

Retention and Effectiveness of Dental Sealant After Twelve Months in Iranian Children

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Background: Pit-and-fissure sealants are safe and effective ways to prevent dental caries and are considered as a part of an overall caries-preventive strategy. Dental caries are a public health problem and the most common intraoral disease affecting mankind. It is an infectious transmissible disease, with the child patient being at the highest risk.

Objectives: The purpose of this study was to evaluate the retention rates and effectiveness of occlusal sealants in children in Hamadan, Iran.

Materials and Methods: A total of 118 sealed first permanent molar teeth in 52 students (mean age, 8 years; male, 48%) were evaluated for fissure sealant retention and occlusal caries status. All teeth were examined 12 months after application of sealants. Data were collected and evaluated by survival analyses methods for age at placement, patient sex, decayed/missing/filled teeth (DMFT) index, fluoride history, toothbrush, tooth position in arch, and refer to dentistry.

Results: The overall success rate with pit-and-fissure sealant was 68.6%; in addition, 38.9% of the seals were completely retained, 38.9% partially lost, and 10.2% completely lost. There were no signs of carious lesions in 69.6% of the teeth. The factors associated with an increased risk of failure included female sex ($P = 0.001$) and no history of fluoride use ($P < 0.01$). There were no significant association between the results and patient age, tooth position in the arch, DMFT index, toothbrush, and refer to dentistry.

Conclusions: Although pit-and-fissure sealants are effective methods for preventing tooth caries, the low success rate of fissure sealants in current study indicated that dental sealant need to be implemented more carefully and follow-up programs are advisable.

Keywords: Pit and Fissure Sealants; Retention; Dental Sealants

1. Background

Dental caries are a public health problem and the most common intraoral disease affecting mankind. It is an infectious transmissible disease with children being at the highest risk (1). Over recent decades, the field of dentistry has shown outstanding scientific advances in restorative materials and innovative prevention techniques, but dental caries remains a highly prevalent pathology worldwide. Although fluorides are highly effective in preventing caries on smooth surfaces, they are not equally effective in protecting occlusal surfaces. One reason might be "the morphology of occlusal pits and fissures that makes mechanical cleaning difficult and facilitates the retention of bacteria, nutrients, and debris". Therefore, a specific barrier between the tooth surface and the oral environment is needed to avoid the development of caries (2, 3). Young permanent molars have been shown to be at an increased risk for caries because of the complex nature of their occlusal surface

morphology. In children aged five to 17, 56% to 70% of all dental lesions are occlusal caries (4).

Primary prevention can reduce this risk of developing caries. One of the most appropriate and cost-effective treatments for the preventing occlusal caries in high-risk children and adolescents is the application of pit-and-fissure sealants (PFS). In the present area of preventive dentistry, the main means available for primary prevention are plaque control, use of systemic or local fluoride, and PFS (1). Preventive strategies including PFS have significantly contributed to decreased caries on sealed occlusal surfaces. The most recent national surveys on caries incidence and prevalence in children and adolescent groups have shown dramatic reductions in dental caries (5-7). PFS were introduced in the 1960s as an effective caries prevention method and have shown high retention rates (8). A variety of PFS with different qualities are available. Preventive capability of PFS is related to their abil-

ity to block the pit and fissures on the tooth surface. This will prevent penetration of fermentable carbohydrates, which can be used by the bacteria remaining on the fissures, as well as colonized by new bacteria. It is assumed that the residual bacteria in biofilm that remain in the fissure after thorough cleaning, do not survive under a properly applied PFS or cannot multiply if they survive (9). A correlation has been found between PFS retention and anti-cariogenic effectiveness; although caries is completely prevented when fissures remain sealed, PFS retention rates decline to 85% after one year and to 50% after five years (10). PFS retention depends on the procedure used for the fissure preparation. The long-term clinical success of PFS is closely related to their proper handling. Mechanical preparation has been suggested to provide better access to the deeper fissure areas, which enables removal of debris, deeper PFS penetration, and improved retention. Although various methods of mechanical preparation have been proposed, no optimal preparation procedure has been established. This can be attributed to the scarcity of in vitro quantitative studies, which compare various PFS preparation methods. A dry enamel surface is necessary to achieve good adhesion. It is not easy to apply rubber dam in children without anesthesia; in addition, cotton-roll isolation requires four-handed dentistry. In these conditions, contamination during swallowing and tongue movement is still possible. The passage of bacteria, fluids, molecules, and ions between the teeth and the sealing material is considered to be the main reason for caries, pulpitis, and necrosis. Therefore, the retention rate becomes a determinant of their effectiveness as a caries prevention measure. On the other hand, a partial loss of the PFS material inherently leads into caries development underneath the PFS (9, 11). A PFS is rarely retained completely over the tooth lifetime and must be reapplied. The retention rates of PFS materials after one year was reported at a rate of 74% to 96% (12) and 79% to 92% (13). Dental caries affects populations of all ages in all the regions of the world, with children being at the highest risk. PFS have shown excellent efficacy in preventing occlusal caries in children; however, there are only few studies regarding evaluation of the retention and caries prevention efficacy on pits and fissures in children population of Iran (14, 15).

2. Objectives

The aim of this study was to evaluate the retention rate and caries-prevention effect of PFS and also to test the influence of clinical and oral hygiene status variable on caries incidence in children population after one year of follow-up in Iran.

3. Materials and Methods

The research protocol was approved by the ethics committee of the School of Dentistry, Hamadan University of Medical Sciences. Following coordination with the Department of Pediatric Dentistry and achieving per-

mission to access to the records of patients who were referred to School of Dentistry in 2012, children who had received PFS in the four permanent first molars were determined. At baseline, 130 children were identified for the study. After one year, the subjects were invited for evaluation by telephone call. Healthy children who aged six to nine years and had received an application of PFS in the four permanent first molars were included children in the study. Children with medical problems such as cardiac diseases and diabetes and evidence of substantial neurologic, psychiatric, or any systemic diseases were excluded. Between November and December 2013, 78 children met our inclusion criteria. After recall, 52 patients with a mean age of eight years (range, 7-11) 12 months after the PFS application (118 PFS; 117 upper molars and 103 lower molars) presented for evaluation. Some patients were lost to follow-up due to change of address or unwillingness to return for evaluation. Written informed consents were obtained from the parents or guardians of all children. Evaluations were made by a dentist who had previously been trained in using WHO caries criteria and recognizing PFS retention by using a mirror and probe and was blinded to the study. The children were treated and examined in the same dental clinic. The same etchant and PFS material had been applied for all children during that period of time. The PFS were evaluated in terms of retention and the presence of caries as follows: full retention, the materials were fully present on the occlusal surfaces; partially lost, the materials were present but part of a previously sealed pit, fissure, or both was exposed as a result of either wear or loss of the material; totally lost, no trace of materials was detected on the surface; and presence of caries, caries lesions were evaluated according to the Caries Associated with Restorations and PFS scores of the ICDAS-II visual classification criteria (9). Only two situations were considered for the outcome analysis: caries prevention (success) was recorded when the PFS completely or partially covered the pits and fissures and the tooth was sound; and caries (failure) was recorded when the PFS was completely or partially lost and the tooth was carious (cavitated lesion). Ethically, in the event of failure, the fissures were resealed on elimination of the sample. Moreover, data such as application of fluoride gel, dental treatment, decayed/missing/filled teeth (DMFT), tooth position, and oral hygiene were recorded in a checklist. The collected data were entered into an Excel spreadsheet and then exported to SPSS version 15 (SPSS Inc, Chicago, IL, USA) for analyses. Descriptive analysis was performed to describe the study sample using frequencies for categorical and continuous variables (gender, completely retained PFS, complete or partial PFS retention, caries prevented, caries, tooth status, and arch). Pearson's chi-square was used for statistical analysis and a P value < 0.05 was considered as significant level.

4. Results

In total, 118 sealed teeth (57 mandibular and 61 max-

illary) were available. Twenty-six patients were lost to recall at 12 months. A successful recall rate of 66.6% was achieved at the end of the one-year follow-up. Table 1 shows the distribution of permanent teeth, surfaces, and retention status of PFS.

The mean age of the treated patients was eight years (SD: 1.602) and 48% of the patients were males. After one year, the overall results for sealant retention were as follows:

38.9% of surfaces, completely retained PFS; 38.2%, partially lost PFS; and 22.9%, completely lost PFS (Table 2). There were no statistically significant association between the results and age ($P = 0.242$), DMFT index ($P = 0.586$), tooth position ($P = 0.409$), toothbrush ($P = 0.730$), and refer to dentistry ($P = 0.371$). The only statistically significant association was seen between results and sex ($P = 0.001$) and fluoride mouth rinse ($P = 0.10$).

Table 1. Distribution of Permanent Teeth and Surfaces and Retention Status of Pit-and-Fissure Sealants ^{a,b}

| Distribution | Fully Retained Without Carries | Partially Lost Without Carries | Partially Lost With Carries | Totally Lost Without Caries | Totally Lost With Carries | Total |
|-----------------------------------|--------------------------------|--------------------------------|-----------------------------|-----------------------------|---------------------------|-------|
| Sex | | | | | | |
| Male | 27 | 18 | 4 | 1 | 11 | 61 |
| Female | 19 | 17 | 6 | 1 | 14 | 57 |
| Age Groups | | | | | | |
| <8 years | 12 | 9 | 5 | 1 | 6 | 33 |
| 8-10 years | 23 | 18 | 3 | 0 | 11 | 55 |
| >10 years | 11 | 8 | 2 | 1 | 8 | 30 |
| Mean DMFT | | | | | | |
| Primary Tooth | 3.7 | 4.1 | 3.8 | 3 | 4.1 | 18.7 |
| Permanent Tooth | 2.6 | 2.8 | 3.2 | 5 | 3.0 | 16.6 |
| Tooth Position in the Arch | | | | | | |
| Maxillary | 22 | 19 | 6 | 2 | 12 | 61 |
| Mandibular | 24 | 16 | 4 | 0 | 13 | 57 |
| Toothbrush | | | | | | |
| Irregular | 20 | 17 | 4 | 1 | 8 | 50 |
| Once | 16 | 10 | 3 | 1 | 9 | 39 |
| Twice and more regular | 10 | 8 | 3 | 0 | 8 | 29 |
| Refer to Dentistry | | | | | | |
| Yes | 6 | 4 | 2 | 0 | 4 | 16 |
| No | 40 | 31 | 8 | 2 | 21 | 102 |
| Fluoride Mouth Rinse | | | | | | |
| Yes | 16 | 10 | 4 | 1 | 3 | 34 |
| No | 30 | 25 | 6 | 1 | 22 | 84 |

^a Abbreviation: DMFT, Decayed/missing/filled teeth.

^b Data are presented as %.

Table 2. Pit-and-Fissure Sealant Retention After Twelve Months in Fifty-Two Children ^a

| Fissure Sealant Status | Number of Patient's Teeth | Results |
|--------------------------------|---------------------------|---------|
| Success | | |
| Fully Retained Without Carries | 46 | 38.9 |
| Partially Lost Without Carries | 35 | 29.7 |
| Failure | | |
| Partially Lost With Carries | 25 | 21.2 |
| Totally Lost With Carries | 10 | 8.5 |
| Totally Lost Without Caries | 2 | 1.7 |
| Total | 118 | 100 |

^a Data are presented as %.

5. Discussion

Rapid development and modernization in the Middle East countries has led to changes in lifestyle and diet that might have an effect on oral health. Poor oral health profoundly affects a person's quality of life. The dental healthcare system in Iran is an integrated public health system with a four-level dental healthcare system from basic oral healthcare services in rural health houses and health centers to advanced treatments at university health centers in the bigger cities. There is one dentist for each 5500 population in Iran (16). The oral health status of children is determined by the prevalence of dental caries and an assessment of periodontal health status. An Iranian oral health survey by including the age groups of three, six, and nine-year-old children illustrated high prevalence of dental caries (17). Reasons for this high prevalence in Iranian schoolchildren include the frequent sugar intake between meals, unhealthy snacks, high intake of fast food, and the custom of offering sugary foods as an expression of hospitality. Unfortunately, there is no published data on oral hygiene practices in six- to nine-year-old children in Iran. The PFS were introduced to eliminate the geometry that harbors bacteria and to prevent nutrients reaching bacteria in the base of the pits or fissures through recognizing the vulnerability of occlusal surface. The primary clinical property of PFS that affects the sealing in narrow, deep, occlusal fissures is its flowability as the penetration pertains to viscosity (11, 12).

Studies regarding the effectiveness of PFS applied by the public dental service is limited (15). In current study, the overall success rate of PFS therapy after one year was 68.16% while the rate of complete PFS retention was 38.9%. Regular evaluation of PFS for retention is critical to achieve successful results, which we did not observe in our patients. During routine recall examinations, it is necessary to re-evaluate the sealed tooth surface both visually and tactually for loss of material, exposure of voids in the material, and caries development. The need for PFS reapplication is usually highest during the first six months after placement (9, 11). When PFS are partially lost and require repair, the dentist should vigorously attempt to dislodge the remaining PFS material with an explorer. If it remains intact to probing, there is no need to completely remove the old material before placing the new one. The dentist can simply follow the usual PFS steps as outlined above, etching both the enamel and the remaining PFS and then applying additional PFS. Success rate for occlusal PFS in this study were different from those reported in previous clinical trials. Each study was done under different circumstances, on different age groups, and with diverse and sometimes unknown variables; hence, comparisons should be made with caution. One of the major problems when considering the success rates of PFS restorations is the variation in techniques and used materials. The PFS should be visually and tactually inspected for complete coverage and absence of voids or bubbles (18).

In contrast to our finding, short-term studies indicated a high rate of success in PFS restorations (19, 20). To compare PFS restoration studies, it is necessary to define success as 100% retention and no present caries in the tooth. In a noteworthy study by Welbury et al. (21), 26% of the PFS restorations were fully retained and caries free while only 2% of the restorations failed because of restoration-associated caries. Memarpour et al. (14) in a 1.5-year study demonstrated that 54.1% of PFS restorations had successful outcome. According to a study conducted in Meath (22), approximately two years after application, PFS retention rates were as follows: 56% completely retained, 27% partly retained, and 12% missing; these rates were comparable with international studies. Marginal discoloration of a restoration was considered as carious and failure, which might be a reasons for current low rate of success in PFS retention. Other possible reasons for these failures included poor oral hygiene and suboptimal fluoridation. PFS were completely missed in 10.2% of the examined teeth. These were probably technique failures that occurred soon after placement. PFS are not expected to completely wear away in such a short period of time. In current study, a high rate of success in PFS restorations was observed in boys in comparison with girls ($P = 0.001$). In Memarpour et al. (14) study, there was no significant association between the results and patients' sex. In present study, the combination of PFS and fluoride rinsing programs significantly reduces the incidence and prevalence of fissure, PFS failure, and smooth surface caries in schoolchildren. A longitudinal study compared the effect of fluoride rinsing alone with PFS application in combination with fluoride rinsing in caries-free second- and third-grade schoolchildren. After a two-year period, 78% of the children in the fluoride rinse group were cariesfree. In comparison, 96% of children receiving the benefits of both fluoride rinsing and PFS placement were cariesfree. The caries incidence in the fluoride rinse group was 13-time greater than that of the combined fluoride-PFS group (23). The better retention of maxillary in comparison to mandibular teeth was confirmed by Burt et al. (24); however, we found no difference in that regard. In addition, there were no significant association between the results and patient age, DMFT index, toothbrush, or refer to dentistry. In previous study, it was shown that higher DMFT index was associated with higher risk of PFS failure (25). In current study, DMFT index was high, which was associated with poor oral hygiene among Iranian children; however, there was no significant association between high DMFT index and PFS success rate. More than 70% of Iranian children in the present study had MDFT index of more than two. In a developing country like Iran, the preventive measures toward oral health are imperative. Even if the initial cost of preventive measures likes PFS are higher than the cost of restorative materials, PFS or any other preventive measure would be more cost-effective in the long term. Although PFS is an effective method for preventing tooth caries, the results of current study indicated that oral health programs need to

be implemented more carefully and follow-up programs are advisable. Finally, PFS is recommended for caries prevention, along with good oral hygiene, optimal fluoridation, and healthy dietary habits.

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Authors Contributions

All authors participated in the preparation of the manuscript. Rezvan Rafatjou developed the original idea. Shokoufeh Nobahar and Mahshad Nikfar abstracted and analyzed data and wrote the manuscript.

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