

The prescription and outcomes of fissure sealants applied to a group of high caries risk children by general dental practitioners working in the North West of England

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Objective To describe the use and outcomes of fissure sealants applied to the first permanent molars (FPMs) of children with high caries risk. **Design** Retrospective cohort study. **Setting** General dental practices in North West England. **Participants** 677 children between the ages of 5 and 14 years who had $\text{dmfs} \geq 2$, and regularly attended 50 general dental practitioners. **Outcomes** Analyses were performed at patient level. Logistic regression models, taking into account the clustering of subjects within dental practices, were fitted to identify whether the decision to fissure seal FPMs was significantly associated with gender, socio-economic status, number of carious primary teeth and percentage of carious primary teeth filled. Similar logistic regression models were fitted for caries experience in FPMs. **Results** Poorer children were significantly ($p < 0.05$, $\text{OR} = 0.84$, $95\% \text{ CI} = 0.71, 0.99$) less likely to receive fissure sealants than affluent children, whilst girls ($p < 0.01$, $\text{OR} = 1.54$, $95\% \text{ CI} = 1.12, 2.12$) were more likely to have sealants than boys. The total number of carious primary teeth was also a significant ($p < 0.01$, $\text{OR} = 1.15$, $95\% \text{ CI} = 1.06, 1.25$) independent predictor of dentists' decisions to fissure seal FPMs. For each carious primary tooth, the odds of having caries in FPMs increased by 1.16 ($95\% \text{ CI} = 1.06, 1.26$). Analysis showed that pit and fissure caries in FPMs was not affected by the presence or absence of fissure sealants. **Conclusions** The decision to fissure seal FPMs is affected by caries experience in the primary dentition. Girls and affluent children were more likely to receive fissure sealants. It appears that the placement of fissure sealants by general dental practitioners was not effective in preventing pit and fissure caries in these high-risk children.

Key words: carious primary teeth, first permanent molars, fissure sealants, first permanent molars, general dental service

Introduction

Fissure sealants, used in clinical practice for over 30 years, have been shown to be effective in preventing caries in permanent molars when applied by trained operators in clinical trials and community-based programmes (Ismail and Gagnon, 1995; Messer *et al.*, 1997). A recently published Cochrane systematic review (Ahovuo-Saloranta *et al.*, 2004) has convincingly demonstrated the efficacy of second-generation resin sealants, with reductions in caries in children aged 5 to 10 ranging from 86% at 12 months to 57% at 48 to 54 months. Another systematic review (Mejàre *et al.*, 2003) reported similar findings therefore the evidence base for this technique is strong.

In the UK the use of fissure sealants has been advocated by the British Society of Paediatric Dentistry (BSPD) (Nunn *et al.*, 2000). These guidelines provide recommendations for the use of fissure sealants based on an assessment of the risk of the child developing caries in the permanent dentition. Although the efficacy of fissure sealants is not in doubt, the BSPD policy document states that 'their effectiveness when applied in other primary and secondary care settings is still not known.' In the UK, the majority of children's dental care is provided in the General Dental Service which in England is about to undergo fundamental changes

as a result of the Health and Social Care (Community Health and Standards) Act 2003 (UK Parliament, 2003). The local contracts which will result from this change in legislation will be strongly influenced by the Options for Change policy document (Department of Health, 2002), which enthusiastically advocated that primary dental care services should focus on prevention. With these impending changes it is important to understand how general dental practitioners' approach preventive care and in particular their use of fissure sealants. How are fissure sealants used in general practice and, more importantly, what are the outcomes of this type of preventive care in the hands of the general dental practitioners?

The aim of this study was to describe both the use and outcomes of fissure sealants applied to the first permanent molars of children with high caries risk who regularly attended 50 general dental practices in the North West of England. The study set out to identify the key factors which influence the prescription of fissure sealants by general dental practitioners. The principal objective was to measure the presence of caries in the first permanent molars of children at 14 years of age who did or did not have fissure sealants applied.

Method

This study involved abstraction of new data collected in a previously reported primary dental care study (Tickle *et al.*, 2003) which looked principally at the care of the primary dentition. All dentists practicing in Bury, Rochdale, Salford, Trafford, North Cheshire and South Cheshire were given the opportunity to participate in the study. Various factors limited the number of dentists involved; some chose not to participate, whilst others were excluded due to strict criteria set for patient inclusion. Eligibility for inclusion in the study was based upon two requirements. Firstly, each dentist must have provided National Health Service care to children and secondly, that the dentist must have at least 10 children who fulfilled the following criteria:

- Date of birth was between 1 January 1984 and 31 December 1985.
- Usually (but not exclusively) seen by the same dentist between the ages of 5 and 14 years.
- Had a history of approximal caries experience in primary molar teeth – i.e. dmfs=2 or more.
- Were regular attenders – being defined as attending the practice at least once every 18 months.

Each participating dentist was required to supply the case notes of between 10 to 20 children meeting the above criteria. For dentists with fewer than 20 children who met the criteria, all children were included in the study. For those dentists with more than 20 suitable patients, 20 case notes chosen at random from the total available. All children included in the study had to have attended their dentist on a regular basis over a period of at least eight-and-a-half years.

Retrospective data were collected from each patient's case notes. Data on fissure sealant treatment and outcomes were transferred from the case notes to a standardised data abstraction form by trained and calibrated data abstractors. The Townsend index (Townsend *et al.*, 1988) of the electoral ward of residence of each child was appended to the dataset and used to divide the population into quintiles of deprivation.

Data analysis was performed at the patient level. Subjects were dichotomised into those who had fissure sealants (applied to at least one of their first permanent molars) and those who did not, according to the principle that fissure sealants should be a treatment delivered to individuals not teeth. Subjects were also categorised

according to the principal outcome measure into two groups; if they had at least one pit or fissure lesion (including buccal pits of lower molars and palatal fissures of upper molars) recorded their first permanent molars or if the pits and fissures remained caries free. As fissure sealants are designed to prevent pit and fissure caries, children who developed a smooth surface lesion in a first permanent molar but did not develop a pit or fissure lesion were classified as pit and fissure caries free for this particular analysis.

Frequency distributions and cross tabulations were derived. The logistic procedure in Stata 8 (Stata Corporation, Texas, USA) was used in multivariate analyses to take into account the clustering of the children within dentists, producing robust variance estimates.

Results

All of the children in the study had at least one approximal carious lesion in a primary molar tooth; the study population had a mean number of 4.65 primary teeth (SD=2.64, range 1-15) affected by caries during the period when the primary teeth were present in the mouth. On average each dentist contributed 13.5 patients to the study (SD=3.3). Only three dentists had more than 20 patients that met the inclusion criteria; for these dentists 20 patients were selected at random. Table 1 shows the fissure sealant prescription pattern for the study population. Of the 677 children, 58.6 percent (n=397) had a record of fissure sealants applied to one or more first permanent molars. If fissure sealants were applied, in the majority of cases (78.3%, n=311) they were applied to all four first permanent molars. The mean age when fissure sealant was first applied was 7.8 years (SD=2.1).

There was a large variation in practice amongst the general dental practitioners. The proportion of patients in each practice that received fissure sealants ranged from 0 to 100 percent. Table 2 demonstrates the distribution of dentists by quartiles according to their fissure sealant prescribing habits. The distribution was not heavily skewed; 38 percent of dentists provided fissure sealants for 75 to 100 percent of their patients, whereas 24 percent of dentists provided fissure sealants for 0 to 25 percent of their patients.

Table 3 presents the results of a logistic regression analysis in which the application of fissure sealant was considered as the dependent variable. After taking clustering of patients within dentists into account, children

Table 1. Number and percentage of children according to the number of first permanent molars that were fissure sealed

Number of teeth sealed	0	1	2	3	4	Total
Number and percentage of children with first permanent molars fissure sealed	280 (41.4)	21 (3.1)	33 (4.9)	32 (4.7)	311 (45.9)	677

Table 2. Number and percentage of dentists (n=50) according to percentage of their patients who had fissure sealants applied to one or more of their first permanent molars

Quartiles of patients who received fissure sealants	0-25%	25-50%	50-75%	75-100%
Number and percentage of dentists in each quartile	12 (24.0)	8 (16.0)	11 (22.0)	19 (38.0)

from poorer backgrounds were significantly ($p < 0.05$, $OR = 0.84$, 95% $CI = 0.71, 0.99$) less likely to have fissure sealant applied to first permanent molars than children from more affluent areas, whilst girls ($p < 0.01$, $OR = 1.54$, 95% $CI = 1.21, 2.12$) were more likely than boys to receive fissure sealants. The total number of carious primary teeth was also a significant independent predictor ($p < 0.01$, $OR = 1.15$, 95% $CI = 1.06, 1.25$) of the dentists' decision to fissure seal first permanent molars; the odds of children receiving fissure sealants increased by 1.15 for each additional carious primary tooth. The proportion of carious primary teeth that were restored was not a significant predictor.

The average age when caries was first recorded in a first permanent molar was 10.7 years ($SD = 3.0$). Table 4 reveals that 51 percent of subjects were recorded as having pit and fissure caries in their first permanent molars by the time they were 14 years of age. A total of 103 (15.3%) children had smooth surface caries in their first permanent molars that required restorative treatment. Table 4 compares the outcomes at patient level, in terms of caries recorded in the pits or fissures of first permanent molars, according to whether or not the child received fissure sealants. In this bivariate analysis a larger proportion (54.7%) of children who had their first permanent

molars fissure sealed subsequently developed caries than those who did not have fissure sealants (45.7%). This difference was statistically significant ($p < 0.05$) after taking into account clustering of patients within dentists.

Table 5 presents the results of a logistic regression analysis (controlling for clustering of patients within dentists) when recorded pit and fissure caries in one or more first permanent molars was considered as a dependent variable. The only significant predictor for development of caries was the total number of carious teeth in the primary dentition. For each carious primary tooth, the odds of having caries in first permanent molars increased by 1.16 (95% $CI = 1.06, 1.26$). This multivariate analysis could demonstrate no effect on recorded pit and fissure caries in the first permanent molars irrespective of whether or not fissure sealants were applied.

Discussion

The British Society of Paediatric Dentistry policy document (Nunn *et al.*, 2000) recommends that 'children and young people with caries in their primary teeth ($dmfs = 2$ or more) should have all susceptible sites on permanent teeth sealed'. All of the children in this study had a $dmfs$ of 2 or more, therefore all subjects can be considered as

Table 3. Odds ratios, 95% confidence interval and p-values from a logistic regression model fitted for the dependent variable application of fissure sealant.

<i>Independent variables</i>	<i>p-value</i>	<i>Odds ratio</i>	<i>95% confidence interval</i>
Gender	< 0.01	1.54	1.12, 2.12
Total number of carious primary teeth	<0.01	1.15	1.06, 1.25
Percentage of carious primary teeth filled	0.83	1.00	0.99, 1.01
Townsend score of ward of residence	<0.05	0.84	0.71, 0.99

Table 4. Pit and fissure caries recorded in first permanent molars of children (number and percentage in parentheses) with or without fissure sealants

	<i>Subjects who did not have pit and fissure caries recorded</i>	<i>Subjects with pit and fissure caries recorded</i>	<i>Total</i>
Subjects who did not have fissure sealant applied	152 (54.3)	128 (45.7)	280 (41.4)
Subjects who had fissure sealant applied	180 (45.3)	217 (54.7)	397 (58.6)
Total	332 (49.0)	345 (51.0)	677

Fitted logistic regression model for dependent variable subjects with pit and fissure caries present with independent variable history of fissure sealants and controlling for clustering of patients within dentists. Results show a significant difference, with children who had fissure sealants more likely to develop caries in their first permanent molars $p < 0.05$.

Table 5. Odds ratios, 95% confidence interval and p-values from a logistic regression model fitted for the dependent variable presence/absence of caries in one or more first permanent molars.

<i>Independent variables</i>	<i>p-value</i>	<i>Odds ratio</i>	<i>95% confidence interval</i>
Gender	0.79	1.05	0.75, 1.45
Fissure sealant applied/not applied	0.15	1.30	0.91, 1.85
Total number of carious primary teeth	<0.01	1.16	1.06, 1.26
Townsend score of ward of residence	0.20	1.10	0.96, 1.26

high risk and all susceptible sites, including buccal pits and palatal fissures, of first permanent molars should have been sealed, yet only 58.6 percent received fissure sealants. Prior to the introduction of the capitation system of remuneration for the care of children in the National Health Service, Cohen and Sheiham (1988) undertook a survey of 1,000 dentists and reported that on average, only 13.4 per cent of their child patients received fissure sealants. The primary reason for not using fissure sealants was that they were not reimbursable by the General Dental Service. This was followed by 'patients are unwilling to pay for the procedure', 'possible to seal in decay', 'placing occlusal fillings is the preferred procedure', 'unsubstantiated by research', and 'they do not last long in the mouth' as reasons for not providing this preventive treatment. Blinkhorn *et al.* (1996), in an evaluation of the capitation-based contract demonstrated considerable increases in the prevalence of fissure sealants under capitation, particularly in areas with high caries levels, noting that some general dental practitioners clearly saw fissure sealants to be cost effective within the financial limits of the capitation scheme. However, given the lower than expected prevalence of fissure sealant in our study population it seems that some of the attitudes described by Cohen and Sheiham (1988) persist. One must query the representativity of the general dental practitioners in the study. We enrolled a large number of general dental practitioners through an open invitation process, so they were self-selecting. However, the constraints of the General Dental Service fee for item system of remuneration makes participation in research difficult for general dental practitioners. This will always compromise the chances of obtaining a good response rate to invitations to participate in a study and therefore reduce the chances of obtaining a truly representative sample of general dental practitioners.

The failure to apply fissure sealants was not confined to a small number of dentists, there was large variation in practice. Only five dentists applied sealants to all patients, whilst at the other end of the spectrum two dentists failed to provide fissure sealants for any of their patients in the study. This variation in the care provided by general dental practitioners to children is not surprising, as it has been reported by other recent studies (Tickle *et al.*, 2003). The reasons for this variation are probably complex, but will be largely due to the nature of the General Dental Service contract and the remuneration system the dentists were working under at the time of the study, which makes co-ordinated implementation of evidence based clinical policies difficult.

A starting point to reduce variation in practice is to identify the predictors for the placement of fissure sealants. Children living in more deprived areas were less likely to receive fissure sealants than their more affluent peers, a worrying example of a health care inequality. This may suggest costs were still an issue for dentists, and perhaps some were providing fissure sealants on a private basis, making this form of treatment less accessible to families living in deprived areas. There was a strong association between caries experience in the primary dentition and placement of sealants, suggesting that dentists are generally sensitive to the caries risk of their patients but perhaps at a higher level to that rec-

ommended by the British Society of Paediatric Dentistry (Nunn *et al.*, 2000).

The use of fissure sealants in the National Health Service in England can be addressed as part of the process of drawing up the new local contracts between general dental practitioners and Primary Care Trusts after local commissioning of services comes into being in 2006. The main focus of the new dental contract is prevention and it is important for Primary Care Trusts to know what to commission. Commissioning decisions should be evidence based, but the findings of this study provide general dental practitioners and Primary Care Trusts with a dilemma. The recent systematic review by Mejäre *et al.* (2003) and the Cochrane review (Ahovuo-Saloranta *et al.*, 2004) demonstrate that fissure sealants are extremely efficacious in preventing pit and fissure caries but our study found no preventive effect for fissure sealants in the hands of general dental practitioners treating children with high levels of dental caries. If fissure sealants are so efficacious, surely we should have found a positive effect in the primary care setting? However, the findings of this study require careful examination and the results need to be treated with caution, as the study is a retrospective analysis of patient records rather than a planned prospective investigation.

The results may be due to a failure to fissure seal all four first molars; patients who only had 1, 2 or 3 teeth sealed could have developed caries in the unsealed teeth. However, further analysis revealed that in children who had all four first permanent molars fissure sealed (N=311, 78.3% of all children who received fissure sealants) 50.2 percent developed caries and 49.8 percent were caries free. It could be that placing fissure sealants may give dentists a false sense of security; general dental practitioners may assume that once the procedure has been completed the teeth are protected. From the results presented here this is clearly not the case and the British Society of Paediatric Dentistry policy document (Nunn *et al.*, 2000) points out the need for regular monitoring of fissure sealed teeth clinically and radiographically and replacement of damaged or lost sealants if necessary.

Perhaps more fundamentally, the reason for the poor performance of fissure sealants in general practice may be because fissure sealants are too technique sensitive for the high pressure environment of the current General Dental Service contract. Fissure sealant placement may be rushed with inadequate moisture control, or coverage could be inadequate, for example failing to seal buccal and palatal pits and fissures. A more appropriate preventive treatment for primary dental care may be use of fluoride varnish, which is less technique sensitive. A Cochrane systematic review (Hiiri *et al.*, 2001) comparing the performance of fissure sealants and fluoride varnish is due to report shortly and the results will be highly informative for general dental practitioners and Primary Care Trusts.

The provision of other forms of prevention could have been a source of bias, for example children who did not have fissure sealants applied may have been treated with fluoride applications instead. However analysis of the data shows that only 96 (14.2 %) of subjects had fluoride varnish applied. We compared the exposure to fluoride varnish of those subjects who had fissure sealants applied and those who didn't and found that children who had

fissure sealants applied were significantly more likely to (also) have fluoride varnish applied. So this was not a factor that would explain the poor performance of the fissure sealants.

Importantly, this was a high risk population: caries in the primary dentition is widely accepted as a significant risk factor for developing caries in the permanent dentition (Helm and Helm, 1990). This risk was reflected in the study findings, as 51 percent of the children subsequently developed caries in their first permanent molars. Although the study showed that children at greater risk of developing caries were more likely to receive fissure sealants, one could suggest that this selection bias may be responsible for finding a non-significant association between fissure sealant placement and prevention of caries, i.e. the children at greatest risk are more likely to receive fissure sealants and to develop caries. Once fissure sealants have been applied they should prevent pit and fissure caries, however caries risk may influence sealant loss, as Bravo *et al.* (1996) reported; the higher a child's dft the greater the risk of sealant failure in permanent teeth. In this study, fissure sealants had no effect on preventing pit and fissure caries in first permanent molars after controlling for caries risk, as determined by the total number of carious primary teeth. Therefore this potential bias was controlled for. So, the results achieved in the systematic reviews (Mejare *et al.*, 2003, Ahovuo-Saloranta *et al.*, 2004) are not being replicated by the general dental practitioners in this study. However, it must be recognised that ours was a high risk population and Mejare *et al.* (2003) concluded that "There is incomplete evidence that fissure sealing is beneficial in child/adolescent populations at high risk for caries" and the Cochrane review (Ahovuo-Saloranta *et al.*, 2004) states that "The information on background levels of caries in the population was insufficient to conduct further analyses to estimate the effectiveness of resin based sealants related to baseline caries prevalence." So we need to undertake randomised controlled clinical trials to determine the effectiveness of fissure sealing in children with high caries risk.

In conclusion, this study raises concerns about the variation in practise and the outcomes of fissure sealants provided in General Dental Practice in a group of high risk children. This is particularly worrying, as the focus of the new NHS dental contract in England is on prevention. As a matter of urgency we need to obtain high quality evidence to inform the preventive care of children with high risk of developing caries. The study also illustrates the difference between efficacy; how well an intervention works under ideal circumstances and effectiveness; how well the same intervention works in the real world in primary care. There are two potential approaches to ensure that the knowledge obtained from research is transferable to primary care; firstly we can undertake more high quality randomised controlled trials in primary care examining the outcomes of interventions performed where the majority of dental services are delivered. This suggestion needs to be taken seriously and adequately resourced. Secondly, clinical audit provides a powerful tool for primary care dentists to measure their performance against the gold standard of the results of systematic reviews. These standards may not be attainable

in general practice but this should not prevent dentists trying to ensure that the outcomes of their clinical care are as close as possible to the gold standard.

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