ranged from 6 to 18 years, with a mean of 12.4 (±3.1) years. As shown in Table 1, the subjects were quite consistent in their oral health practices. No community water sources were fluoridated; natural water fluoride levels ranged from 0.2 to 0.3 ppm, well below the recommended level of 1 ppm supported by the Manitoba Health Authority.

Of 160 treated teeth that were assessed for filling material retention and caries status, 33 had received type A PRRs, 21 received type B PRRs, 68 received nonprepared sealants, and 38 were of an unknown sealant type (Table 2). These 38 were excluded from the analysis. Material retention and caries status was, therefore, assessed for 122 treated permanent premolars and molars.

MATERIAL RETENTION/DENTAL CARIES

On follow-up examination of 122 treated teeth, 103 (84%) were found to be caries free. Of these, 81 teeth (66%) were found to have completely intact restorations, while 22 (18%) had partially intact restorations. Caries was found to be present in 19 teeth (16%), all of which had completely lost the sealants or flowable composites. No caries was found in teeth with partially intact restorations, and for this reason, intact and partially intact filling materials were collapsed into a single category for further analysis.

When compared with nonprepared sealants or type A PRRs, a significantly (P<.001) higher proportion of type B PRRs were found to be completely lost at follow-up examination, with complete material loss found in 22%, 9%, and 52%, respectively (Figure 1). The retention rates for type A PRRs were higher, but not statistically different from nonprepared sealants. Of special note is the fact that the rate of complete loss of preventive resin restoration type B increased from 13% when in place for less than 12 months to 77% after 12 months or more.

When compared with nonprepared sealants or type A PRRs, a significantly higher proportion of teeth (P<.001) with type B preventive restorative resins were found to have caries at follow-up examination, with caries present in 9%, 9%, and 48%, respectively (Figure 2). The caries rate found in teeth with nonprepared sealants and type A PRRs was not significantly different. Similar to the finding reported for sealant retention rates, caries was even more common (69%) when type B PRRs had been in place for 12 months or more.

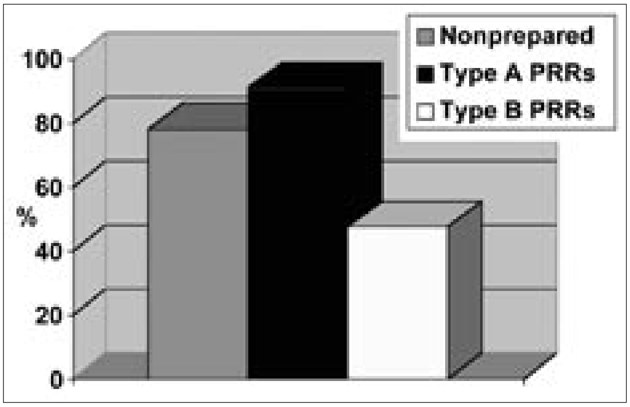

Figure 1. Retention rates of nonprepared sealants, types A and B preventive resin restorations (PRRs). Type B PRR retention significantly different (P<.001) from nonprepared and type A PRR retention. Nonprepared retention not significantly different (P>.05) from type A PRRs.

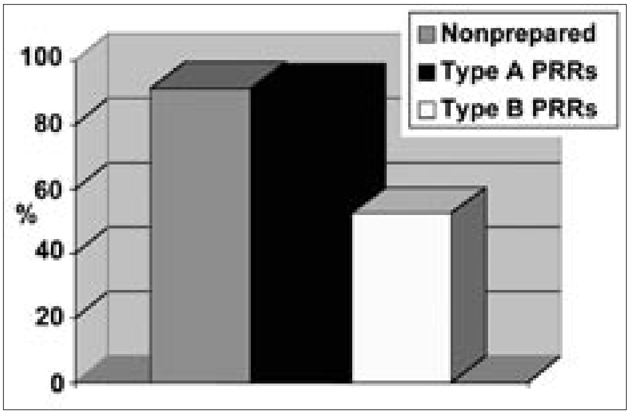

Figure 2. Percentage of caries-free teeth with nonprepared sealants and types A and B preventive resin restorations (PRRs).. Type B PRR caries rate significantly greater (P<.001) than for nonprepared and type A PRRs.

Table 1. Profile of the Children Included in This Study

Subject profile	Count (valid %)
Brushed within past 24 hours	29 (76)
Floss at least once a day	0 (0)
Using fluoridated tooth paste	31 (97)
Receive sweet snacks	42 (100)
Sweet snacks received at 3 PM	31 (74)
Receive solid sweet snacks	42 (98)
Receive liquid sweet snacks	3 (7)
Chew gum	41 (95)

DISCUSSION

This prospective cohort study assessed the effectiveness of nonprepared pit and fissure sealants and types A and B PRRs in 122 treated permanent teeth from 43 children living in identical cultural, economical, and environmental backgrounds. The main finding of this study is that, in the long term, restorative materials were less likely to be retained in teeth with type B PRRs. This study also showed that teeth with type B PRRs have an increased propensity to develop caries, as compared to nonprepared teeth or type A PRRs. This is likely due to tooth preparation, creating a defect that flowable material was inadequate to restore.[16,19]

In a 6-year clinical study, Shapira and Eidelman[10] found that mechanical preparation of fissures significantly improved the retention rate over sealants placed on non-

Table 2. Teeth Included in the Re-evaluation of Sealant Retention

Teeth	Treatment	Sealant placed <1 y	Sealant placed >1 y
Molars	Type B PRR	8	13
	Type A PRR	11	7
	Nonprepared	12	32
Bicuspids	Type B PRR	0	0
	Type A PRR	13	2
	Nonprepared	10	14
Molars+bicuspids	Type B PRR	8	13
	Type A PRR	24	9
	Nonprepared	22	46
Totals		54 (44%)	68 (56%)

prepared surfaces.[17] Others have demonstrated slight, but not dramatic improvement in retention after fissure widening.[20] This slight discrepancy in results may be attributed to differences in techniques and the materials used as well as the socioeconomic and environmental heterogeneity of patients involved in the studies, pooling together patients with diverse oral hygiene and dietary habits.

Children involved in this study were from a genetically and culturally isolated group of Hutterites living in rural farming colonies who share a homogeneous environment. Residents have the same meal time and eat the same food prepared in a communal kitchen. Children are served the same snacks, usually in the form of cookies or chocolate. Everyone drinks water from the same source. This standardizes external variables that would normally bias a study of this nature, such as variations in diet, oral hygiene habits, and fluoride levels in drinking water increase the confidence appropriate for study findings.

The decision to prepare the fissures with ½ or ¼ round bur (ie, type A PRRs) or seal nonprepared fissures was based on the relatively high success rate of both techniques.[16,21,22] Studies have also shown that the preparation of fissures may reduce the microleakage and improve the retention of the restorative material used.[8,23] Similarly, this study has demonstrated a high success rate for both techniques (ie, 80% to 90%), whereas the preparation of fissures was a somewhat, but not significantly, more successful technique. If fissure preparation would reveal presence of minor enamel caries, however, a type B PRR was placed.[11,12] Notably, opening suspicious grooves would not only help assure detection of caries, but also augment ultimate resin retention by combining traditional mechanical interlocking with the benefits of acid etch associated with micromechanical retention.

The restorative material used for types A and B PRRs was a flowable composite resin, which has lower filler volumes (≤70%) and decreased viscosity, permitting easier application on narrow and shallow surfaces.[8,24] In this study, type B PRRs demonstrated the lowest success rate of the techniques used. The low number of caries-free teeth observed with this technique cannot be attributed to the poor tooth preparation. This is because it has been previously demonstrated that sealing incipient caries lesions is an effective method for arresting these lesions.[25] Furthermore, the low retention rate of the flowable composite resin, used to restore type B PRRs, indicates that it is more likely the choice of material that was inappropriate for this type of restoration. Placement of a thicker layer of flowable resin may expose it to high impact forces of opposing cusps (ie, "jack hammer effect"). Over a period of time, this could result in a more frequent breakdown of the restorative material. Collectively, flowable composites have been used for small Class I restorations. The increased polymerization shrinkage and decreased wear resistance and strength of these materials, however, makes it less desirable for the restoration of cavities, even small and shallow cavities as in type B PRRs.[24]

This study potentially had a number of limitations. All sealants were placed by senior dental students in the dental school environment.[26] While this study's retention rates are consistent with those reported by others,[5,6,15,17] it is not clear what impact a large number of inexperienced clinicians may have had on study results. As a cohort study design, the type of sealant placed was not randomly assigned, but rather left to the choice of the student and supervising dentist. The authors cannot rule out the chance that a form of selection bias could have resulted in more teeth with early caries (and higher risk of failure) being provided with prepared resin restorations, thus biasing the results.

CONCLUSIONS

The significantly reduced retention rate of type B preventive resin restorations placed in a dental school setting suggests that this technique requires careful assessment of tooth preparation as well as the use of filled resin to restore the cavity.

ACKNOWLEDGEMENTS

A Major Outreach Award bestowed by the University of Manitoba supported this study. The authors would also like to acknowledge the work of Dr. Kavita Mathu-Muju in preparing the proposal for ethics committee approval and in helping to obtain the data.

REFERENCES

1. National Institute of Dental Research. Oral Health of United States Children: The National Survey of Dental Caries in U.S. School Children, 1986-87: National and Regional Findings. Bethesda, Md: Epidemiology and Oral Disease Prevention Program, National Institute of Dental Research, U.S. Dept. of Health and Human Services, Public Health Service, National Institutes of Health; 1989:379.
2. Dietz ER. Pit and fissure sealants. Dent Assist 1988;57:11-20.
3. Bravo M, Llodra JC, Baca P, Osorio E. Effectiveness of visible light fissure sealant (Delton) versus fluoride varnish (Duraphat): 24-month clinical trial. Community Dent Oral Epidemiol 1996;24:42-46.

4. Gonzalez CD, Fraizer PJ, Messer LB. Sealant use by general practitioners: A Minnesota survey. J Dent Child 1991;58:38-45.
5. Simonsen RJ. Retention and effectiveness of dental sealant after 15 years. J Am Dent Assoc 1991;122:34-42.
6. Ripa LW. Sealants revisited: an update of the effectiveness of pit-and-fissure sealants. Caries Res 1993;27:77-82.
7. Siverstone LM. The use of pit and fissure sealants in dentistry: Present status and future developments. Pediatr Dent 1982;4:16-21.
8. Hatibovic-Kofman S, Wright GZ, Braverman I. Microleakage of sealants after conventional, bur, and air abrasion of pits and fissures. Pediatr Dent 1998;20:173-176.
9. Garcia-Godoy, de Araujo FB. Enhancement of fissure sealant penetration and adaptation: The enameloplasty technique. J Clin Pediatr Dent 1994;19:13-18.
10. Shapira J, Eidelman E. The influence of mechanical preparation on enamel prior to etching and the retention of sealants: Three-year follow-up. J Pedod 1984;8:272-277.
11. Simonsen RJ. Preventive resin restorations: Three-year results. J Am Dent Assoc 1980;100:535-540.
12. Hicks MJ. Caries-like lesion formation around occlusal alloy and preventive resin restorations. Pediatr Dent 1984;6:17-23.
13. De Craene GP, Martens C, Dermaut R. The invasive pit and fissure sealing technique in pediatric dentistry: An SEM study of a preventive restoration. J Dent Child 1988;55:34-42.
14. De Craene GP, Martens C, Dermaut R, Surmont PAS. A clinical evaluation of a light-cured fissure sealant (Helioseal). J Dent Child 1989;56:97-102.
15. Lygidakis NA, Oulis KI, Christodoulidis A. Evaluation of fissure sealants retention following four different isolation and surface prevention techniques: Four-year clinical trial. J Clin Pediatr Dent 1994;19:23-25.
16. Houpt M, Fukus A, Eidelman E. The preventive resin (composite resin/sealant) restoration: Nine-year results. Quintessence Int 1994;3:155-159.
17. Shapira J, Eidelman E. Six-year clinical evaluation of fissure sealants placed after mechanical preparation: A matched pair study. Pediatr Dent 1986;8:204-205.
18. Lekic PC, Schroth RJ, Odlum O, deVries J, Singer D. A program to ensure adequate clinical experience in undergraduate pediatric dentistry. J Dent Educ 2000;64:440-444.
19. Davis MW. Success with sealants. Gen Dent 1998;l:176-179.
20. Le Bell Y, Forsten L. Sealing of preventively enlarged fissures. Acta Odontol Scand 1980;38:101-104.
21. Walker J, Floyd K, Jakobsen J, Pinkham JR. The effectiveness of preventive resin restorations in pediatric patients. J Dent Child 1996;63:338-340.
22. Feigal RJ. Sealants and preventive restorations: Review of effectiveness and clinical changes for improvement. Pediatr Dent 1998;20:85-92.
23. Pope BD Jr, Carcia-Godoy F, Summitt JB, Chan DDCN. Effectiveness of occlusal cleansing methods and sealant micromorphology. J Dent Child 1996;63:175-180.
24. Bayne SC, Thompson JY, Swift EF Jr, Stamatiades P, Wilkerson M. A characterization of first-generation flowable composites. J Am Dent Assoc 1998;129:567-577.
25. Mertz-Fairhurst EJ, Curtis JW Jr, Ergle JW, Rueggeberg FA, Adair SM. Ultraconservative and cariostatic sealed restorations: Results at year 10. J Am Dent Assoc 1998;129:69-77.
26. Walker JD, Pinkham JR, Jakobsen J. Comparison of undergraduate pediatric dentistry clinical procedures from 1982-83 through 1996-97. J Dent Child 1999;66:411-414.