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The success of fissure sealants placed by dentists and dental care professionals

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Objective: To obtain preliminary data on the effectiveness of fissure sealants placed by dentists and dental care professionals (DCPs). ***Research design:*** Case-note review of fissure sealants provided for paediatric patients within primary dental services in South Yorkshire. ***Participants:*** Records were retrieved for 1,100 fissure sealants, placed on first and second permanent molars of 312 children by 25 participating dentists and 25 DCPs during 2001-2003. ***Main outcome measures:*** Independent variables included operator details and patient-related factors including: caries experience at baseline, age, gender, and socio-economic status. The outcome variables were sealant retention and progression to caries at three years. Bivariate analyses were used to explore the role of potential factors associated with the success of fissure sealant survival. Kaplan-Meier survival analysis and Cox's regression models were used to estimate the probability of sealant success for both operator groups. ***Results:*** Retention rates at three years for fissure sealants placed by dentists and DCPs were 62.4 % (SD=22.1) and 58.1% (SD=21.5) respectively. After three years, 87.1% (SD=9.8) and 84.2% (SD=11.6) of teeth sealed by dentists and DCPs remained sound. Exploratory analysis found no significant difference in sealant retention or caries transformation rates according to operator type. ***Conclusions:*** On the basis of these preliminary findings, delegation of fissure sealants to DCPs would seem to be justified in view of the comparable sealant success rates achieved by dentists and DCPs. These data can now be used to inform future randomised controlled trials on the effectiveness of fissure sealants by different operator groups.

Key words:, Caries prevention, dental care professional, fissure sealant.

Introduction

Despite the effectiveness of caries preventive methods such as water fluoridation, topical fluoride preparations and dietary control, pit and fissure caries still present a major challenge for public health programmes (Manton and Messer, 1995). The use of fissure sealants, as a means of occluding and protecting caries-prone tooth surfaces, is well recognised as an evidence-based practice within an overall preventive strategy for high caries-risk children (Ahovuo-Saloranta *et al*., 2008). However, the cost effectiveness of sealants is an important consideration that has been highlighted by numerous reports (Benedict *et al.,* 2002). In light of this, it has been suggested that the cost-effectiveness of sealants would be enhanced by employing trained auxiliaries to apply them (Burt, 1984). In the United Kingdom, the term 'dental auxiliary' has now been superseded by 'dental care professional' (DCP), following the *Dental Auxiliary Review Group Report* of 1998 (General Dental Council, 1998).

Continued changes in oral health status and the delivery of health care services have stimulated a need to review the roles of DCPs in providing quality care cost-effectively. However, a systematic review conducted by Galloway and colleagues (2003) concluded that there was a paucity of good research on the effectiveness of dental treatment undertaken by DCPs. Furthermore, as the majority of studies had been conducted during the 1970s, their relevance to current day practice was questionable. There would seem to be a clear need for high quality research to be undertaken in this area.

The purpose of this study, therefore, was to obtain preliminary data to compare the effectiveness of fissure sealants placed by both primary care dentists and DCPs that could be used to plan future randomised controlled studies.

Method

The overall approach was a case-note review of fissure sealants provided for paediatric patients in primary dental services in South Yorkshire. Research ethical approval was sought from the Multi-Centre Research Ethics Committee and research governance approval was obtained from primary care trusts of each host service including: Sheffield, Doncaster, Leeds, North Lincolnshire, Rotherham, and Barnsley.

Recruitment of participants was undertaken by sending letters of invitation to all dentists and DCPs working in primary dental services within a 50 mile radius of Sheffield. For study inclusion, participating clinicians had to have identifiable records of paediatric patients who had received fissure sealants during 2001- 2003. A quota sample was collected for the first 20 fissure sealants placed by each clinician after 1st January, 2001. Inclusion criteria for children dictated that they had received one or more sealants on their first or second permanent molars during this period and had returned for at least one recall visit six months or more after initial sealant placement. Children with banded molars, failed recall, or missing clinical details were excluded from the study sample. The data collected retrospectively for each pa-

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tient, from their existing dental records, were as follows:

- Type of operator: hygienist, therapist or dentist
- Patient characteristics: age, caries experience (dmft), and index of multiple deprivation
- Tooth sealed: upper, lower, first, or second permanent molar
- Primary outcome: retention of sealant
- Secondary outcome: prevention of caries

With respect to fissure sealant retention, the investigator used the first documented date that the sealant was recorded by the clinician at the routine recall visit as being lost, deficient or replaced.

The 'GeoConvert' database was used to assign the index of multiple deprivation (IMD) according to each patient's postcode. This database was accessed electronically from the University of Sheffield's library (http://www.shef.ac.uk/library/cdfiles/geoconvert.html).

Pilot studies were undertaken within the paediatric dentistry clinic, Charles Clifford Dental Hospital, Sheffield, to refine the data collection sheet and determine inter- and intra-examiner repeatability for data retrieval. This was found to be good with Kappa coefficients of k=0.85 and k=0.87 respectively.

There were two levels of sampling in this study: the dental operators and the patients who had received fissure sealants. Descriptive statistics were used to describe patient-related socio-demographic and clinical data, as well as operator details. Fissure sealant retention and progression to caries was described using 3-year survival rates with appropriate measures of spread. Exploratory analyses including bivariate analyses, Kaplan-Meier survival analysis and Cox's regression models were used to estimate the probability of sealant success and test the relationship of sealant treatment failures to different variables such as patient gender, age, caries experience, tooth type as well as operator type.

Reliability of data collection and entry were determined by re-collecting 10% of the sample. All statistical tests were repeated using these data and found the same relationships between variables as identified for the original data set.

Results

Data were obtained for 1,100 fissure sealants placed by 25 dentists and 25 DCPs (14 therapists and 11 hygienists) from a total of 312 paediatric patients' dental records. Fifteen dentists and five DCPs practiced within the community dental service and the remaining clinicians worked in general dental practice. There was an equal gender distribution amongst dentists (14 males, 11 females) but all DCPs were female.

The mean age of children at initial fissure sealant placement was seven years (SD=1.6), and there were an equal number of boys and girls. Children had a high caries experience, with a mean dmft at baseline of 4.5 (SD=3.9). Patients were also found to be from areas of high social deprivation having a mean IMD of 32.6. Dentists and DCPs saw a similar case-mix with no significant differences in these patient-related characteristics according to operator type.

The retention rate of fissure sealants at three years for dentists was 62.4% (SD=22.13) and 58.1% (SD=21.47) for DCPs (hygienists=61.3%, therapists=53.1%). After three years, 87.18% (SD=9.87) of the teeth treated by dentists remained sound compared with 84.2% (SD=11.68) of teeth sealed by DPCs (hygienists =89.23%, therapists=80.17%).

Exploratory bivariate analyses revealed a significant relationship between the type of operator and fissure sealant retention (p=0.02). However, there were no significant differences for fissure sealant retention according to patient socio-demographic or clinical characteristics. With respect to caries transformation, there were no significant differences according to operator type but there were significant associations with IMD (p=0.005), patient's age (p=0.02), and dmft at baseline (p=0.04).

Using fissure sealant retention as the outcome, and taking into consideration the varying follow-up time period for each tooth, Kaplan-Meier survival analysis was used to estimate the cumulative survival of sealants. Sealants placed by dentists and DCPs had a mean survival time of 5.1 and 4.4 years respectively. The 95% confidence interval for dentists was (4.84, 5.39) and (4.18, 4.65) for DCPs. Kaplan-Meier survival curves, showing sealant retention rates, are presented in Figure 1 where each line represents the cumulative survival of sealants placed by each of the three operator groups. As multiple fissure sealants were placed in some children, they were not completely independent variables. Therefore data were adjusted by clustering patients and treating them as a binary variable. Using this approach, and with fissure sealant retention as an outcome, no significant differences were detected between operator types.

With caries transformation as the outcome, Kaplan-Meier survival analysis was used to estimate the probability of sealant success. The mean survival time for fissure sealants placed by dentists and DCPs was the same, at 6.4 years. The 95% confidence interval was (6.16, 6.71) for dentists and (5.94, 6.53) for DCPs. Kaplan-Meier survival curves were plotted to show rates of failure for each operator type (Figure 2).

Using Cox's regression model, no significant differences were found for caries transformation for sealed teeth according to operator type. However, the patient's age at initial sealant placement was related to subsequent caries transformation: as the patient's age increased at the time of initial sealant placement the likelihood of subsequent caries development decreased.

Discussion

The main purpose of this study was to obtain preliminary data on the effectiveness of fissure sealants provided by different operator types in primary care settings. This was considered important as there is a paucity of current UK data on the use of fissure sealants for caries prevention, and there is recognised need to evaluate the roles of DCPs in different aspects of service provision. The effectiveness of fissure sealants was determined primarily as sealant retention, a proxy measure, since the incidence of caries is very low in the study population. Caries transformation was, however, employed as a secondary outcome measure.

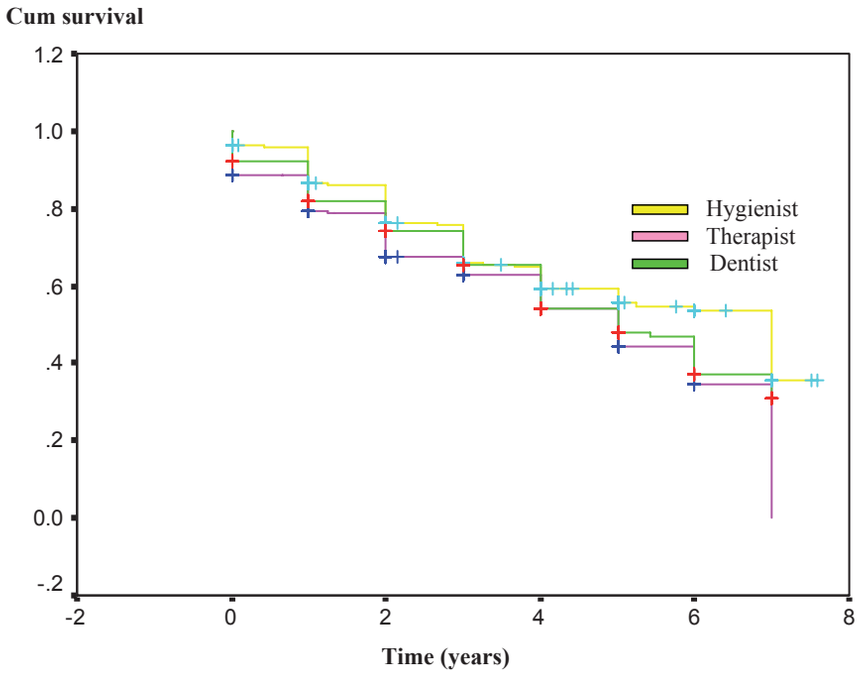

Figure 1. *Kaplan-Meier survival plots for retention of sealants, in years, placed by dentists, therapists and hygienists*

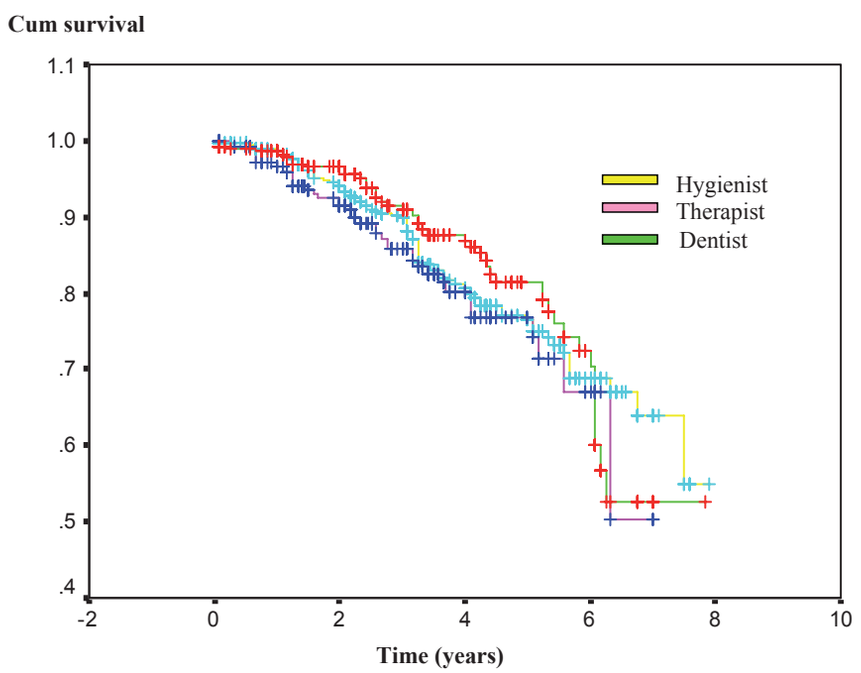

Figure 2. *Kaplan-Meier survival plots for carious transformation of teeth with fissure sealants placed by dentists, therapists and hygienists*

Key findings were that there were no significant differences in fissure sealant retention, or caries transformation, at three years between the different operator groups. Thus it can be concluded that dentists and DCPs are equally effective in sealant provision for caries prevention in paediatric patients. This has obvious economic and resource implications for providers and commissioners of dental services: DCPs being the more cost-effective operator for fissure sealant therapy.

Our data are comparable with those from previous studies, although operator type was not considered as a variable by these investigations. The 2008 Cochrane systematic review (Ahovuo-Saloranta *et al*.) reported that fissure sealant retention at 36 months ranged from 61% (Charbeneau and Dennison, 1979) to 85% (Kervanto-Seppälä *et al*., 2008). It should be noted that the mean age of patients included Kervanto-Seppälä's study (2008) was 14 years, which may, in part, explain their high retention rates as compliance, and thus ease of sealant placement, is likely to be better in older children. A further study (Straffon *et al.,* 1985) reported that, after three years, 31% of sealed teeth required at least one retreatment. It can be assumed, therefore, that 69% of fissure sealants were retained, which is more comparable with the 58-62% retention rate found by our study.

Data presented in the Cochrane review (Ahovuo-Saloranta *et al*., 2008) for caries transformation, three years following sealant placement, ranged from 31% to 42% (Brooks *et al*., 1979; Charbeneau and Dennison, 1979; Hunter, 1988; Kervanto-Seppälä *et al*., 2008). These data are considerably higher than the 13-16% caries transformation rates found by the present study. It is speculated that, the most likely reason for our low caries transformation rates, is the overall reduction in caries incidence seen amongst British children over the past two decades (Chadwick *et al*., 2003).

The data in our study was also subject to bivariate and binary logistic regression to further compare sealant retention and caries transformation for the different operator groups, and to consider the effect of additional patient-related and tooth-related variables. These were viewed only as exploratory analyses as the study did not have adequate power to employ these tests as definitive analyses. Kaplan-Meier survival analysis found a similar mean survival time for sealants placed by both dentists (5.12 years: 95% CI= 4.84, 5.39) and DCPs (4.42 years: 95% CI= 4.18, 4.65). Cox's proportional hazards models also found the survival time of fissure sealants to be similar for both operator types (p=0.11). With caries transformation as the outcome, survival times were also found to be similar for dentists and DCPs.

Folke *et al.,* (2004) investigated the caries preventive effect of fissure sealants placed by DCPs and dentists in the USA, in a single private practice. Their data were also evaluated by survival analyses methods and reported a mean survival time of five years. Although Folke's results are comparable with those from our study, it should be noted that data were only collected from a single private practice and may not be applicable to all settings.

A second objective of the present study was to be able to calculate a sample size for a future randomised controlled trial on the effectives of fissure sealants by different operator groups. The method for sample size calculation is the one used for negative trials, as this type of trial is interested in demonstrating equivalence results between two types of operator (Pocock, 1983). On the basis of our data, sampling 20 fissure sealants for each of 76 operators (dentists and DCPs) would lend a 95% confidence interval to detect a difference of the magnitude seen in this study with an alpha of p<0.05. However, the use of a split mouth design, where the dentist places sealants on one side of the patient's mouth and the DCP treats the other side, would reduce the required sample number.

The mean dmft at baseline for paediatric patients seen by dentists and DCPs ranged from 4.0-5.1, which suggests high caries experience. Indeed, this was approximately three times higher than the mean dmft (1.49) for an average 5-year-old living in Yorkshire. (Pitts *et al.,* 2007). The mean IMD for the children included in our sample was 32.56, which is close to upper limit of IMD for the overall population resident in Yorkshire (range=5.4-40.11). Both these findings highlight the high level of caries experience and social deprivation demonstrated by children included in the study. Furthermore, they suggest that high-risk children were specifically targeted for fissure sealants by the study participants. This would appear to be an appropriate strategy and is in keeping with the British Society of Paediatric Dentistry policy statement on the selection of children for sealant therapy (Nunn *et al.,* 2000). It is also interesting to note that the mean age of children receiving fissure sealants was seven years, indicating that the primary dental services included in our study were adhering to accepted guidelines for placement of sealants soon after eruption of first permanent molars in high-risk children.

Our study has some acknowledged limitations that are common to all retrospective case note reviews. It is accepted that there may have been insufficient documentation regarding the partial retention of fissure sealants, thus it could not be conclusively determined whether sealants had been completely, or only partially lost, before re-treatment. We therefore defined any documented resealing of an occlusal surface as a failure of the initial sealant. It is possible, however, that some of these resealed surfaces still possessed sufficient sealant to remain effective (Simonsen, 1991) and our study may thus tend to underestimate sealant success.

Another potential inaccuracy stems from the possible disparity between the actual time of sealant failure and the documented detection of the failure. Since patients were not appointed at standard time intervals for the specific purpose of sealant review, sealants may have failed some months before a routine recall. Thus, sealant longevity may have been overestimated. However, this would have been the case for both dentists and DCPs and does not invalidate comparisons between operator types. An alternative approach could have been to calculate the time of sealant failure as the mid-point between the date of the appointment when the sealant was noted to have failed, and the previous appointment. However, as appointment intervals were standardised for all settings and operators, this was not felt to offer no advantage to data analysis, and may have even introduced some bias if there were longer time intervals between appointments for some patient groups.

It should be mentioned that recruitment of study participants was extremely difficult within general dental practice, and there may be a number of reasons for this. Dentists may have had concerns about the time commitment involved in participation, or they may have had underlying worries about what the study may reveal about their clinical competency or record-keeping. Potential barriers to study participation therefore need to be identified and strategies developed to encourage greater participation by general dental practitioners in primary care research.

As a simple case-note review, this study cannot account for all possible confounders that may have had an effect on the overall success of fissure sealants. Thus there is a need for further research, which takes into account potential confounders such as fluoride usage by patients. Following on from this study, we have also undertaken a qualitative enquiry to determine whether there are actually any systematic differences in the case-mix of patients seen by dentists of DCPs for sealant therapy (Nilchian *et a*l., 2009).

Conclusion

This is the first UK study to provide comparative data for the effectiveness of fissure sealants placed by dentists and DCPs in primary care settings. Preliminary data suggest that both operator types have similar success rates in terms of sealant retention and prevention of caries transformation. Future randomised controlled trials may draw on these useful baseline data to help inform their study design.

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