Effects of glass ionomer sealants in newly erupted first molars after 5 years: a pilot study

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Abstract – Objectives: The aim of the study was to investigate the caries-preventive effect of high-filled glass ionomer sealant in newly erupted first molars in a high-risk group. This investigation is part of a larger study amongst eight hundred and thirty-five 6–7-year-old Syrian children. Methods: Children that had 1, 2 or 3 just erupted or erupting and at least one unerupted first molar (control) were enrolled in this pilot study. A total of 60 children fulfilled the inclusion criteria. There were 49 children with a total of 83 sealants available for examination at the evaluation year 5. Results: Almost two out of the three sealants (69%) had disappeared between evaluation years 2 and 3. 1.2% (SE = 1.2) of the sealants survived were fully retained and 10.3% (SE = 3.3) of the sealants survived were fully and partially retained at the evaluation year 5. Caries prevalence of the children in the study group at the evaluation year 5 was 55%. The Odds ratio concerning sealed and control group at year 5 was 2.6 with 95% confidence limits of 1.2 and 5.7, implying a relative risk (RR) of 2.1. Unsealed unerupted first molars had 2.1 times higher chance than sealed newly erupted first molars to develop dentinal lesions in this child population after 5 years. Conclusions: It is concluded that sealing newly erupted first molars with high-filled glass ionomer may be a caries-preventive measure in high-risk children. However, a well-designed clinical trial should be implemented to confirm the initial findings.

Key words: caries prevention; erupting molars; glass ionomer; high-risk group


Probably, the most caries-susceptible period of a first molar tooth concerns the 1.0–1.5-year-long eruption phase (1). At that period, the enamel is not fully matured, the child and parents often do not know that a new tooth is emerging and it is usually difficult for the child to clean the erupting tooth surfaces.

A number of caries-preventive measures have been developed. These include cleaning the occlusal surfaces with a toothbrush and a fluoridated toothpaste (2, 3), application of a fluoride varnish (4), application of a chlorhexidine varnish (5), sealing pits and fissures with a composite resin and/or a glass ionomer (6–8) and combinations of these preventive measures (9).

The most appropriate measure depends very much on the assessed caries risk of the child. For example, Axelsson (10) suggested a combination of professional mechanical tooth cleaning (PMTC) and application of a glass ionomer sealant for use in high to very high caries-risk children. This suggested combination requires frequent visits to an oral health professional, particularly for the application of PMTC. Also, the application of a fluoride varnish or gel and that of a chlorhexidine varnish are based on a regular recall scheme. The need for the latter situation is the relatively short contact time between the preventive agents in these gels and varnishes, and the tooth surfaces. It is obvious that only a few oral health systems in the world have the finances to afford such a frequent recall pattern.

It is therefore essential that, in order for children in countries with a less-fortunate oral health system, e.g. in Syria, to benefit from caries-preventive measures in newly erupted molars, the preventive agents need to be able to exercise their preventive
activities for a long time. Such a preventive measure for use in occlusal surfaces is the sealant. Two sealant materials are commonly used: composite resin and glass ionomer. The advantage of the use of autocured glass ionomer as a fissure protection measure in newly erupted first molars is its fluoride release, its moisture tolerant nature and the relatively short application time. An added advantage is its independence of electricity. Whilst it is generally accepted that composite resin sealants are retained longer than glass ionomer sealants, there appears no difference in their caries-preventive effect over a long period (7, 11–14).

A low-filled glass ionomer was used in all the cited glass ionomer sealant studies. However, high-filled glass ionomers have been produced in recent years. The 3-year retention rates of partially and fully retained sealants using high-filled glass ionomers were reported to be 71–72% (15, 16). These results are higher than reported for sealant using a low-filled glass ionomer (7, 11, 12, 14). However, the high-filled sealants were placed, as part of the atraumatic restorative treatment (ART) approach, in first and second molars of the 12–14-year-olds, not in newly erupted first molars. The question therefore remains that would the application of a high-filled glass ionomer fissure sealant be effective in preventing caries in newly erupted first molars in high-risk groups in countries that are unable to spend adequate funds on oral health programmes?

Materials and methods

Sampling procedure
This investigation is part of a larger study amongst eight hundred and thirty-five 6–7-year-old Syrian children comparing the treatment of dentinal lesions in deciduous teeth through the ART and conventional approach (17). Children that had 1, 2 or 3 just erupted or erupting and at least one unerupted first molar were enrolled in this pilot study. The just erupted/erupting molars had to be free from visible caries. The occlusal surface of the newly erupted first molars needed to be fully visible and free of mucosal tissues. There was no recording of the stage of tooth eruption. The nonerupted first molars were the controls.

Sealant procedure
The first molars wereisolated using cotton wool rolls. The occlusal surface was cleaned with a probe, conditioned with polyacrylic acid for 10–15 s and washed and dried with cotton wool pellets. The glass ionomer (Fuji IX®; GC Europe) was hand-mixed, according to the manufacturer’s instructions. The mixed glass ionomer was applied on the occlusal surface with an applicator instrument and pressed into the pits and fissures with a petroleum-jelly-coated index finger (18). Excess material was removed with a carving instrument. The sealant was coated with Vaseline®. Children were instructed not to eat for at least 1 h. The eight dentists who also carried out the caries treatment comparison study (17) placed the sealants. The number of children receiving sealants by the dentists varied from 2 to 11 per dentist.

Children received instructions on good oral health behaviour, and were shown how to clean their teeth on an individual basis prior to the start of the treatment.

Evaluation
Caries was recorded according to the criteria described in Table 1. The coverage of the pits and fissures with sealant material was not recorded at baseline. The evaluation took place on the concept of ‘intention to treat’, which means that it was assumed that all pits and fissures were covered with the sealant material at baseline. The following sealant retention criteria were used: 0 = no pits and fissures visible; 1 = part of pits and fissures visible; 2 = all

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>Sound surface</td>
</tr>
<tr>
<td>1</td>
<td>Early enamel lesion. White/opaque or brownish/dark lesion in enamel only, including loss of tooth surface; considered being active or inactive</td>
</tr>
<tr>
<td>2</td>
<td>Carious enamel lesion; lesion cannot be penetrated with smallest excavator</td>
</tr>
<tr>
<td>3</td>
<td>Dentinal lesion; lesion can be penetrated with smallest excavator</td>
</tr>
<tr>
<td>4</td>
<td>Dentinal lesion; pulp possible or definitely exposed</td>
</tr>
<tr>
<td>5</td>
<td>Restoration</td>
</tr>
<tr>
<td>7</td>
<td>Missing as a result of caries</td>
</tr>
<tr>
<td>8</td>
<td>Unerupted permanent tooth</td>
</tr>
<tr>
<td>9</td>
<td>Unable to make diagnosis</td>
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pits and fissures visible. Both caries and sealant criteria were applied to each of the three sections (mesial, central, distal), in which the occlusal surface arbitrary was divided.

The evaluation took place annually between 1998 and 2002. The same two Syrian dentists, who were not operators, carried out the evaluation at years 1, 2 and 4. These dentists were unable to participate at the third year of evaluation. Instead, an evaluator from the Netherlands did the assessments that year. One Syrian and one Dutch evaluator carried out the fifth-year evaluation. The evaluators were calibrated, and they also assessed the restorations of the main study (17). Duplicate examinations were carried out on 10 and 14% of the children at the fourth and fifth years of evaluation, respectively.

The kappa coefficient for assessing the interevaluator consistency in recording sealant retention and diagnosing caries (yes/no) was 1.0 for both conditions at evaluation year 4. However, there were no dentinal lesions diagnosed. The interevaluator consistency test at evaluation year 5 showed a kappa value of 0.95 (SE = 0.03) and 0.31 (SE = 0.25) for sealant retention and diagnosing caries, respectively. Because of the low incidence of dentinal lesions in the molars over 5 years in the duplicate sample, the percentage of observed agreement was also calculated. The $P_{obs}$ for sealant retention and diagnosing caries at evaluation year 5 was 98 and 95%, respectively.

**Statistical analyses**

The data were entered into a database, checked for errors and analysed using SPSS software (Release 6.1 version). Caries scores 0 and 1 were combined in the analyses as sound. Caries was considered present for the combined scores 2-7. If either the mesial or the distal section had a sealant score 1 and the other sections a score 0, this combination was considered a fully retained sealant. The sealant survival curve was calculated using the product rule for survival probabilities and the error according to Greenwood (modified SPSS procedure). The Mantel-Haenszel procedure was applied to estimate the sealant effect (Odds ratio) and to test the difference between the sealed and the control molars (19).

**Results**

**Background information**

Informed parental consent was received in writing through the school authorities. A total of 60 children fulfilled the inclusion criteria. A total of 101 sealants were placed at baseline of which 95 were available for evaluation over the 5 years. Four children could not be evaluated at any of the 5 years of evaluation. The calculations and analyses were carried out on the data of 56 children. The age of these children at the start of the study was 6.7 years. Sixty percent were boys. There were more sealants placed in the first molars of the lower jaw ($N = 55$) than in those of the upper jaw ($N = 40$).

Table 2 shows the number of sealed and control first molars at the baseline and at the evaluation year 5. The percentage of children lost-to-follow-up per year of evaluation is presented in Table 3. There were 49 children with a total of 83 sealants available for examination at evaluation year 5.

**Dental caries situation at start**

The caries prevalence of the population of 6- to 7-year-olds from which the 56 children were recruited was 85%. The mean dmfs and dmft scores were 9.0 and 4.4, respectively (17). The caries prevalence of the 56 children in the present study was 88%. The mean dmfs and dmft scores were 10.0 and 5.1, respectively.

**Retention of sealants**

The cumulative survival percentage of partially and fully retained sealants by the year of evaluation is presented in Fig. 1. Almost two out of the three sealants (69%) had disappeared between evaluation years 2 and 3. 1.2% (SE = 1.2) of the sealants survived were fully retained and 10.3% (SE = 3.3) of the sealants survived were fully and partially retained at evaluation year 5.

**Caries development**

All originally recorded unerupted first molars had erupted at evaluation year 1. Caries prevalence of the children in the study group at evaluation year 5 was 55%. Fourteen children had caries-free sealed first molar(s), but had dentinal lesions in the control molars.
molar(s). Dentinal lesions were observed both in the sealed and control first molar(s) of 11 children, and 2 children had developed dentinal lesions in the sealed molar(s), but not in the control molar(s). The development of dentinal lesions in first molars in the sealed and control groups over the 5 years of investigation is shown in Table 3.

### Table 3. Lost-to-follow-up children (%) and number of first molars having developed dentinal lesions in the sealed and control group per year of evaluation

<table>
<thead>
<tr>
<th>Year</th>
<th>Sealed</th>
<th>Lost-to-follow-up (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Year 1</td>
<td>No 126</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>Yes 3</td>
<td>0</td>
</tr>
<tr>
<td>Year 2</td>
<td>No 119</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Yes 4</td>
<td>0</td>
</tr>
<tr>
<td>Year 3</td>
<td>No 115</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Yes 6</td>
<td>1</td>
</tr>
<tr>
<td>Year 4</td>
<td>No 101</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Yes 17</td>
<td>4</td>
</tr>
<tr>
<td>Year 5</td>
<td>No 81</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Yes 32</td>
<td>13</td>
</tr>
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</table>

**Discussion**

Considering the caries levels in the deciduous dentition, the child population from which this sample was drawn was assumed to be at a high risk of developing caries. This assumption was confirmed by the results of an epidemiological study in permanent teeth amongst, on average, 7.5-year-old school children, residing in the same area where the children from this study lived. The prevalence of caries was 57.6%, and the mean DMFS and DMFT was 1.6 and 1.4, respectively (20).

The present investigation was a pilot study. Hence, a few methodological aspects could not be adhered to. For example, a power calculation was not performed, neither was it possible to randomise the sealants over the first molars by the jaw and by the right/left side of the mouth. Another important methodological aspect needs to be discussed. The kappa coefficient, expressing the reliability of diagnosing dentinal lesions at evaluation year 5, was low, but the related standard error (SE) was high. This implies that the kappa coefficient lies somewhere between −0.20 and 0.80, which makes it a useless measure for assessing the quality of the caries data. This large variation is as a result of the low incidence and skewed distribution of the dentinal lesions in the duplicate sample over the 5-year study period. Hence, in addition to the kappa coefficient values, we have calculated the percentage of observed agreement between the evaluators for evaluated and fully retained sealants (%) by year of evaluation. Vertical bars denote standard error (SE).
both sealant retention and caries diagnoses. There were no quality checks performed at evaluation years 1, 2 and 3 because of the very low incidence of caries in the study group. In conclusion, it is fair to say that the results of the present study should be interpreted with care.

Although the exposure to the oral environment of the molars in the two groups differed, we assume that the actual exposure time difference over the 5-year study period is so minimal that it has not relevantly biased the study outcomes. Therefore, within the limitations of the present pilot study, the results seem to indicate that sealing newly erupted first molars may protect the occlusal surfaces from becoming decayed after 4 and 5 years. In children with high risk of caries in this age, the occlusal surfaces are the ones most vulnerable to decay. Therefore, attention was directed at protecting these surfaces in order to buy time for the children to adopt healthy oral health behaviours. The remaining tooth surfaces need to be protected through preventive measures such as tooth cleaning with a fluoride toothpaste and dietary control.

There is another study in which the sealant part of the ART approach has been investigated. Unsealed occlusal surfaces with early enamel lesions in first and second molars of, on average, 14-year-olds had a four times higher chance of developing a dentinal lesion than occlusal surfaces in comparable molars sealed with a glass ionomer after 3 years (21). Although different in age and tooth type, this result is in line with the results obtained in the present study after 4 and 5 years.

This investigation has revealed that the tooth-contact-time of this fluoride-releasing high-filled glass ionomer sealant is much longer than any other common preventive measures. Torppa–Saarinen and Seppä investigated the pits and fissures of glass-ionomer-sealed occlusal surfaces of just erupted second molars and premolars that had partly or totally lost the sealant under stereomicroscope or SEM after 4 months (22). In most of the cases, glass ionomer was still left in the bottom of the fissures. The authors assumed that this finding was partly the reason why glass ionomer sealants have prevented caries even after they appear to be lost, which is in agreement with the conclusion of studies conducted by other researchers (11, 12).

We conclude that sealing newly erupted first molars with high-filled glass ionomer may be a caries-preventive measure in high-risk children. However, a well-designed clinical trial should be implemented to confirm the initial findings.

Acknowledgements

The authors are grateful to the children, teaching staff of the primary schools, evaluators and operators. The assistance provided by the staff of the Regional Oral Health Centre is highly appreciated. This study was financed by the Government of Netherlands through the WHO Global ART Project, Dental Health International Netherlands, 3MESPE (Germany) and GCEurope (Belgium).

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