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Original Article

Clinical Evaluation of Pit-and-Fissure Sealant Retention and Caries Incidence Among Children Aged 8–12 Years in Najaf, Iraq

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Abstract

Background: Pit and fissure sealants are used for the prevention of occlusal caries in permanent teeth. Clinical efficacy of the sealants depends largely on the retention of the material. **Objective:** This study was conducted to evaluate the retention of the sealant after six months of application and the incidence of new caries among the permanent premolars and molars of children aged 8-12 years in Najaf, Iraq. **Materials and Methods:** This prospective longitudinal clinical study included 119 sound permanent premolars and molars in 64 children aged 8-12 years that were treated by sealing with a light-cured resin sealant after 37% phosphoric acid etching and followed up six months later. The retention rate was calculated based on Simonsen's criteria, while any new carious lesion was recorded. The individual tooth was considered as the statistical unit, and relationships were tested by the Fisher-Freeman-Halton exact test. **Results:** At the six months follow up, (119) permanent teeth were evaluated for sealant retention and caries incidence. Complete sealant retention was observed in 94 teeth (79.0%), partial retention in 21 teeth (17.6%), and complete sealant loss in 4 teeth (3.4%). New caries lesions were detected in 4 teeth (3.4%), which were all found in teeth that had completely lost their sealants, and this association was statistically significant ($p < 0.001$). Complete sealant retention was more likely to be seen in maxillary than mandibular teeth (85.1% vs. 68.9%; $p = 0.013$) and in premolars than in molars (86.7% vs. 61.1%; $p < 0.001$) without any significant relation to age ($p = 1.000$) and gender ($p = 0.342$).

Conclusion: The six-month retention of the sealant material used was quite good, with the incidence of caries being seen only in those teeth from which the sealant had been lost.

Keywords: fissure sealants; dental caries; retention of sealants; permanent teeth; children.

1. Introduction

Dental caries continues to be one of the most common chronic diseases among children and is viewed as a serious public health problem [1,2]. According to WHO, untreated dental caries in permanent teeth is a problem for billions of people around the world, with children being especially vulnerable to it owing to poor nutrition, inadequate oral hygiene, and lack of preventive dental services [3]. The occlusal surfaces of permanent molars are highly susceptible to caries due to their complicated anatomical structure that includes deep pits and fissures [4]. Pits and fissures provide the ideal conditions for plaque formation and bacterial colonization, while limiting the ability to self-cleanse with saliva and tooth brushing [5]. Despite

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the fact that the occlusal surfaces occupy a small proportion of the whole tooth area, they are responsible for the vast majority of the carious lesions in children and adolescents. The prevention of caries in these susceptible surfaces represents a key priority in modern pediatric preventive dentistry. [5,6]

Sealants are considered among the most efficient methods of prevention for occlusal caries. Sealants work as a physical barrier that closes the pits and fissures, thus preventing bacterial colonization and nutrient access. Being invented in the 1960s, sealants have gained extensive usage since then [7]. After the protective properties of sealants were discovered, a range of sealant materials was created, such as those based on resins, glass ionomers, and polyacid-modified resin composites [4]. Many scientific studies have found that resin sealants are able to decrease the risk of developing occlusal caries by more than 70 percent during the first two years after placement and provide a protective effect in case of material retention [5,8]. Efficacy of sealant treatment is closely connected with proper clinical technique, moisture control, etching of enamel, and long-lasting material retention [5].

Retention of sealants is a key factor in determining their effectiveness. Total retention of sealants is generally considered as the most definitive indicator of sealant success due to the fact that failure of retention of sealants means that the tooth will be exposed to biofilm attack. Factors that influence sealant retention include tooth eruption status, patient compliance, operator skills, isolation, material properties, and the clinical environment [9,10]. Recent scientific data continue to emphasize that clinical technique remains one of the best predictors of sealant retention regardless of the type of sealant used [9-11]. It is therefore imperative to assess sealant retention in the clinical setting since sealants have proven to be effective in the prevention of dental caries if retained [12].

Dental caries is still very common among children in Iraqi schools even though there is rising knowledge about preventive dentistry; nevertheless, there is a lack of local clinical studies about the retention of the sealants in the pits and fissures of the teeth and the incidence of caries in the sealed teeth. Therefore, the purpose of this study was to conduct a clinical evaluation of the retention and caries incidence in the pit and fissure sealants used in the permanent molars and premolars of 8- to 12-year-old children in Najaf city, Iraq.

2. Materials and Methods

Study Design

This prospective longitudinal clinical study was conducted at the Dental Clinic of the Department of Pediatric and Preventive Dentistry, College of Dentistry, University of Kufa, Najaf, Iraq. Pit and fissure sealants were applied in October 2025, and participants were followed up after six months, in April 2026. The purpose and procedures of the study were explained to each parent or legal guardian, and written informed consent was obtained from them, along with assent from each child. Participation was entirely voluntary, and refusal to participate had no effect on the dental care provided.

Study Population and Eligibility Criteria

The participants for this study consisted of 64 children who were between 8 and 12 years old. Out of these children, 119 premolars and molars were selected for this study. The selection criteria included fully erupted teeth, sound teeth, unrestored teeth, deep and retentive pits and fissures, and teeth without any history of having been sealed. Teeth with clinically detectable caries or cavitation were excluded. Children whose parents or legal guardians did not provide informed consent were also excluded.

Baseline Examination and Preventive Measures

Caries baseline was measured according to the DMFT index (decayed, missing, and filled teeth) and DMFS index (decayed, missing, and filled surfaces), following the World Health Organization (WHO) guidelines [13]. Before sealants were applied, the

patients underwent dental health education and prophylaxis.

Sealant Application Procedure

Selected occlusal surfaces were cleansed and polished, followed by isolation with cotton rolls. The enamel surfaces were etched with 37% phosphoric acid gel (Super Etch, SDI Limited, Bayswater, Victoria, Australia) for 30 seconds as per the manufacturer's guidelines. After etching, the surfaces were rinsed with water for 10-20 seconds and dried with an air syringe. An adhesive bonding agent was not used. Light cured resin-based pits and fissures sealants (Nexobio Co., Ltd., Heungdeok-gu, Cheongju-si, South Korea) were placed on the etched pits and fissures as per the manufacturer's recommendations. Evaluation of occlusion was done with the help of articulating paper, and premature contacts were corrected using composite finishing burs.

Six-Month Follow-up and Outcome Assessment

Six months following the placement of the sealants, all teeth treated with sealants were re-examined clinically. Retention of sealants was based on the criteria set out by Simonsen [14], which include complete retention (score 0), partial loss (score 1), and complete loss (score 2) of the sealants. These criteria have been used in previous research for evaluating retention of sealants [15,16]. The primary outcome was the retention of sealants after six months. The secondary outcome was the incidence of new caries, defined as the occurrence of new carious lesions, identified at the six-month follow-up examination, in teeth that were sound at baseline. Baseline status was determined from the baseline clinical records, including DMFT/DMFS scores.

Statistical Analysis

Data were entered in Microsoft Excel 2013 and analyzed using SPSS 23 (IBM Corp., Armonk, NY, USA). The tooth was the unit of analysis for calculating the frequency and percentage of different types of teeth, whereas the child was the unit of analysis for calculating the mean and standard deviation for DMFT and DMFS scores of individual children. The association between sealant retention and jaw (maxillary vs. mandibular), type of tooth, age group of the child (8-10 years vs. 11-12 years), and gender was tested using Fisher-Freeman-Halton exact test. This test was also used to test the association of sealant retention in a child's mouth and caries incidence. A P-value < 0.05 was considered statistically significant.

3. Result

Table 1 presents the demographic features of the subjects. The total number of children involved in the study was 64, out of which 48 were boys (75.0%) and 16 were girls (25.0%). The majority of the children were boys, and the majority of them belonged to the older age group of 11-12 years (79.7%).

Table 2 provides information on the demographic profile of the teeth that have been assessed. Every tooth was taken into consideration as an individual sampling unit, thus leading to the conclusion that a total of 119 teeth collected from 64 children were used for the final analysis. It was found that the largest number of teeth examined were from boys (73.9%) and from children who were between 11-12 years old (80.7%). In relation to their location in the arch, 62.2% were located in the Maxillary arch while 37.8% were located in the Mandibular arch. In terms of tooth type, second premolars represented the highest proportion (35.3%), followed by first premolars (34.5%), first molars (20.2%), and second molars (10.1%).

Table 3 presents retention rates for sealants and caries presence or absence six months post-application. Most sealants have been completely retained (79.0%). The other sealants have shown partial retention and complete loss in 17.6% and 3.4% of teeth, respectively. Generally, 96.6% (N = 115) of examined teeth were found to be caries-free, whereas only 3.4% (N = 4) of teeth had new carious lesions.

Table 1. Demographic characteristics of the participants (N=64)

Variable	Category	N	%
Gender	Boys	48	75.0
	Girls	16	25.0
Age (years)	8–10	13	20.3
	11–12	51	79.7

Table 2. Demographic characteristics of the included teeth (N=119)

Variable	Category	N	%
Gender	Boys	88	73.9
	Girls	31	26.1
Age (years)	8–10	23	19.3
	11–12	96	80.7
Arch	Maxillary	74	62.2
	Mandibular	45	37.8
Tooth type	First premolar	41	34.5
	Second premolar	42	35.3
	First molar	24	20.2
	Second molar	12	10.1

Table 3. Condition of the sealed teeth at six-month follow-up (N=119)

Outcome	Category	N	%
Sealant retention	Complete retention	94	79.0
	Partial retention	21	17.6
	Complete loss	4	3.4
Caries status	Caries-free	115	96.6
	Caries present	4	3.4

Table 4 illustrates the association between sealant retention and the incidence of dental caries six months post-application. There was a statistically significant association between retention status and incidence of caries ($p < 0.001$). No dental carious lesions were noted on the teeth with complete/partial sealant retention (0.0%), while all four new carious lesions were seen only in the completely lost sealants (100.0%).

Table 5 presents descriptive statistics for the DMFT and DMFS indices in the subjects of the study (N=64). The mean value for the DMFT index is (1.98) with (SD = ±1.11). The mean value for the DMFS index is (3.95) with (SD = ±2.29). There is strongly and positively correlation was observed between DMFT and DMFS (Spearman p =0.805, P <0.001).

The results for the distribution of sealant retention according to jaw location are shown in Table 6. Of the 74 maxillary teeth that had been sealed, 63 (85.1%) were completely retained, 11 (14.9%) were partially retained, and 0 (0.0%) were completely lost. On the other hand, out of the 45 mandibular teeth that had been sealed, 31 (68.9%) were

completely retained, 10 (22.2%) were partially retained, and 4 (8.9%) were completely lost. A statistically significant association was observed between sealant retention status and jaw location (P = 0.013).

Sealant retention by type of tooth is shown in Table 7 after six months. Of the 83 premolars that received sealants, 72 (86.8%) had complete retained, 7 (8.4%) had partial retained, and 4 (4.8%) were completely loss. On the other hand, out of the 36 molars that had sealants, 22 (61.1%) had complete retention, 14 (38.9%) had partial retention, and none (0.0%) had complete loss of sealants. There was a statistically significant relationship between tooth type and sealant retention (p = 0.003).

Retention status of sealants according to the demographic variables (age and gender) is provided in Table 8 for the 6-month follow-up period. For 23 teeth belonging to children aged 8-10 years, 19 (82.6%) showed complete retention, 4 (17.4%) showed partial retention, and 0 (0.0%) showed complete loss. In addition, for 96 teeth belonging to children aged 11-12 years, 75 (78.1%) showed complete retention, 17 (17.7%) showed partial retention, and 4 (4.2%) showed complete loss. In relation to gender, among 89 teeth belonging to boys, 68 (76.4%) showed complete retention, 18 (20.2%) showed partial retention, and 3 (3.4%) showed complete loss, while for 30 teeth belonging to girls, 26 (86.7%) showed complete retention, 3 (10.0%) showed partial retention, and 1 (3.3%) showed complete loss. No statistically significant association between retention status of sealants and age/gender was found (p > 0.05).

Table 4. Relationship of retention with caries development after six months (N = 119).

Retention status	**Total N**	**Caries-free, n (%)**	**Caries present, n (%)**	**p-value**
Complete retention	94	94 (100.0)	0 (0.0)	<0.001*(HS)
Partial retention	21	21 (100.0)	0 (0.0)	
Complete loss	4	0 (0.0)	4 (100.0)	
Total	119	115 (96.6%)	4 (3.4%)	

Fisher- Freeman –Halton exact test was used; HS: highly significant (P <0.001)

Table 5. Descriptive statistics of DMFT and DMFS scores of the participants (N=64)

Variables	Maximum	Minimum	Mean	±S.D.
DMFT	4	0	1.98	1.11
DMFS	8	0	3.95	2.29

Spearman's rank correlation coefficient: ρ = 0.805, P <0.001 Highly significant)

Table 6. Retention of sealants according to jaw position after six months (N = 119).

Arch	**Complete retention, n (%)**	**Partial retention, n (%)**	**Complete loss, n (%)**	**Total**	**p-value**
Maxillary	63 (85.1)	11 (14.9)	0 (0.0)	74	0.013*(S)
Mandibular	31 (68.9)	10 (22.2)	4 (8.9)	45	
Total	**94 (79.0)**	**21 (17.6)**	**4 (3.4)**	**119**	

The Fisher-Freeman-Halton exact test was used, with significance being accepted when (P < 0.05.)

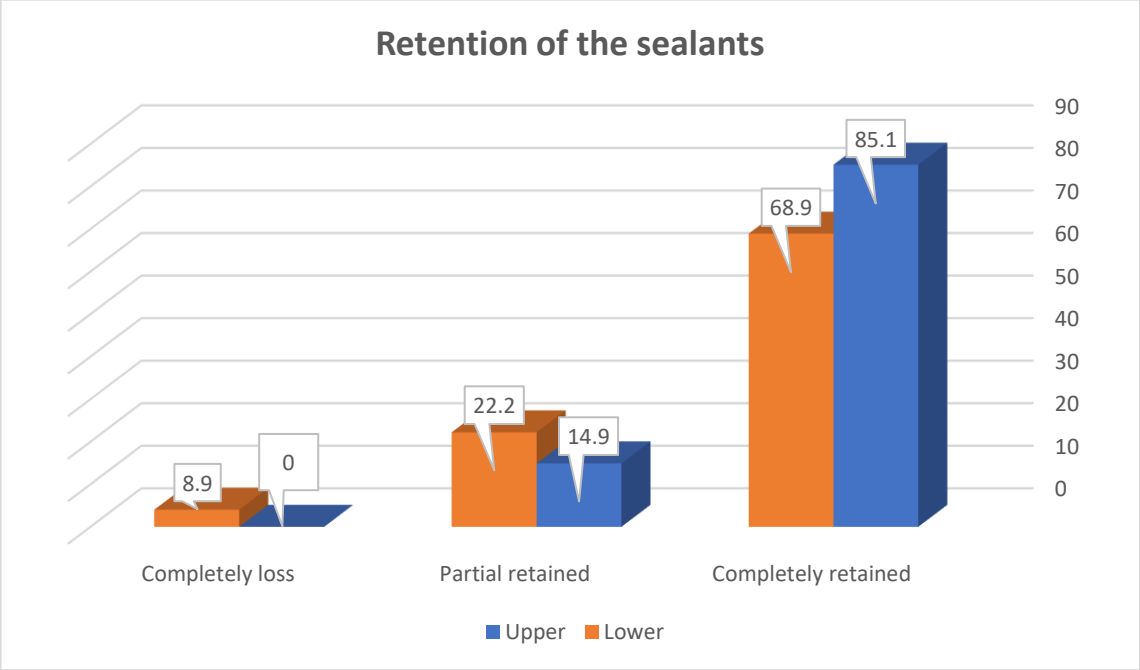


Figure 1. Distribution of sealant retention according to jaw location after 6 months

Table 7. Sealant Retention According to Tooth Type at Six Months Follow-Up Visit (N=119).

Tooth type	Complete retention, n (%)	Partial retention, n (%)	Complete loss, n (%)	Total	p-value
Premolars	72 (86.8)	7 (8.4)	4 (4.8)	83	0.0003* (S)
Molars	22 (61.1)	14 (38.9)	0 (0.0)	36	
Total	**94 (79.0)**	**21 (17.6)**	**4 (3.4)**	**119**	

Fisher-Freeman–Halton exact test was used; S denotes statistically significant ($P < 0.05$).

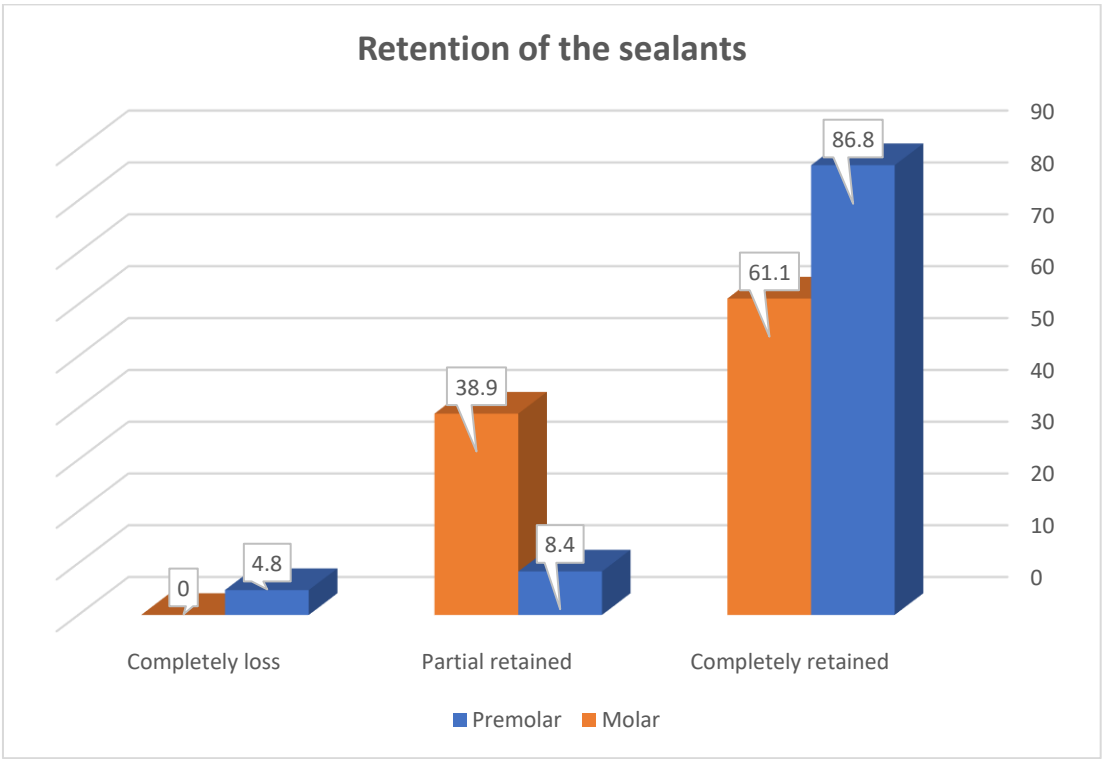


Figure 2. Distribution of sealant retention according to teeth type after six months

Table 8 shows the sealant retention status for different age categories and gender groups.

Variable	Category	Complete retention, n (%)	Partial retention, n (%)	Complete loss, n (%)	Total	p-value
Age	8–10 years	19 (82.6)	4 (17.4)	0 (0.0)	23	1.000*
	11–12 years	75 (78.1)	17 (17.7)	4 (4.2)	96	
Gender	Boys	67 (76.1)	18 (20.5)	3 (3.4)	88	0.342*
	Girls	27 (87.1)	3 (9.7)	1 (3.2)	31	

Fisher-Freeman-Halton exact test.

4. Discussion

Age distribution among the participants of the study shows that most of the participants were in the age group of 11-12 years (79.7%), and 20.3% were in the age group of 8-10 years. The above distribution highlights the fact that the sample population consisted mostly of children from an older age group. Participation of children in these age groups is very important in the clinical assessment of pit and fissure sealants because the teeth develop during this age, making it a critical window for preventive dental care [17].

The cumulative success rate of pit and fissure sealants after six months of follow-up was 79.0%, showing that the majority of sealants were intact. The above finding is reinforced by the finding that 96.6% of the teeth examined did not have caries, and only four teeth had caries after the follow-up period. The teeth with partial loss of sealants did not have carious lesions. The above protection might have been due to the short follow-up period, retention of resin tags in the deep microporosity of fissures, and factors like oral hygiene and diet that affect caries initiation and development [18]. The above findings correspond to those presented in [19].

In addition, the low-viscosity, fluoride-releasing resin sealant used in this study is thought to be another reason for the decrease in the incidence of caries in this study because of the good flow characteristics of the resin sealants, which allow deep penetration into the microporosity of pits and fissures [20].

Partial retention was found in 17.6% of the tested teeth. While partial removal may impair the sealant as an effective barrier, it can still act as a protective agent on its own by covering the deep areas of fissures. Still, partial retention of sealants should be periodically monitored since progressive material loss increases the likelihood of plaque accumulation and caries [21, 22].

Complete removal of sealants was seen in just 3.4% of the teeth in six months' time. This percentage shows that the sealants demonstrate sufficient clinical effectiveness due to correct selection of teeth, proper moisture control, and adherence to procedures of application. Several systematic reviews list operator skill, isolation technique, enamel conditioning, and inherent material characteristics as the main factors determining sealant retention and durability [23, 24]. Improper isolation leads to saliva contamination and impairs formation of resin tags, thus significantly reducing mechanical bond strength [20].

Statistical significance was found in regard to sealant retention in terms of differences between maxillary and mandibular arches. The rate of complete sealant retention in the maxillary arch was much higher (85.1%) compared to the rates of partial retention (14.9%) and no retention (0.0%), whereas

the mandibular arch had lower complete retention (68.9%), higher partial retention (22.2%), and higher complete loss (8.9%). The findings revealed that the jaw quadrant affects sealant retention. The factors influencing higher retention of sealants in the maxillary arch include differences in anatomy and function. For example, there are fewer direct occlusal forces affecting the teeth in the maxillary arch, and the fissure system is simpler. At the same time, the mandibular arch has more complex fissures and is exposed to more occlusal pressure. Besides, the problem of moisture control is higher in the mandibular arch due to the presence of major salivary gland ducts [25].

These results agree with previous studies [25]. However, they differ from those of [23, 26], where no differences in retention were found between upper and lower teeth. Such variations could be caused by differences in design, subject population, composition of the sealant, skillfulness of the operator, as well as testing time periods. Regardless of that, maintaining careful moisture control is an absolute necessity for achieving maximum retention (27,28).

As for the type of tooth, premolars retained sealants better than molars ($p < 0.05$). The increased retention in premolars can be explained by the simple morphology of the occlusal surfaces of this tooth type; their shallow fissures make it easier for sealants to penetrate fully. In comparison with premolars, molars have a deeper and more complicated pit-and-fissure pattern; they receive larger occlusal forces and emerge earlier, thus receiving more functional stress (29,30). In the current study, the number of premolars was higher because the molars frequently presented with pre-existing caries, making this tooth type less suitable for sealant application among children of this age (11–12 years old). A similar situation was noted by (22, 31); however, other authors have found the opposite (27).

A strong positive relationship was found to exist between DMFS and DMFT indices consistent with recent epidemiological findings (32,33).

5. Conclusion

The resin sealant showed adequate retention on the permanent premolar and molar teeth among school-going children from Najaf. In total, 79.0% of sealants were retained perfectly, while 96.6% were retained either completely or partially, and the occurrence of new decay cases only took place on those teeth whose sealant was totally lost. Resin sealant retention was significantly higher in the maxilla and premolars, while there was no association found between age and gender and sealant retention. This shows that resin sealants can be used for sound permanent posterior teeth through a recall system, as long as strict isolation is necessary in the mandibular arch and partially retained sealants are constantly monitored.

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